GCSE GEOGRAPHY

Living with the physical environment

UNIT 1 – The challenge of natural environments

YEAR 9 2018-21

Student Name: ____

Class: ___________

Key Ideas

Natural hazards pose major risks to people and property
Earthquakes and volcanic eruptions are the result of physical processes
The effects of, and responses to, a tectonic hazard vary between areas of contrasting levels of wealth.
Global atmospheric circulation helps to determine patters of weather and climate
Tropical storms (hurricanes, cyclones, typhoons) develop as a result of particular physical conditions
Tropical storms have significant impacts on people and the environment
The UK is affected by a number of weather hazards
Extreme weather events in the UK impact on human activity
Climate change is the result of natural and human factors, and has a range of effects
Managing climate change involves both mitigation (reducing causes) and adaptation (responding to change)

Scheme of work

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The specification:

AQA GCSE GEOGRAPHY(8035)

3.1 Living with the physical environment

This unit is concerned with the dynamic nature of physical processes and systems, and human interaction with them in a variety of places and at a range of scales.
The aims of this unit are to develop an understanding of the tectonic, geomorphological, biological and meteorological processes and features in different environments, and the need for management strategies governed by sustainability and consideration of the direct and indirect effects of human interaction with the Earth and the atmosphere.

3.1.1 Section A: The challenge of natural hazards

In this section, students are required to study all the themes.

Natural hazards pose major to people and properties.

- Definition of a natural hazard.
- Types of natural hazard.
- Factors affecting hazard risk.

Earthquakes and volcanic eruptions are the result of physical processes.

- Plate tectonics theory.
- Global distribution of earthquakes and volcanic eruptions and their
- relationship to plate margins.
- Physical processes taking place at different types of plate margin
- (constructive, destructive and conservative) that lead to earthquakes and volcanic activity.
- An example of how urban planning is improving the quality of life for the urban poor.

The effects of, and responses to, a tectonic hazard vary between areas of contrasting levels of wealth .

- Primary and secondary effects of a tectonic hazard.
- Immediate and long-term responses to a tectonic hazard.
- Use named examples to show how the effects and responses to a tectonic hazard vary between two areas of contrasting levels of wealth.
- Management can reduce the effects of a tectonic hazard.

Global atmospheric circulation helps to determine patterns of weather and climate

- General atmospheric circulation model: pressure belts and surface winds.

Tropical storms (hurricanes, cyclones, typhoons) develop as a result of particular physical conditions.

- Global distribution of tropical storms (hurricanes, cyclones and typhoons).
- An understanding of the relationship between tropical storms and general atmospheric circulation.
- Causes of tropical storms and the sequence of their formation and development.
- The structure and features of a tropical storm.
- How climate change might affect the distribution, frequency and intensity of tropical storms.

Tropical storms have significant effects on people and the environment.

- Primary and secondary effects of tropical storms.
- Immediate and long-term responses to tropical storms.
- Use a named example of a tropical storm to show its effects and responses.
- How monitoring, prediction, protection and planning can reduce the effects of tropical storms.

The UK is affected by a number of weather hazards.

- An overview of types of weather hazard experienced in the UK.

Extreme weather events in the UK have impacts on human activity.

An example of a recent extreme weather event in the UK to illustrate:

- causes
- social, economic and environmental impacts
- how management strategies can reduce risk.
- Evidence that weather is becoming more extreme in the UK.

Climate change is the result of natural and human factors, and has a range of effects.

- Evidence for climate change from the beginning of the Quaternary period to the present day.
- Possible causes of climate change:
  • natural factors – orbital changes, volcanic activity and solar output
  • human factors – use of fossil fuels, agriculture and deforestation.
- Overview of the effects of climate change on people and the environment.

Managing climate change involves both mitigation (reducing causes) and adaptation (responding to change).

- Managing climate change:
  • mitigation – alternative energy production, carbon capture, planting trees, international agreements
  • adaptation – change in agricultural systems, managing water

Glossary Chapter 1: Natural Hazards

Key Term	Definition
Atmospheric hazards	natural hazards associated with Earth's atmosphere, such as hurricanes, tornadoes, wind, snow, drought, lightning and rain
Drought	a long, continuous period of dry weather
Earthquake	a sudden or violent movement within the Earth's crust followed by a series of shocks
Fatalities	deaths caused by disasters or accidents
River flood	where river discharge exceeds river channel capacity and water spills

	onto the floodplain
Geological hazards	natural hazards associated with Earth's geological processes, such as volcanoes, landslides, mudflows, avalanches and earthquakes
Hazard risk	the probability or chance that a natural hazard may take place
Landslides	the movement of rock, earth or debris down the slope of a hill
Mudflow	when saturated soil and weak rock flow down a slope
Natural disaster	when a natural event, or hazard, impacts on human activities
Natural hazard	a natural event that a poses a threat to humans and/or property
Poverty	deprivation in well-being, such as lack of access to wealth, food, shelter, water and education
Social impact	the effect of an event on the lives of people or community
Tropical storm (hurricane, cyclone, typhoon)	an area of low pressure with winds moving in a spiral around a calm central point called the eye of the storm – winds are powerful and rainfall is heavy
Tsunami	huge waves caused by earthquakes
Urbanisation	when an increasing percentage of a country's population comes to live in towns and cities
Volcano	a large landform, typically conical in shape, formed by a series of volcanic eruptions over a long period of time

Glossary Chapter 2: Tectonic Hazards

Key Term	Definition
Composite volcanoes	steep-sided volcanoes found at constructive plate margins
Conservative plate margin	two plates sliding alongside each other, in the same or different directions
Constructive (transform) plate margin	tectonic plate margin where rising magma adds new material to plates that are diverging or moving apart
Continental crust	the low density, thick outer layer of Earth which forms our continents
Convection currents	circular movement of heat within Earth which drive the movement of tectonic plates
Destructive plate margin	tectonic plate margin where two plates are converging and oceanic plate is subducted – there could be violent earthquakes and explosive volcanoes
Earthquake	a sudden or violent movement within the Earth's crust followed by a series of shocks

Fold mountains	uplifted land that is crumpled by the collision of two plates
Geophysical measurements	measurements taken at the surface of the Earth to detect changes below, such as detecting changes in gravity as magma rises to the surfaces
Ground deformation	changes in the shape of volcanoes which is closely monitored to predict eruptions
Hot spots	where the Earth's crust is thin so magma is able to break through the surface, forming volcanoes
Hydrology	the study of Earth's water
Immediate responses	reaction of people as the disaster happens and in the immediate aftermath
Landslide	the movement of rock, earth or debris down the slope of a hill
Lava	magma that has erupted from a volcano
Long-term responses	later reactions that occur in the weeks, months and years after the event
Magma	molten rock beneath the Earth's surface
Management strategies	techniques of controlling, responding to, or dealing with an event
Mantle	a hot, dense layer of Earth found between the crust and core
Monitoring	recording physical changes, i.e. detecting heat and shape changes of volcanoes using remote sensing, to help forecast when and where a natural hazard might strike
Oceanic crust	the dense, thin outer layer of Earth that lies underneath the ocean
Disaster planning	actions taken to enable communities to respond to, and recover from, natural disasters
Plate margin	the border between two tectonic plates
Prediction	using historical evidence and monitoring, scientists can make predictions about when and where a hazard may happen
Primary effects	initial impact of a natural event on people and property, caused directly by it, i.e. the buildings collapsing following an earthquake
Protection	actions taken before a hazard strikes to reduce its impact, such as educating people or improving building design
Remote sensing	satellites detect heat and changes to a volcano's shape
Search and rescue	an immediate response to a disaster where people are removed from danger and aid is provided

Secondary effects	after-effects that occur as indirect impacts of a natural event, sometimes on a longer timescale, i.e. fires due to ruptured gas mains, resulting from the ground shaking
Seismicity	the frequency and distribution of earthquakes in a certain area, recorded by seismographs
Shield volcano	broad, flat volcano with non-violent eruptions formed at constructive margins and at ‘hot spots’
Subduction	at a destructive margin, where the denser oceanic plate moves beneath the less dense continental plate
Tectonic hazard	natural hazard caused by the movement of tectonic plates (i.e. volcanoes and earthquakes)
Tectonic plate	section of the Earth’s crust about 100km thick
Tsunami	huge waves caused by earthquakes
Volcanic belt	distribution pattern of volcanoes that follows plate margins
Volcano	an opening in the Earth’s crust from which lava, ash and gases erupt

Glossary Chapter 3: Weather Hazards

Key Term	Definition
Aerial photo	an image taken from above ground-level looking down on a landscape, they can either be (1) Vertical – looking directly down to the ground or, (2) Oblique – looking sideways
Aid	Money, goods and services given by single governments or an organisation like the World Bank or IMF to help the quality of life and economy of another country
Atmosphere	a highly complex mass of gases, liquids and solids that envelopes the Earth
Atmospheric circulation	circular movement of air within Earth’s atmosphere
Cells	section of Earth’s atmosphere where air moves in circular motions, together these form the overall circulation of Earth’s atmosphere
Climate	the average weather over a long period of time
Climate change	a long-term change in the earth's climate, especially a change due to an increase in the average atmospheric temperature
Coriolis effect	the spinning effect caused by the rotation of the Earth

Cyclone	the term given to a tropical storm in south-east Asia and Australia
Cyclone shelter	accommodation for people who have been evacuated from areas threatened by cyclones (tropical storms), often built from strong concrete and on stilts to prevent flooding
Depressions	areas of low atmospheric pressure
Dredging	the removal of silt deposited on the river bed to increase river capacity
Drought	a long, continuous period of dry weather
Equator	an imaginary line that divides Earth's surface into a northern and southern hemisphere
Evacuation	movement of people away from danger to a place of safety
Extreme weather	when a weather event is significantly different from the average or usual weather pattern, and is especially severe or unseasonal
Eye (of the storm)	a small area at the centre of a storm where relatively cold air descends rapidly
Eye wall	the outer edge of the eye of a storm where the most intense weather conditions occur
Flood risk	the predicted likelihood and frequency of floods in an area
Flood	where river discharge exceeds river channel capacity and water spills onto the floodplain
Global warming	the increase of global temperatures
Grid reference	a map reference that indicates a location using numbered vertical and horizontal lines that run up and down, and increase in value from bottom to top of the map
Heatwave	an extreme weather event of very high temperatures
Hurricane	the term given to a tropical storm in the USA and Caribbean
Immediate response	reaction of people as the disaster happens and in the immediate aftermath
Jet stream	a narrow ribbon of air in Earth's atmosphere that encircles the globe, which create that cause weather systems to cross over the UK mainly from west to east
Latitude	lines that run parallel to Earth's Equator, measured in degrees
Long-term response	later reactions that occur in the weeks, months and years after the event

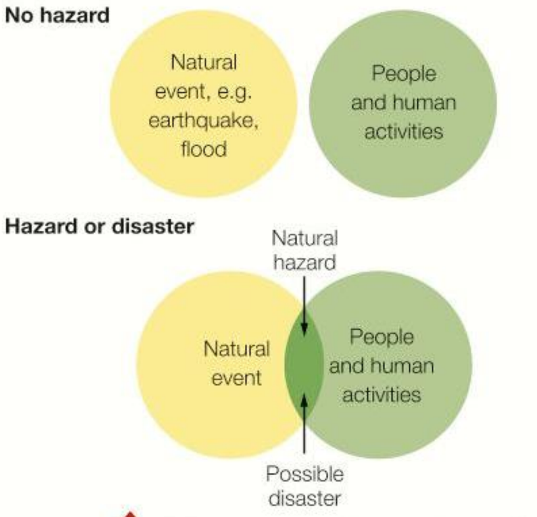
Monitoring	recording physical changes, i.e. tracking a tropical storm by satellite, to help forecast when and where a natural hazard might strike;
Planning	actions taken to enable communities to respond to, and recover from, natural disasters
Hazard prediction	using historical evidence and monitoring, scientists can make predictions about when and where a hazard may happen
Pressure belts	zones of either high or low pressure that encircle the Earth between circulation cells
Primary effects	initial impact of a natural event on people and property, caused directly by it, i.e. the buildings collapsing following an earthquake
Protection	actions taken before a hazard strikes to reduce its impact, such as educating people or improving building design
Saffir-Simpson Scale	scale used to measure the strength of hurricanes based on wind speed
Secondary effects	after-effects that occur as indirect impacts of a natural event, sometimes on a longer timescale, i.e. fires due to ruptured gas mains, resulting from the ground shaking
Storm surge	a wall of water often 3-5 metres high, driven onshore by a tropical storm. The most destructive hazard associated with tropical storms
Trade winds	easterly winds that blow towards the Equator
Tropical storm **(hurricane, cyclone, typhoon)**	an area of low pressure with winds moving in a spiral around a calm central point called the eye of the storm – winds are powerful and rainfall is heavy
Tropics	regions either side of the Equator where the Sun moves directly overhead from its farthest point in the North and the South
Weather	the day to day conditions of the atmosphere, for example, temperature, winds and rainfall
Weather warning	advance information that helps people prepare for potential threats and hazards
Weather hazard	extreme weather events that pose a threat to humans and/or property

Glossary Chapter 4: Climate Change

Key Term	Definition
Adaptation	actions taken to adjust to natural events such as climate change, to reduce damage, limit the impacts, take advantage of opportunities, or cope with the consequences
Alternative energy	sources of energy that are not produced from the burning of fossil fuels, such as hydro-electricity, nuclear power and solar power
Atmosphere	a highly complex mass of gases, liquids and solids that envelopes the Earth
Axial tilt	the angle of Earth's axis
Carbon capture and storage (CCS)	technology that captures CO_2 produced from the burning of fossil fuels, which is compressed, transported and then injected underground into suitable geological reservoirs
Carbon sinks	the removal of CO_2 from the atmosphere
Climate change	a long-term change in the earth's climate, especially a change due to an increase in the average atmospheric temperature
Eccentricity	the path of the Earth as it orbits the Sun
Enhanced greenhouse effect	the increased effectiveness of the greenhouse effect, believed to be the cause of recent global warming
Fossil fuel	a natural fuel such as coal or gas, formed in the geological past from the remains of living organisms
Global warming	the increase of global temperatures
Greenhouse effect	the blanketing effect of the atmosphere in retaining heat given off from the Earth's surface
Greenhouse gases	atmospheric gases such as carbon dioxide and methane that can absorb heat
Ice cores	columns of ice that are extracted from ice sheets and used to reconstruct temperature patterns from the past 400,000 years
Milankovitch cycles	three distinct cycles of Earth's orbit around the Sun (Eccentricity, Precession, Axial tilt) which scientists believe affect the timings and seasons of Earth's climate
Mitigation	action taken to reduce the long-term risk from natural hazards, such as earthquake-proof buildings or international agreements to reduce greenhouse gas emissions
Precession	the natural 'wobble' of Earth's axis as it orbits around the Sun

Quaternary period	the geological time period that covers the last 2.6 million years
Renewable energy	a resource that cannot be exhausted, i.e. wind, solar and tidal energy
Solar flare	large explosions on the surface of the Sun
Sunspots	a dark patch that occasionally appears on the surface of the Sun
Volcanic eruption	when volcanoes blast ash, gases and liquids onto the Earth's surface and atmosphere

Lesson 1: What are natural hazards?



B *When is a natural event a hazard?*

C *Different types of natural hazard*

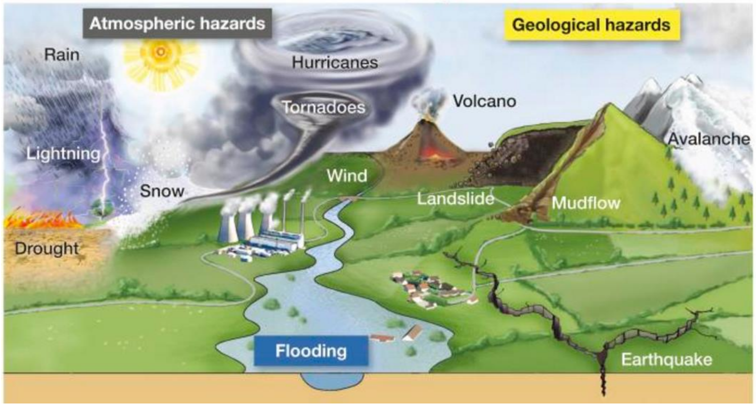
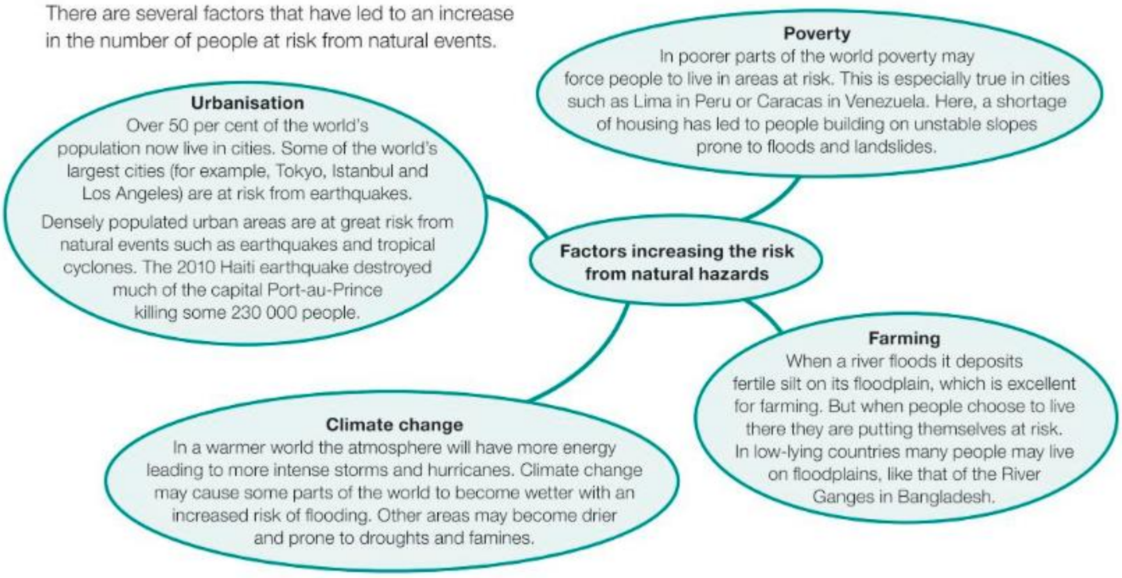


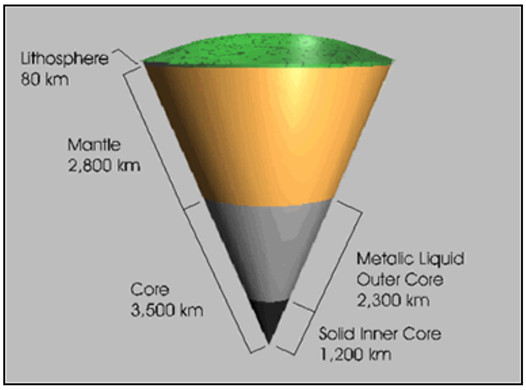
Diagram **B** is a Venn diagram. Notice that that a natural hazard occurs when a natural event overlaps with human activities. Diagram **C** shows how natural hazards can be sorted into 3 main groups.

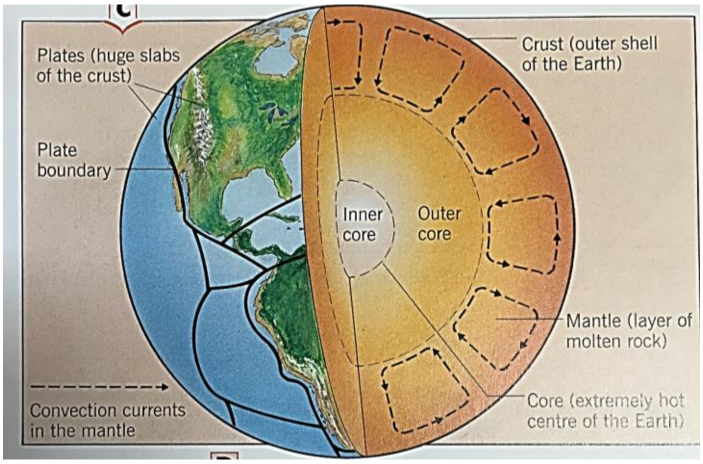
What factors affect risk?

There are several factors that have led to an increase in the number of people at risk from natural events.

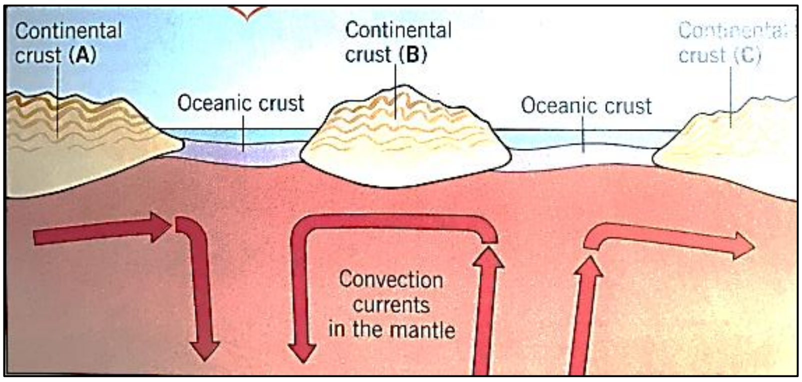


Lesson 2. Distribution of earthquakes and volcanoes



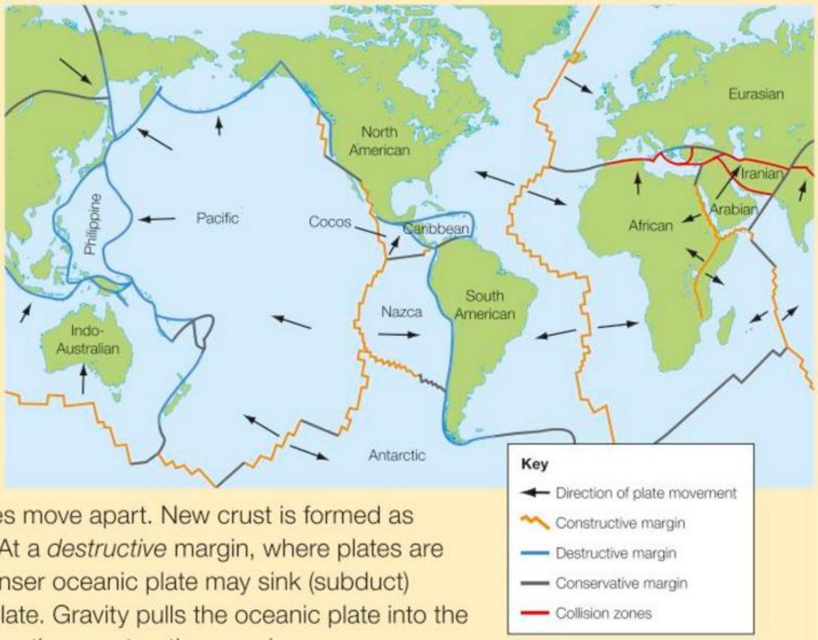


Convection currents within the mantle

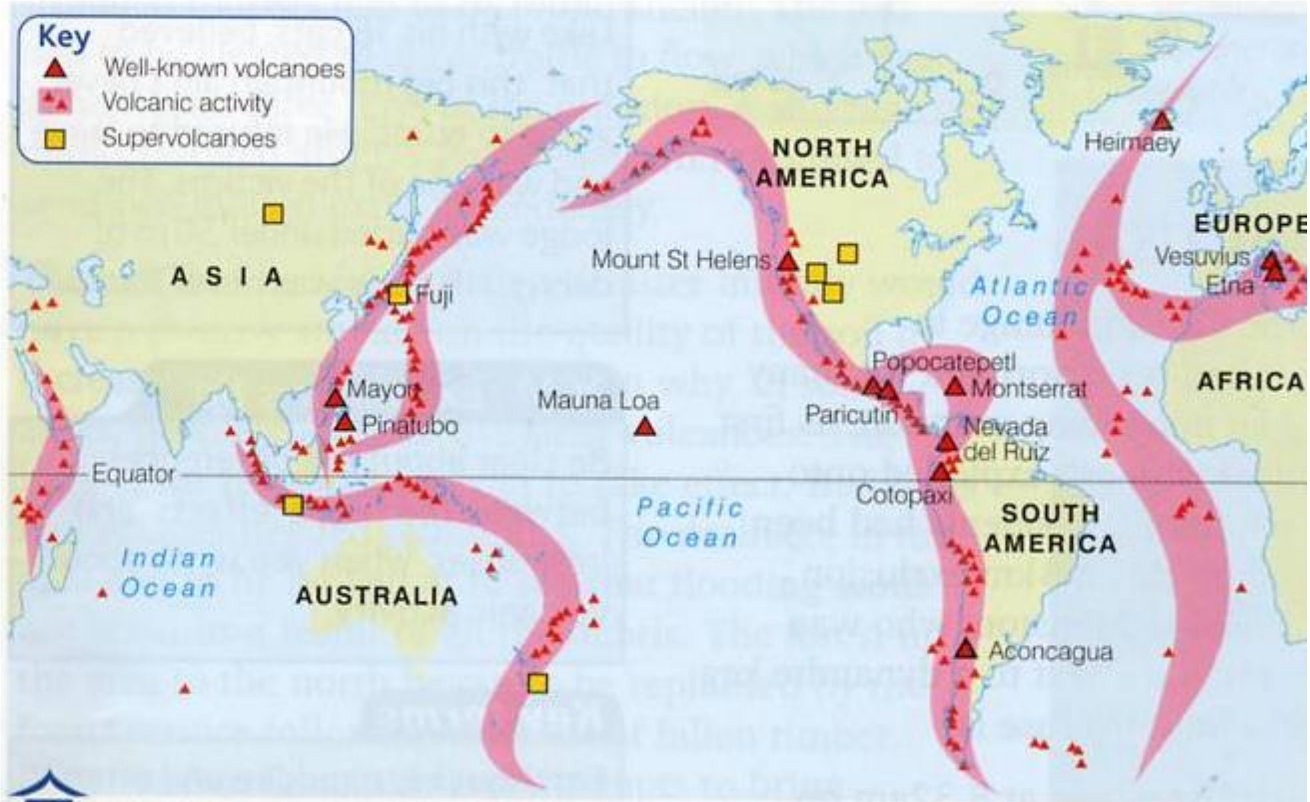


Tectonic plates

- The Earth's crust is split into a number of plates about 100 km thick.
- There are two types of crust – dense, thin oceanic crust and less dense, thick continental crust.
- Plates move in relation to each other due to convection (heat) currents from deep within the Earth. Gravitational pull may play a part.
- At a *constructive* plate margin plates move apart. New crust is formed as magma rises towards the surface. At a *destructive* margin, where plates are moving towards each other, the denser oceanic plate may sink (subduct) beneath a less dense continental plate. Gravity pulls the oceanic plate into the mantle, dragging the plate away from the constructive margin.
- Tectonic activity at plate margins causes earthquakes and volcanoes.



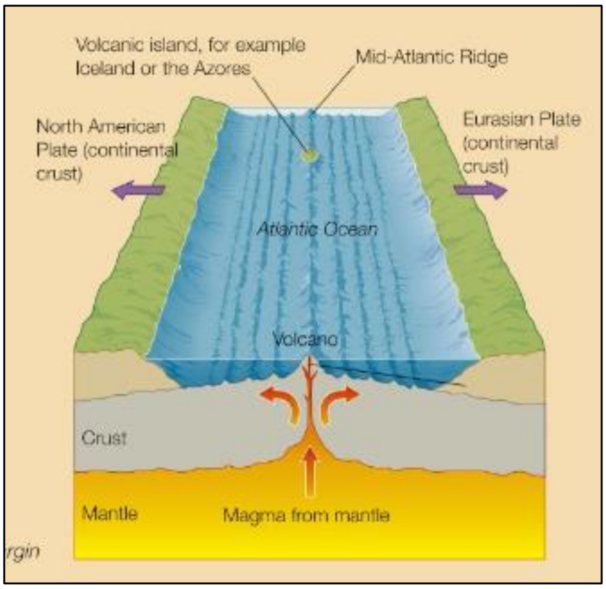
B *The Earth's tectonic plates*

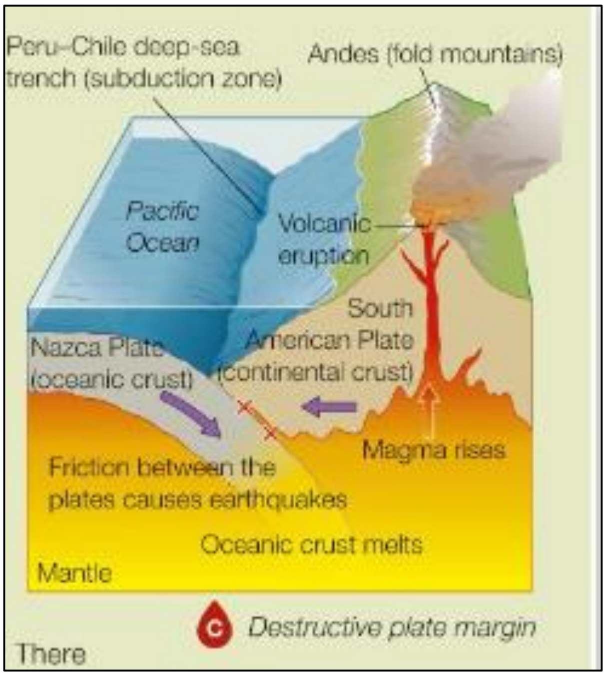


A The distribution of active volcanoes and supervolcanoes

Lesson 3. Physical processes at plate margins

Margin	Description	Sketch	Hazard or feature	Example	Case Study
Destructive	Where an oceanic plate moves…		Volcanoes and earthquakes. Fold mountains & trench.	Pacific plate, Philippines plate & Eurasian plate	Chile Earthquake Eruption of Mount Pinatubo
Conservative	Where two plates …		Earthquakes	Juan de Fuca Plate & North American Plate	California Earthquake
Collision	Where two continental plates…		Fold mountains	Indo-Australian plate & Eurasian Plate	Construction of the Himalayan Mountains
Constructive	Where two…		Volcanoes and earthquakes.	Eurasian & North American Plate	Formation of Iceland





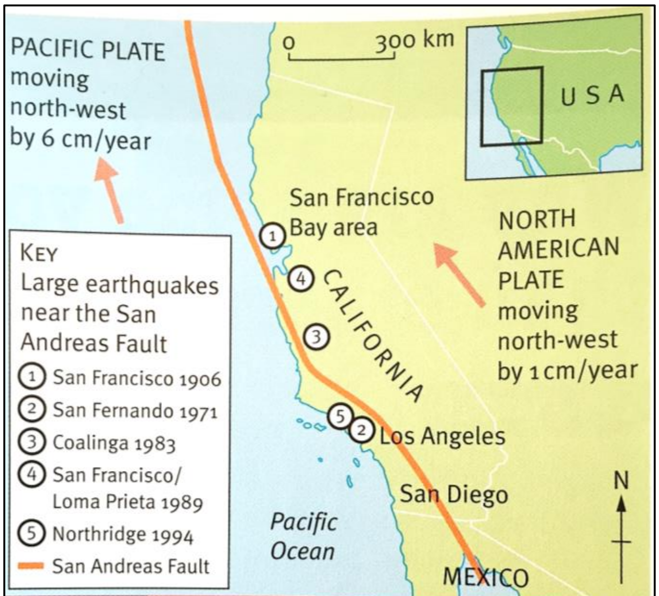


Figure 3.10 Transform boundary: the San Andreas Fault.

'It's only a question of time': California is overdue for a massive earthquake
Doyle Rice USA TODAY Published 9:52 p.m. UTC Apr 18, 2018

San Francisco instantly became a hellscape of rubble and ruin 112 years ago today, thanks to a magnitude-7.9 earthquake and subsequent fire that killed thousands of people.

Seismologists have said California is due — and perhaps overdue — for the "big one," another massive earthquake that would cause significant damage, but just when such a quake would strike is unpredictable.

"There is a 99.9% chance that there will be a damaging quake (magnitude greater than or equal to 6.7) somewhere in California in the next 30 years," said Peggy Hellweg, a seismologist at the University of California, Berkeley. "We don't have any idea exactly where and when such a quake can happen."

John Vidale of the Southern California Earthquake Center, said California's fears are legitimate. A "big one" quake of a magnitude-8.0 near the San Andreas Fault would break several hundred miles along the faultline. Even more crippling, would be a smaller magnitude-7.0 placed in the heart of Los Angeles, he said. "We have no real due date," Vidale said.

Jen Andrews, a seismologist at the Caltech Seismo Lab, said when the infamous San Andreas fault is broken up into three sections — top, central and lower — it's clear the section that's gone the longest amount of time without a big quake is the southern portion.

In fact, the lower section hasn't seen a large event for about 300 years.

"They don't happen like clockwork, nor do they happen with the same frequency on different sections of the fault," Andrews said. "However, the average time between quakes tends to be on the order of 100 to a few hundred years, and in several places it has been about that interval since the last large quake."

Lesson 5 The effects of Earthquakes: Chile

The earthquakes in Chile and Nepal

Earthquakes can have devastating effects on peoples' lives and activities. **Primary effects** are caused by ground shaking and can include deaths and injuries, and damage to roads and buildings. **Secondary effects** are the result of primary effects (ground shaking) and include tsunami, fires and landslides. Responses to earthquakes include emergency care and support and help with longer-term reconstruction.

Indicator	Chile	Nepal	UK
Gross Domestic Product (GDP) – a measure of wealth	38th out of 193 countries	109th out of 193 countries	6th out of 193 countries
Human Development Index (HDI) – a measure of the level of development	41st out of 187 countries	145th out of 187 countries	14th out of 187 countries

A *Contrasting Chile and Nepal*

Development indices

A development **index** measures a country's performance according to specific development indicators. Some countries may appear to be developed according to some indices, but not according to others.

Country	Development indicators
Vietnam and **Pakistan**	Both countries have a similar *per capita GDP*. However, **life expectancy** and **literacy** are considerably higher in Vietnam than they are in Pakistan.
Saudi Arabia and **Croatia**	Saudi Arabia has a **per capita GDP** comparable to that of **Croatia**. However, in Saudi Arabia there is greater inequality between men and women when considering access to education and political power. So, although they are equal on an economic development index - Saudi Arabia is less developed on a human development index.

Problems with indices

Development indices can be misleading and need to be used with care. For example:

- Many indices are averages for the whole population of a country. This means that indices do not always reveal substantial inequalities between different segments of society. For example, a portion of the population of a highly developed country could be living below the poverty line.

- In some countries, the data used in indices could be out of date or hard to collect. Some countries do not wish to have certain index data collected - for example, many countries do not publish statistics about the number of immigrants and migrants.
    - To balance inaccuracies, indices tend to be an amalgamation of many different indicators. The United Nations **Human Development Index (HDI)** is a weighted mix of indices that show **life expectancy**, knowledge (**adult literacy** and education) and standard of living (Gross Domestic Product/GDP per capita). As **Vietnam** has a higher literacy rate and life expectancy than **Pakistan**, it has much higher HDI value even though it has a similar per capita GDP.
    - HDI is measured between 0 and 1. The USA has an HDI of 0.994 whereas Kenya has an HDI of 0.474.

Exam tips

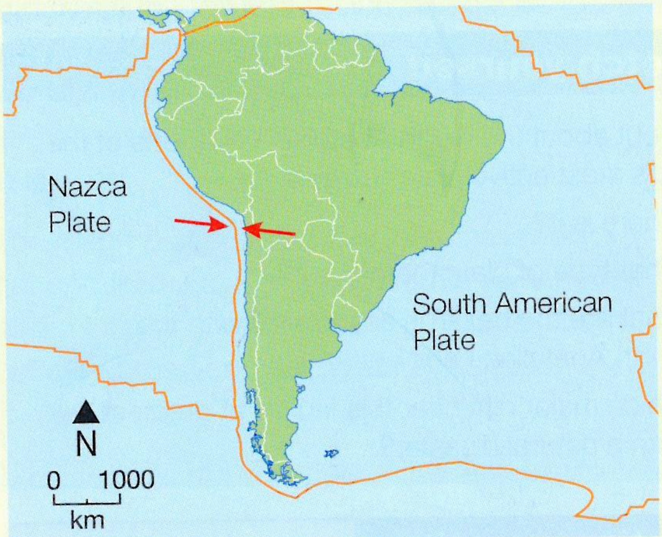
- In an exam you may be given some development indicators for different countries. Read the information for each country carefully. Always look at all the data presented. Don't jump to conclusions about a country on the basis of one or two indicators.

Chile

Imagine what it would be like if the ground shook underneath you for three minutes! This is what happened on 27 February 2010 when a very powerful earthquake measuring 8.8 on the Richter scale struck just off the coast of central Chile (map **B**). The earthquake occurred at a destructive plate margin where the Nazca Plate is moving beneath the South American Plate.

It was followed by a series of smaller aftershocks.

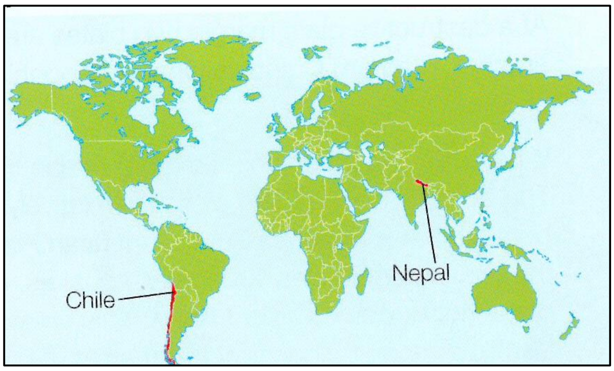
Because the earthquake occurred out to sea, tsunami warnings were issued as waves raced across the Pacific Ocean at speeds of up to 800 km per hour.



B *The Chile earthquake*

Primary effects (caused by ground shaking)

- Around 500 people killed and 12 000 injured – 800 000 people affected.
- 220 000 homes, 4500 schools, 53 ports, 56 hospitals and other public buildings destroyed.
- Port of Talcahuanao and Santiago airport badly damaged.
- Much of Chile lost power, water supplies and communications.
- Cost of the earthquake estimated at US$30 billion.



Secondary effects (tsunamis, fires and landslides)

- 1500 km of roads damaged, mainly by landslides – remote communities cut off for many days.
- Several coastal towns devastated by tsunami waves.
- Several Pacific countries struck by tsunami – warnings prevented loss of life.
- A fire at a chemical plant near Santiago – the area had to be evacuated.

Chile: immediate responses

- Emergency services acted swiftly. International help needed to supply field hospitals, satellite phones and floating bridges.
- Temporary repairs made to the important Route 5 north-south highway within 24 hours, enabling aid to be transported from Santiago to affected areas.
- Power and water restored to 90% of homes within 10 days.
- A national appeal raised US$60 million – enough to build 30 000 small emergency shelters (photo **A**).

A *Temporary wooden shelters for those made homeless by the earthquake*

Chile: long-term responses

- A month after the earthquake Chile's government launched a housing reconstruction plan to help nearly 200 000 households affected by the earthquake.
- Chile's strong economy, based on copper exports, could be rebuilt without the need for much foreign aid.
- The President announced it could take four years for Chile to recover fully from the damage to buildings and ports (photo **B**).

B *Buildings destroyed by the Chile earthquake*

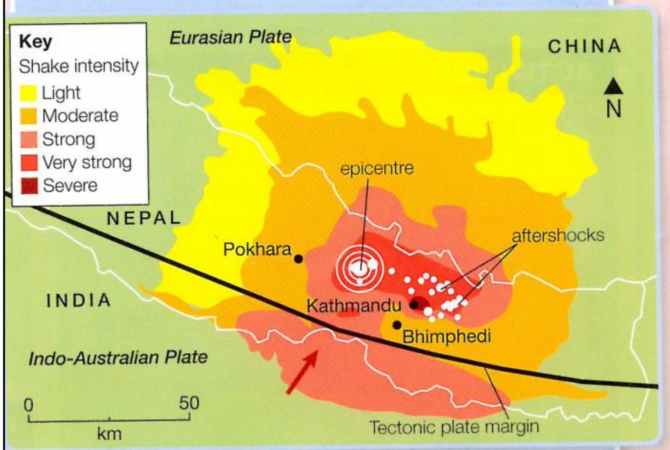
Earthquakes in Chile are quite common. Local communities and the government were prepared and knew how to respond quickly and effectively to the earthquake. Chile had the money to support people and to rebuild.

Lesson 6. The effects and responses to earthquakes - Nepal

Nepal

On 25 April 2015 Nepal was struck by an earthquake measuring 7.9 on the Richter scale. The epicentre was about 80 km (50 miles) to the north-west of Nepal's capital Kathmandu in the foothills of the Himalayas (map **C**). This is a destructive plate margin where the Indo-Australian Plate is colliding with the Eurasian Plate at a rate of 45 mm per year. The collision and pressure at this margin are responsible for the formation of the Himalayas.

The earthquake was very shallow, just 15 km below the surface. This resulted in very severe ground shaking and widespread landslides and avalanches. The earthquake caused damage hundreds of kilometres away in India, Tibet and Pakistan.



C *The Nepal earthquake*

Primary effects

- 9000 people died and 20 000 injured – over 8 million people (a third of Nepal's population) affected.
- 3 million people left homeless when homes were destroyed.
- Electricity and water supplies, sanitation and communications affected.
- 1.4 million people needed food, water and shelter in the days and weeks after the earthquake.
- 7000 schools destroyed and hospitals overwhelmed.
- International airport became congested as aid arrived.
- 50% of shops destroyed, affecting food supplies and people's livelihoods.
- Cost of damage estimated at over US$5 billion.

E *The effects of the Nepal earthquake*

Secondary effects

- Ground shaking triggered landslides and avalanches, blocking roads and hampering relief efforts.
- Avalanches on Mount Everest killed at least 19 people – the greatest loss of life on the mountain in a single incident.
- An avalanche in the Langtang region left 250 people missing.
- A landslide blocked the Kali Gandaki River, 140 km (90 miles) north west of the capital, Kathmandu – many people evacuated in case of flooding.
- The earthquake occurred on land so did not cause a tsunami.

Earthquakes in Nepal are not uncommon. Scientists have identified a pattern of large earthquakes in this region every 80 years or so. Despite these warnings and new building regulations, little had been done to prepare the city and its people for when the earthquake struck.

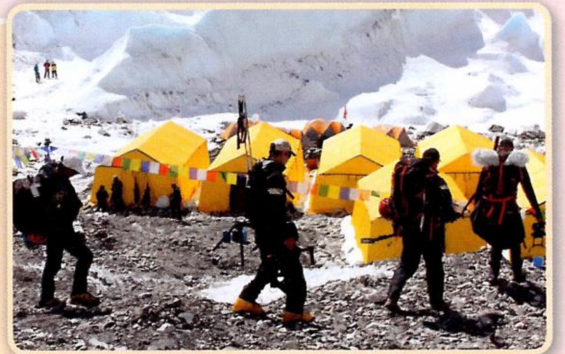
Nepal: immediate responses

- Search and rescue teams (photo **C**), water and medical support arrived quickly from countries such as UK, India and China.
- Helicopters rescued many people caught in avalanches on Mount Everest and delivered supplies to villages cut off by landslides.
- Half a million tents needed to provide shelter for the homeless.
- Financial aid pledged from many countries.
- Field hospitals set up to support overcrowded main hospitals.
- 300 000 people migrated from Kathmandu to seek shelter and support with family and friends.
- Social media widely used in search and rescue operations and satellites mapped damaged areas.

C *Searching a building for survivors in Kathmandu*

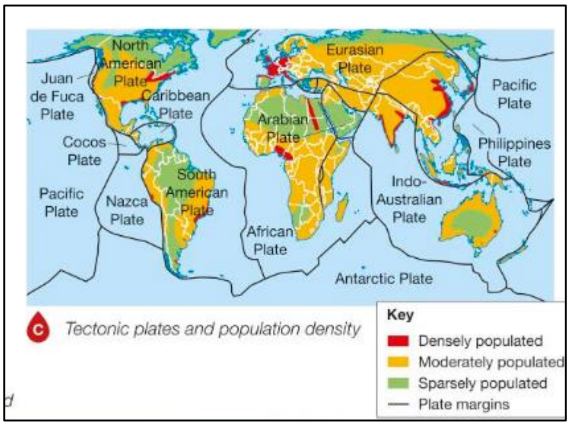
Nepal: long-term responses

- Roads repaired and landslides cleared. Lakes, formed by landslides damming river valleys, need to be emptied to avoid flooding.
- Thousands of homeless people to be re-housed, and damaged homes repaired. Over 7000 schools to be re-built or repaired.
- Stricter controls on building codes.
- In June 2015 Nepal hosted an international conference to discuss reconstruction and seek technical and financial support from other countries.
- Tourism, a major source of income, to be boosted – by July 2015 some heritage sites re-opened and tourists were starting to return.
- Repairs to Everest base camp (photo **D**) and trekking routes – by August 2015 new routes had been established and the mountain re-opened for climbers.
- In late 2015 a blockade at the Indian border badly affected supplies of fuels, medicines and construction materials.



D *Everest base camp*

Lesson 7 and 8: Living with the risk



Tectonic plates and population density

It has been estimated that 500 million people now live in areas that are likely to be affected by earthquakes, volcanic eruptions and tsunamis. In some places, like Mexico City, Tokyo and San Francisco, populations are actually increasing despite the knowledge that another earthquake will inevitably happen.

So why do so many people live in danger zones? The most obvious reason is that some of the areas, particularly those that are volcanic, can provide **benefits** to people that are living there (see your worksheet that you have done in class). Another reason is some people have always lived there and are happy to do so and there is little perceived risk (in living memory). For many people it would seem that the advantages of living in the danger zone far outweigh the risk of coping with the remote possibility of an earthquake or volcanic eruption.

It is impossible to prevent earthquakes but there is much that can be done to reduce the damage caused by them. Measures to reduce the effects of earthquakes are usually in two parts. The first is to **predict** where and when the event might happen. The second is to **prepare** the local people and emergency services for the disaster should it occur.

Predicting earthquakes

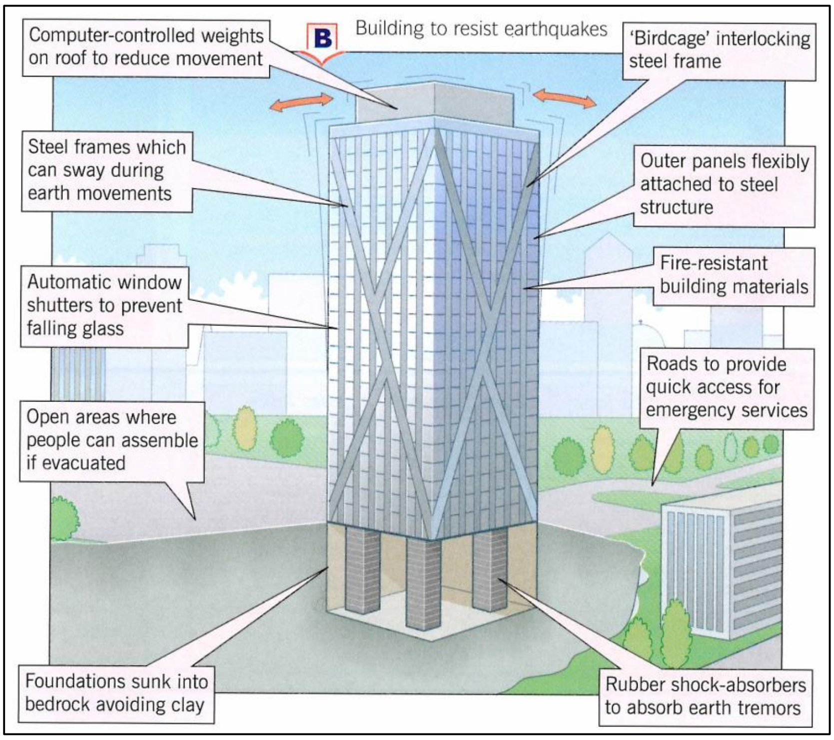
Scientist still cannot say exactly when or where an earthquake will strike but they do know that most will be close to a tectonic plate boundary. It is here that most research and monitoring will be carried out. The diagram below gives some of the early warning signs.

- Sensitive instruments known as **seismometers** can be used to measure small fore-shocks that occur before the main earthquake. They can also show increases in temperature, pressure and the release of radon gas.
- Mapping centres of earlier earthquakes (where pressure in the Earth's crust will have been released) and identifying 'gaps' where earth movements have not occurred for a long time (and where pressure will not have been released) can help to identify likely places.
- Plotting earthquake regularity helps to show if there is a recognisable time-length pattern. For example, the area around Tokyo in Japan has experienced a major earthquake every 70 to 80 years since 1620.
- Observing unusual animal and fish behaviour can suggest that an earthquake is about to occur. This may include dogs howling, rats fleeing houses and fish jumping shortly before the earthquake strikes.

Preparing for earthquakes

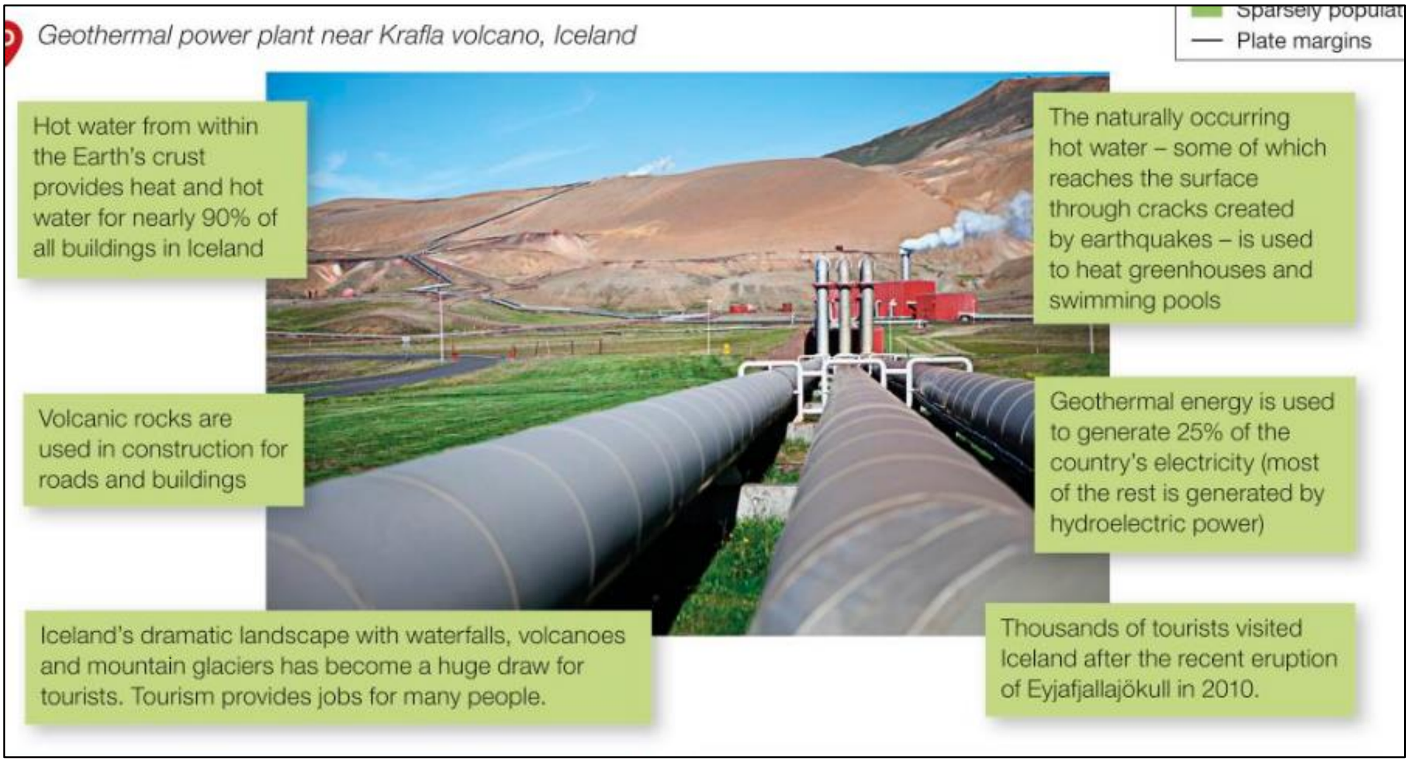
Good preparation and planning should involve local authorities and emergency services as well as people living in the area. These include the following:

- Preparing disaster plans and carrying out regular practices. In Japan, people in schools, industry and public buildings have to practise earthquake drills at least once a month. Earthquake preparation is taught in Japanese schools at least once a month as part of the curriculum.
- Training emergency services such as police, fire and ambulance crews.
- Organising emergency water, food, medical and power supplies.
- Setting up efficient earthquake warning and information system using television, radio and SMS.



• Drawing up and enforcing strict building regulations. These should ensure that buildings are earthquake resistant and provide protections rather than causing danger in an earthquake (see diagram b). They should also restrict building on unstable surfaces like clay and reclaimed land where earth movement is greatest and building collapse is likely.

As scientists begin to develop more accurate methods of predicting these events, this risk of living in danger areas is further reduced. Perhaps for this reason, the number of people populating the sides of active volcanoes and valley areas has increased in recent years. Even areas liable to earthquakes, a still far from predictable hazard, have seen a steady growth in population. Measuring the advantages against the disadvantages if living in a danger zone is a called risk assessment.



Monitoring- Using scientific equipment to detect warning signs of events such as a volcanic eruption.

Prediction- Using historical evidence and monitoring, scientists can make predictions about when and where a tectonic event may happen.

Protection- destroying buildings that will withstand tectonic hazards.

Planning-identifying and avoiding places most at risk.

Monitoring

Volcanoes

As magma rises through a volcano it gives a number of warning signs that an eruption is likely to occur (diagram **A**).

All of the world's active volcanoes are closely monitored by scientists. If an eruption seems likely, warnings can be issued and action taken to evacuate surrounding areas. Modern hi-tech equipment is used, some of which is located on the volcano itself. Scientists monitor volcanoes in the following ways:

- *Remote sensing* – satellites detect heat and changes to the volcano's shape.
- *Seismicity* – seismographs record earthquakes.
- *Ground deformation* – changes to the shape of the volcano are measured using laser beams.
- *Geophysical measurements* – detect changes in gravity as magma rises to the surface.
- *Gas* – instruments detect gases released as magma rises.
- *Hydrology* – measurements of gases dissolved in water.

Earthquakes

Earthquakes generally occur without warning. Whilst there is some evidence of changes in water pressure, ground deformation and minor tremors prior to an earthquake, scientists have yet to discover reliable ways to monitor and predict earthquakes.

Prediction

Volcanoes

The prediction of a volcanic eruption is based on scientific monitoring. In 2010 an increase in earthquake activity beneath the Eyjafjallajökull ice cap in Iceland enabled scientists to make an accurate prediction about the eruptions that took place in March and April that year.

Earthquakes

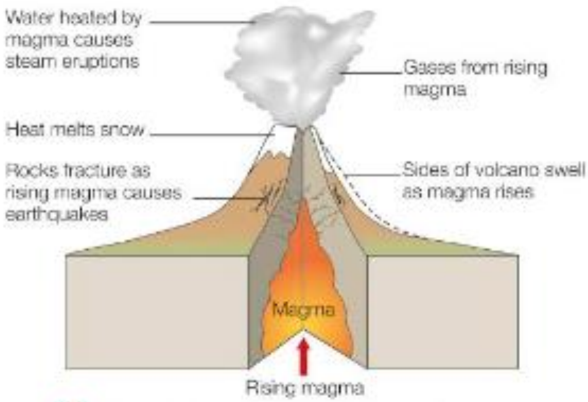
It is impossible to make accurate predictions about earthquakes due to the lack of clear warning signs. However, scientists studying historical records of earthquakes at plate margins have identified locations that they believe are at greatest risk. Map **B** shows why scientists believe the city of Istanbul in Turkey is at risk from an earthquake … soon!

B *Migration of earthquakes along the North Anatolian Fault, Turkey*

How can the risks from tectonic hazards be reduced?

There are four main **management strategies** for reducing the risk from tectonic hazards:

- **Monitoring** – using scientific equipment to detect warning signs of events such as a volcanic eruption.
- **Prediction** – using historical evidence and monitoring, scientists can make predictions about when and where a tectonic hazard may happen.
- **Protection** – designing buildings that will withstand tectonic hazards.
- **Planning** – identifying and avoiding places most at risk.



A *Warning signs of a volcanic eruption*

Lesson 9-10. Global Atmospheric Circulation

What is latitude?

1. What does the term 'latitude' mean?

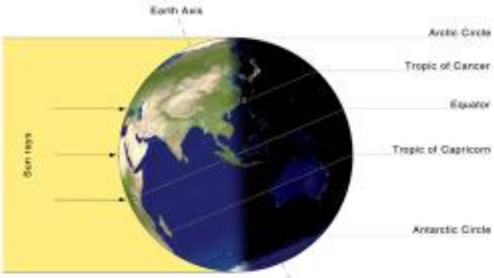
How far north or south a place is from the Equator.

2. Other than the Equator, name the other <u>four</u> main lines of latitude?

Arctic Circle
Tropic of Cancer
Tropic of Capricorn
Antarctic Circle

How does latitude impact our weather?

How does latitude impact our weather?



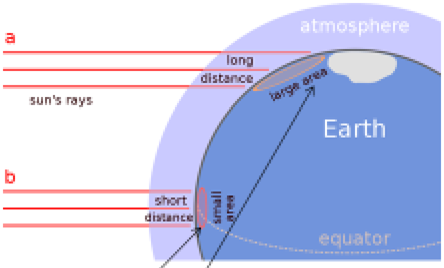
- The Earth revolves around the sun over the course of 1 year.
- The Earth is tilted on its axis.
- Antarctica therefore has six months of darkness and six months of daylight.

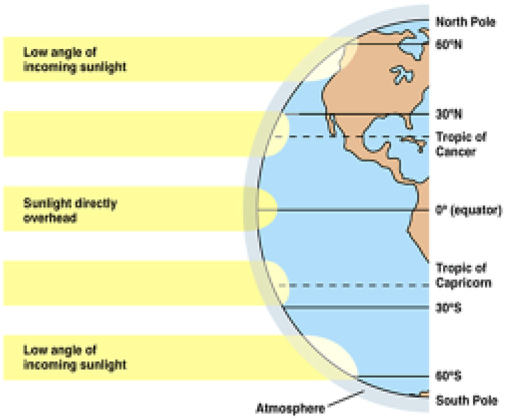
The Curvature of the Earth

Close to the poles, the sun has to pass through a larger area of atmosphere.

More energy is lost and so the air is cooler.

3. Explain why insolation varies with latitude.





The sun's rays are concentrated at the Equator, but spread out at the poles.

Key word:

Insolation – incoming solar radiation

How does air pressure impact our weather?

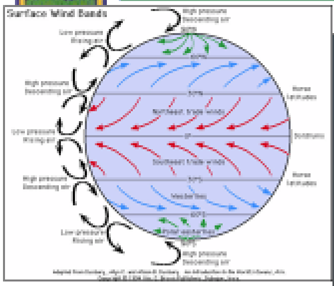
- Winds on the ground are distorted by the **Earth's rotation**. They **curve** as they move from areas of high pressure to areas of low pressure.
- **Surface winds** are very important in **transferring heat** and **moisture** from one place to another.

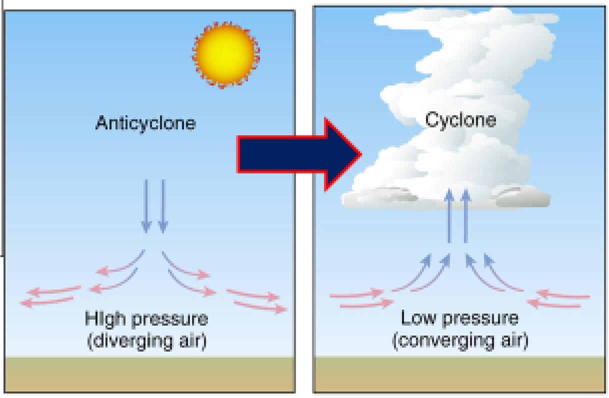
Winds are deflected to the right in the northern hemisphere and to the left in the southern hemisphere.

Winds blow from high pressure zones to low pressure zones

This is also known as the Coriolis effect, which results from the difference in velocity as the earth spins.

How does air pressure affect our weather?





Winds blow from **high pressure zones**

http://www.kevinflint.org/ppt/chap5/Animations/global_circ_anim.html

- Air that is **sinking towards** the ground surface forms areas of **high** pressure, e.g. at the North Pole. Winds on the ground move **outwards** from these areas. (High pressure = lots of air pressing down on the ground)
- Air that is **rising from** the ground surface forms areas of **low** pressure on the ground, e.g. at the Equator. Winds on the ground move **towards** these areas of low pressure. (Low pressure = not much air pressing down on the ground)

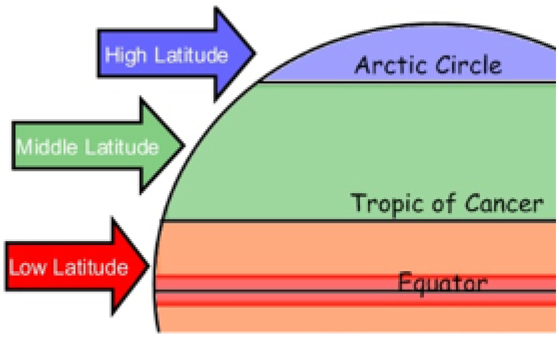
The Coriolis effect results from the difference in velocity.

- The patterns of **pressure belts** and **winds** are affected by **seasonal changes**.
- The tilt and rotation of the Earth causes relative changes in the position of the overhead sun. These seasonal changes cause pressure belts and winds to move north during our summer and then south during our winter.

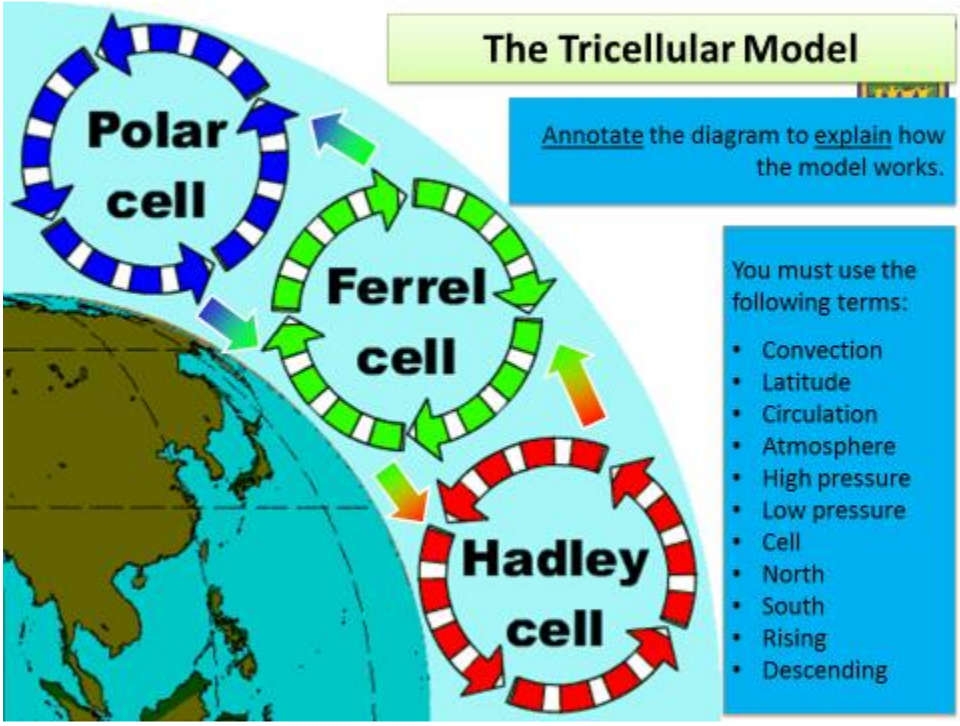
The sun heats up air in the Earth's atmosphere. The temperature of the Earth's atmosphere depends on latitude (how far away you are from the Equator). As the Equator is closest to the sun, the air here is warm and the air at the North and South Pole is cold.

High latitudes have warm/cold air because...

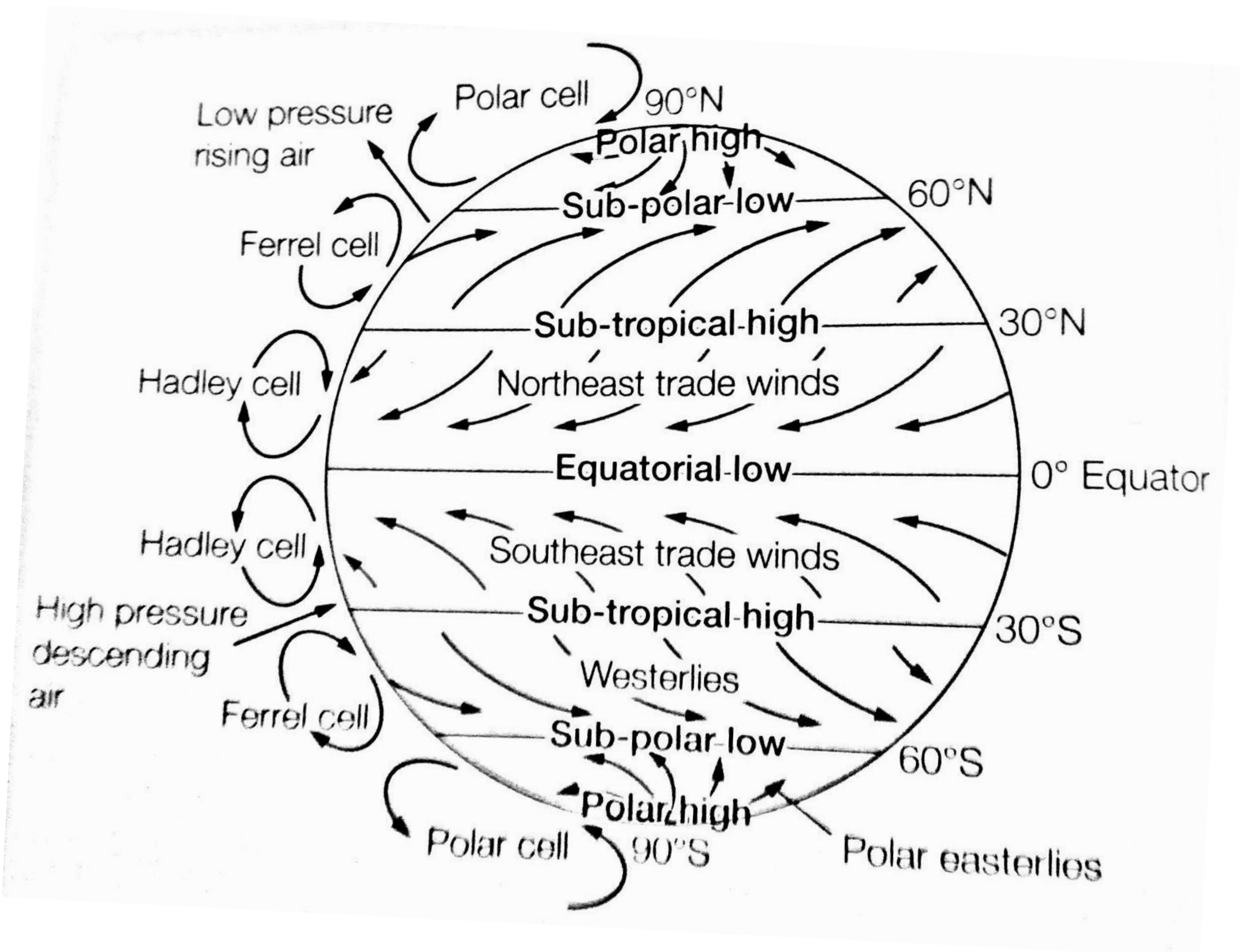
Low latitudes have warm/cold air because...



4. Explain, using examples, how latitude and the curvature of the earth impact our weather.



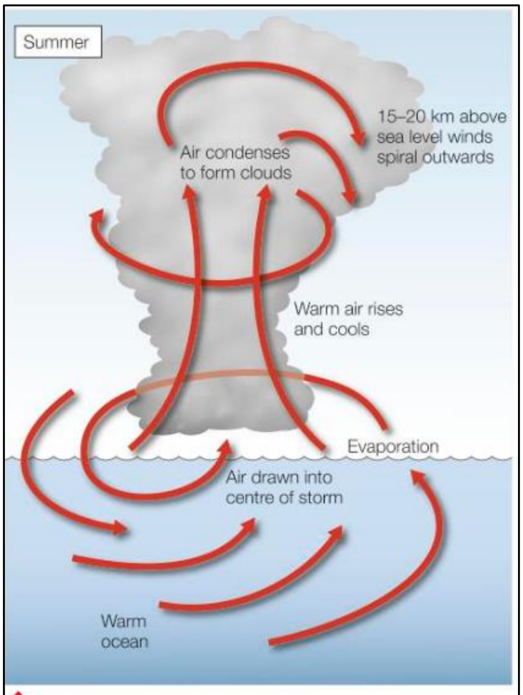
The Tricellular Model
Annotate the diagram to explain how the model works.
You must use the following terms:
Convection
Latitude
Circulation
Atmosphere
High pressure
Low pressure
Cell
North
South
Rising
Descending
Polar cell
Ferrel cell
Hadley cell



Low pressure rising air
Polar cell
90°N
Polar high
Sub-polar-low
60°N
Ferrel cell
Sub-tropical-high
30°N
Hadley cell
Northeast trade winds
Equatorial-low
0° Equator
Hadley cell
Southeast trade winds
High pressure descending air
Sub-tropical-high
30°S
Westerlies
Ferrel cell
Sub-polar-low
60°S
Polar high
Polar cell
90°S
Polar easterlies

Lesson 11-12-Where and how are tropical storms formed?

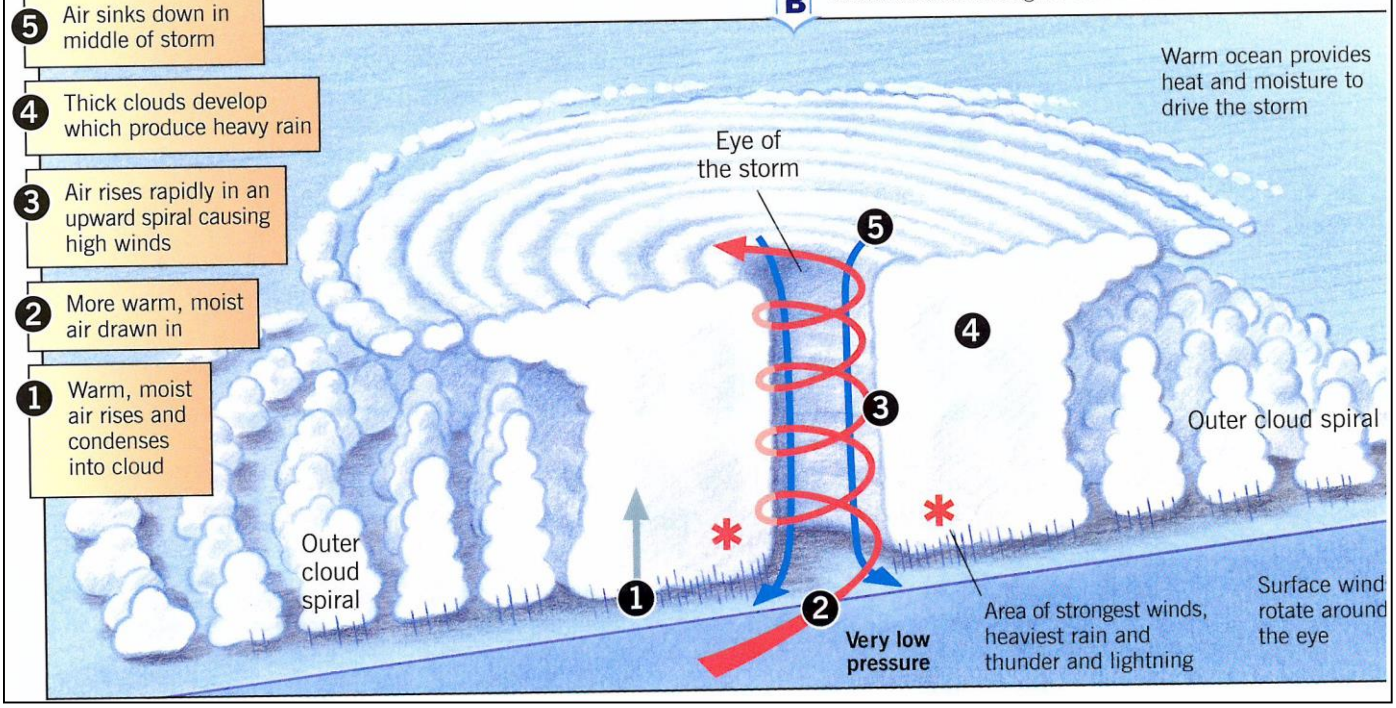
The tropics have some of the fiercest and most destructive storms on Earth. The hurricanes that occur in that region claim an average of 20,000 lives each year and cause immense damage to property, vegetation and shipping.

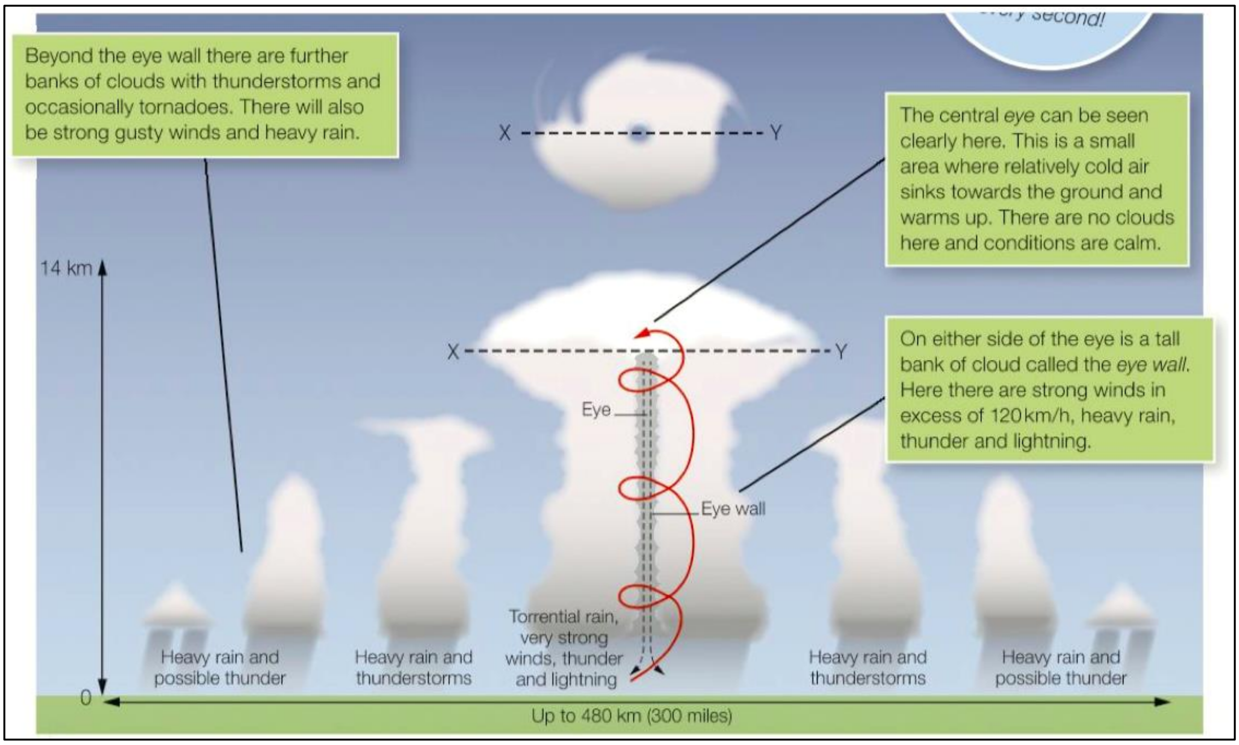


D Formation of a tropical storm

1. Tropical storms develop when the sea temperature is 27°c or higher and when the wind shear (the difference in wind speed) between the higher and the lower parts is low. Warm, moist air rises and condensation occurs. This releases huge amounts of energy, which makes the storms powerful. The rising air creates an area of low pressure, which increases surface winds.
2. Tropical storms move towards the west because of the easterly winds near the equator.
3. The Earth's rotation (Coriolis effect) deflects the paths of the winds, which causes the storms to spin.
4. The storm gets stronger due to energy from the warm water, so wind speeds increase. They lose strength when they move over land or cooler water because the energy supply from the warm water is cut off.
5. Most tropical storms form at low latitudes between 5 ° and 30° North and South but they do not occur at the equator- any further from the equator and the water just isn't warm enough. The majority of storms occur in the Northern Hemisphere (especially over the Pacific), in late summer and autumn, when the sea temperatures are at their highest.

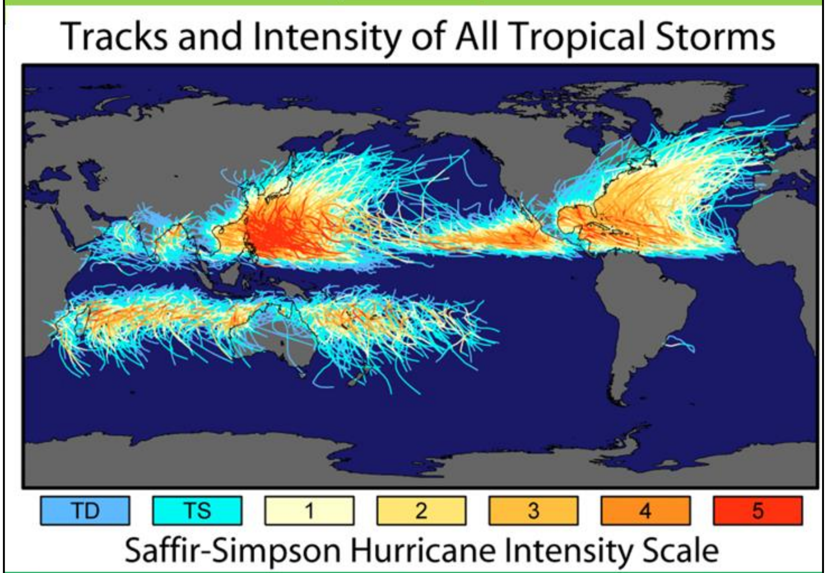
B Cross-section through a hurricane





The **Saffir-Simpson** Hurricane Wind **Scale** is a 1 to 5 rating based on a hurricane's sustained wind speed. This **scale** estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage.

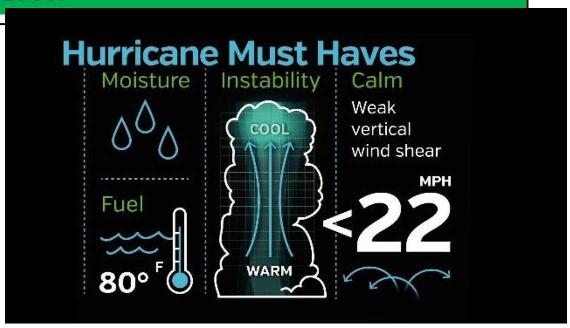
Present

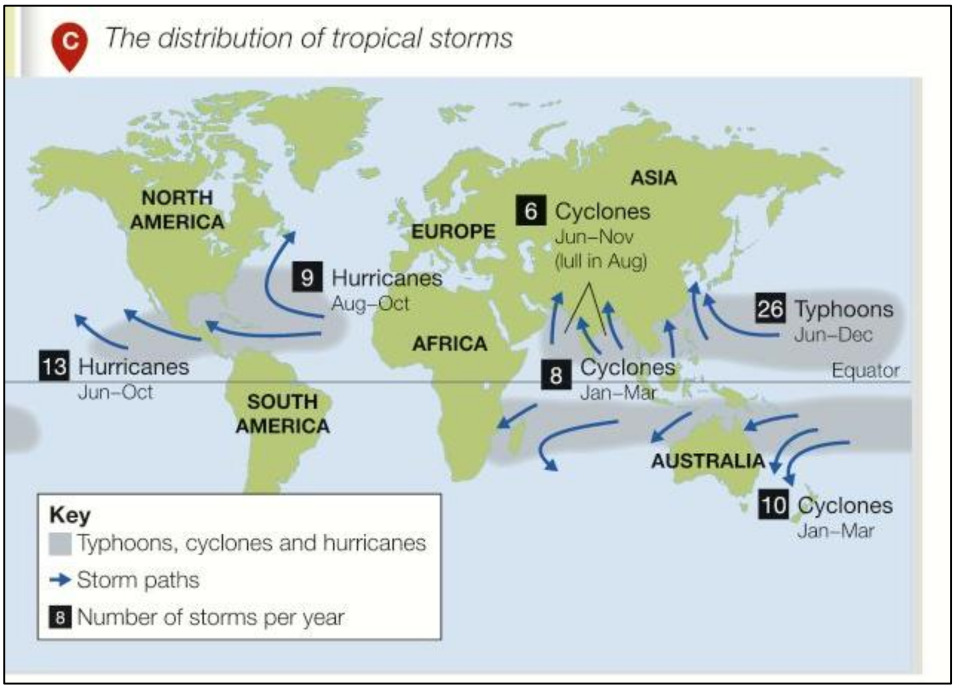


The map shows the tracks of nearly 150 years of tropical cyclones across the world. The map is based on all storm tracks available from the National Hurricane Center and the Joint Typhoon Warning Center up to September 2006.

Extended Saffir-Simpson Hurricane Scale

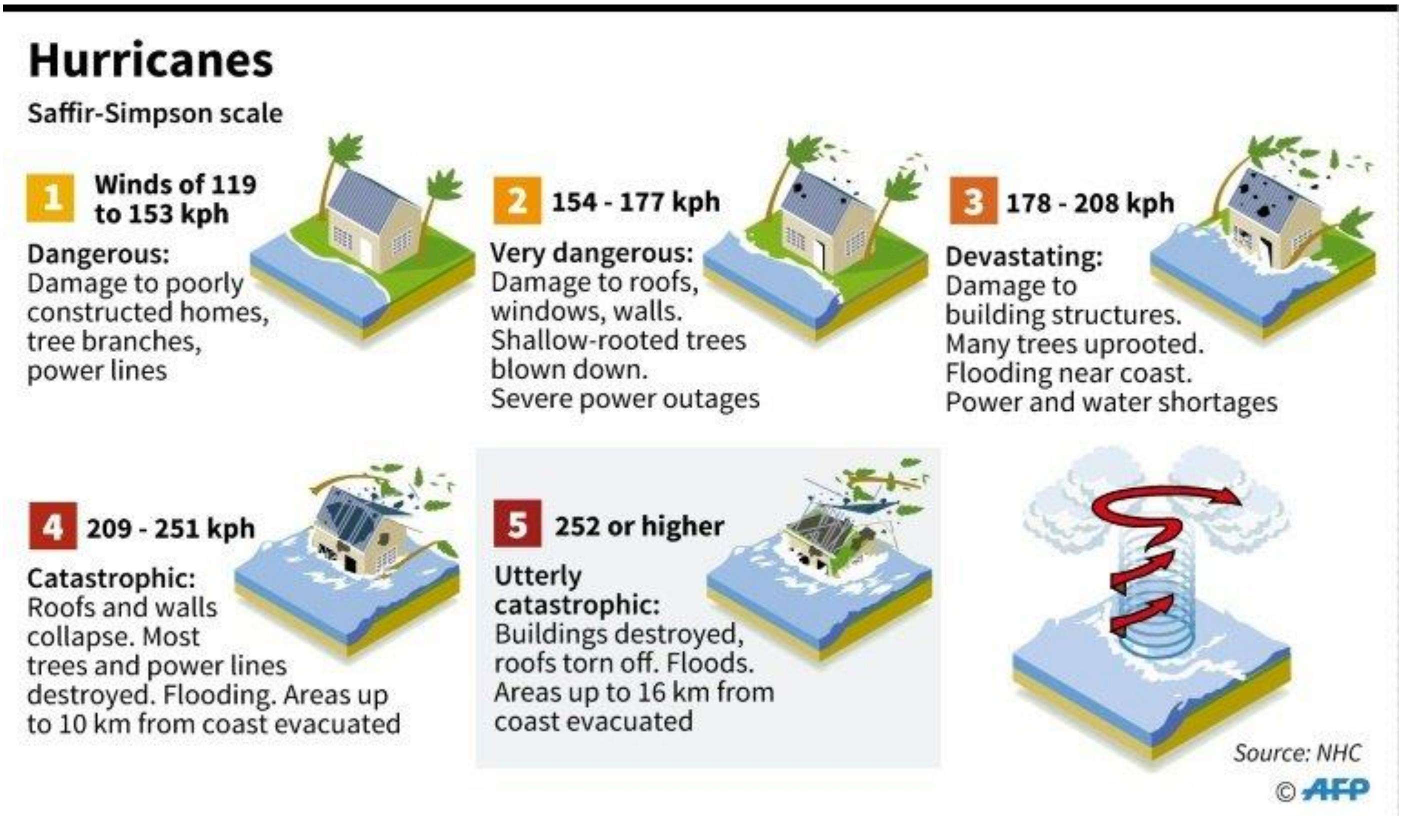
Category	Wind (mph)	Δ	Storm Surge (ft)	Δ
7	208 plus	∞	35 plus	∞
6	182 - 207	25	27 - 34	9
5 rev	156 - 181	25	19 - 26	7
4	131 - 155	24	13 - 18	5
3	111 - 130	19	9 -12	3
2	96 - 110	14	6 - 8	2
1	74 - 95	21	4 - 5	1
Trop St.	39 - 73	34	1 -3	2
Trop. dp.	0 - 38	38	0	0





The Saffir-Simpson scale

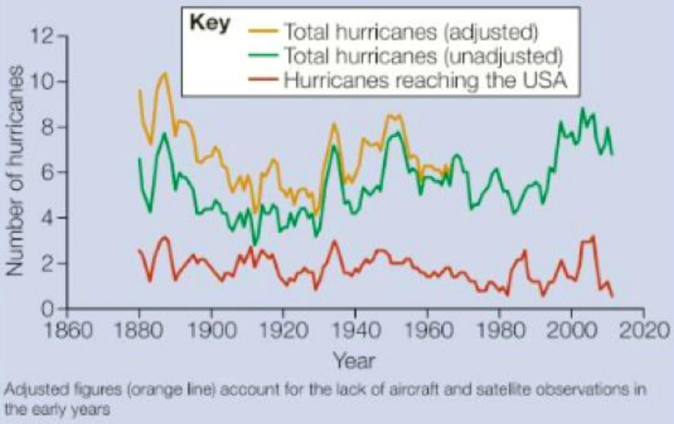
Hurricanes are the most extreme form of tropical storm. The Saffir-Simpson scale is a 1-5 rating based on a hurricane's sustained wind speed at that time. It can be used to give an indication of the potential damage and flooding.



Category	Wind speed	Description
1	119-153 km/h	**Low level of damage.** Roof coverings could partly be removed. Mobile homes and carports could be destroyed. Glass could be broken and people and livestock could be injured or killed by flying debris. Large branches of trees could break. Power cables could be damaged, resulting in power cuts.
2	154-177 km/h	**Moderate damage** caused by strong winds. All types of mobile homes and flimsy structures could be destroyed or shredded by flying debris. Roof structures on poorly constructed houses could be ripped off and unreinforced buildings could be damaged.
3	178-208 km/h	**Extensive level of damage.** People and livestock would risk death from flying debris. Older buildings, such as those made of metal could collapse. Windows could be blown out or smashed from flying debris. Trees could become uprooted. Gable ends and temporary structures, such as decking would be destroyed.
4	209-251 km/h	**Extreme level of damage**. Well-built homes can be damaged and poorly built homes can be completely destroyed. Windows from many buildings would be blown out. Signs and fences would be ripped out. Power cuts and water shortages would be significant.
5	Greater than 252 k/h	**Catastrophic level of damage.** Complete devastation. People and livestock could be killed even if indoors. Total destruction of homes regardless of age or building type. Damage from flying debris catastrophic. Industrial buildings destroyed. Significant power cuts and water shortages.

Frequency

Graph **B** shows the number of hurricanes recorded in the North Atlantic since 1878. Six of the ten most active years since 1950 have happened since the mid-1990s. Some computer models indicate that the frequency of tropical storms may decrease in the future – but, their *intensity* might increase.

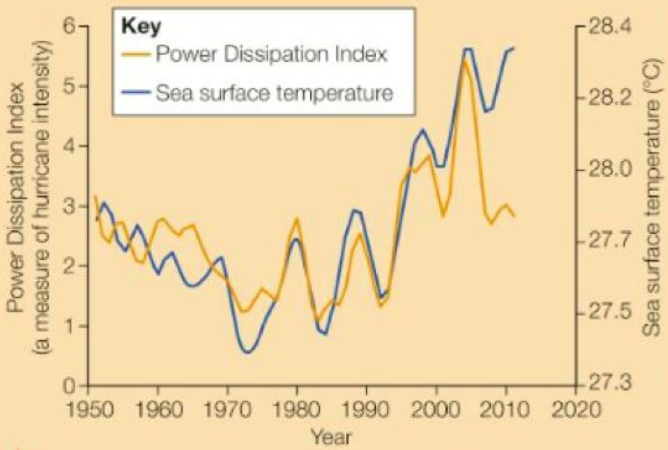


Adjusted figures (orange line) account for the lack of aircraft and satellite observations in the early years

B *Hurricanes in the North Atlantic, 1878–2013*

Intensity

Graph **C** shows hurricane intensity in the North Atlantic has risen in the last 20 years. This appears to be linked to increases in sea surface temperatures. But comparisons with the past may not be completely reliable. More data will be needed over a longer period of time.



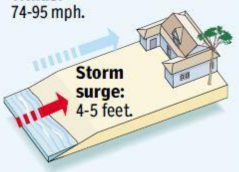
C *Hurricane intensity in the North Atlantic, 1951–2011*

SAFFIR-SIMPSON SCALE

The Saffir-Simpson Damage-Potential Scale determines the strength of a hurricane by categories, 1 being the weakest and 5 the strongest. Any hurricane of Category 3 or stronger is considered major. The scale was created by former director of the National Weather Center Robert Simpson, of Corpus Christi, and consulting engineer Herbert Saffir in the early 1970s.

CATEGORY 1

Winds:
74-95 mph.



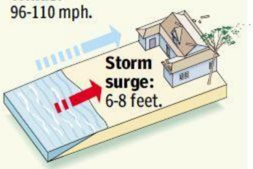
Example:
Earl, September 1998, Florida

Damage: Minimal.

- Damage to shrubbery, trees, foliage and unanchored homes.
- Low-lying coastal roads inundated, pier damage.

CATEGORY 2

Winds:
96-110 mph.



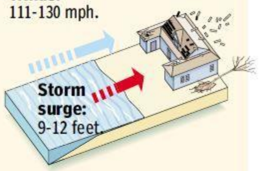
Example:
Georges, September 1998, Florida

Damage: Moderate.

- Some trees down.
- Major damage to exposed mobile homes. Some damage to roofing materials of buildings; some window and door damage.
- Considerable damage to piers. Marinas flooded.

CATEGORY 3

Winds:
111-130 mph.



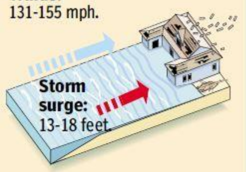
Example:
Katrina, August 2005, Florida, Louisiana

Damage: Extensive.

- Large trees blown down.
- Some damage to roofing materials of buildings; some wind and door damage.
- Some structural damage to small buildings.
- Mobile homes destroyed.

CATEGORY 4

Winds:
131-155 mph.



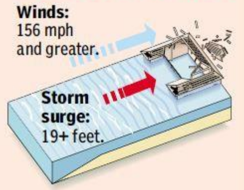
Example:
"Galveston," September 1900, Galveston

Damage: Extreme.

- Failure of roofs.
- Inland flooding as far as 6 miles cutting some escape routes.
- Damage to lower floors of structures near shore.
- Major erosion
- Evacuation of all residences within 500 yards of shore possibly required.

CATEGORY 5

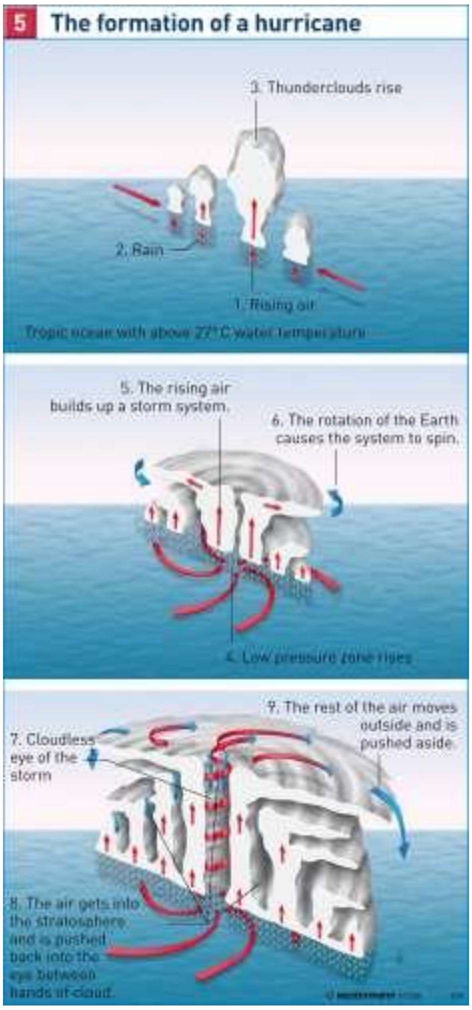
Winds:
156 mph and greater.

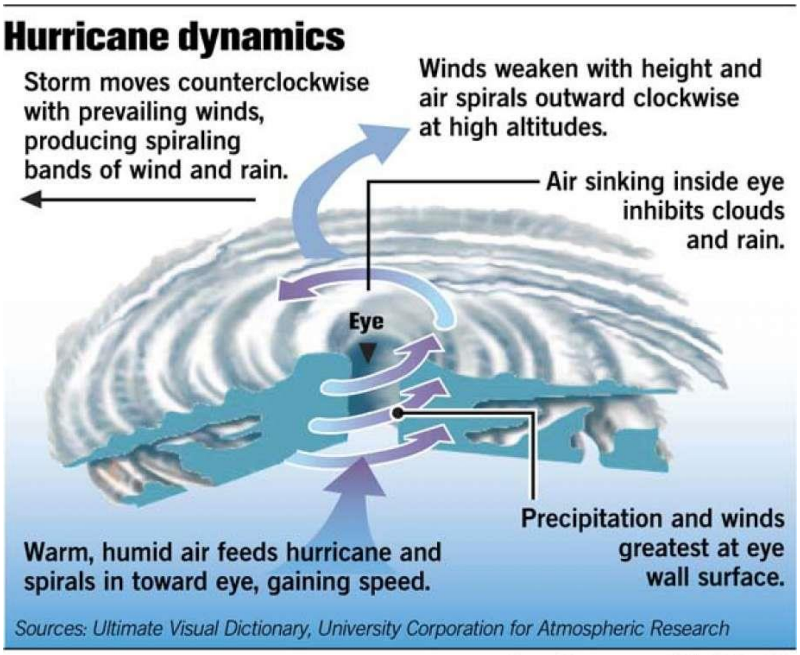


Example:
Camille (reached wind speeds of 190 mph), August 1969, Mississippi

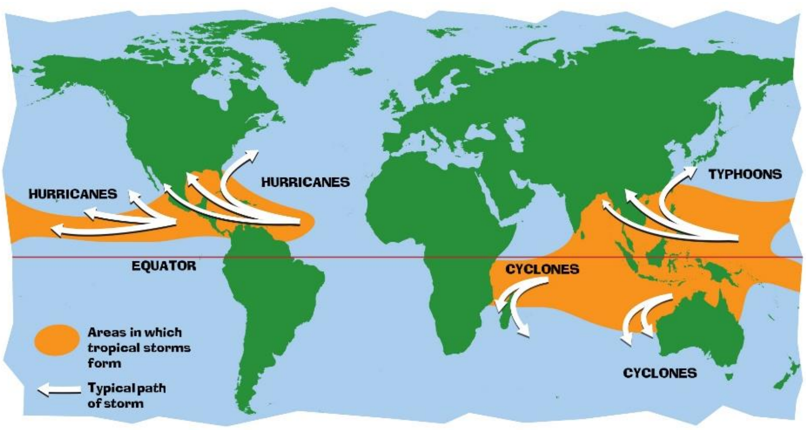
Damage: Catastrophic.

- Very severe and extensive damage to windows and doors.
- Failure of roofs on many buildings.
- Some complete building failures.
- Small buildings overturned.
- Massive evacuation possibly required.





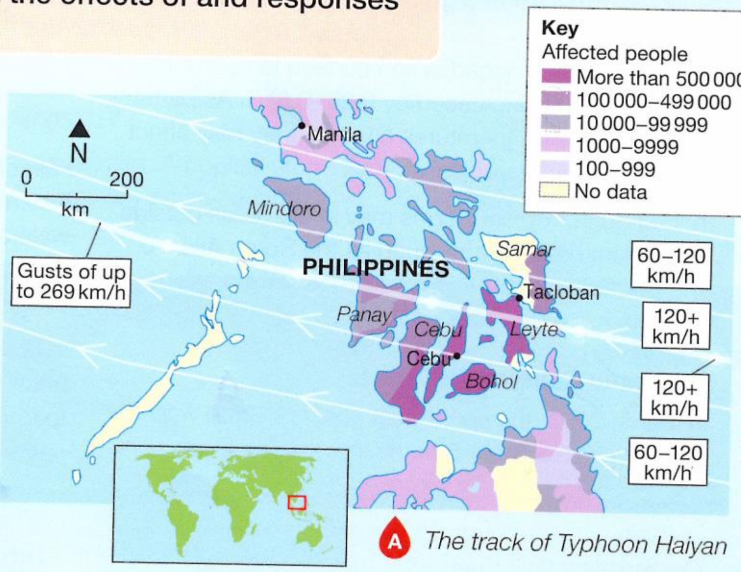
JOHN BLANCHARD / *The Chronicle*



On this spread you will find out about the effects of and responses to Typhoon Haiyan

Tropical storms can have devastating effects on people and property. The strong winds can tear off roofs, overturn cars and make large objects fly. Torrential rain can lead to flooding. Strong winds and low atmospheric pressure may cause the sea level to rise by several metres to form a destructive storm surge. These storm surges cause the most loss of life.

Tropical storms can be tracked and warnings given for people to evacuate coastal areas. In the aftermath, people need emergency support. Reconstruction may take many months.



A *The track of Typhoon Haiyan*

What happened?

In November 2013 'Super' Typhoon Haiyan – a category 5 storm on the Saffir-Simpson scale – hit the Philippines (map **A**). Huge areas of coastline and several towns were devastated by winds of up to 275 km/h (170 mph) and waves as high as 15 m (45 ft). It was one of the strongest storms ever recorded.

What were the effects of Typhoon Haiyan?

The province of Leyte took the full force of the storm. The city of Tacloban was one of the worst affected places, with most of the 220 000 inhabitants left homeless.

Most of the destruction in Tacloban was caused by a 5-metre high *storm surge*. This is a wall of water similar to a tsunami. The very low atmospheric pressure associated with the typhoon caused the level of the sea to rise. As the strong winds swept this water onshore, it formed a wall of water several metres high.

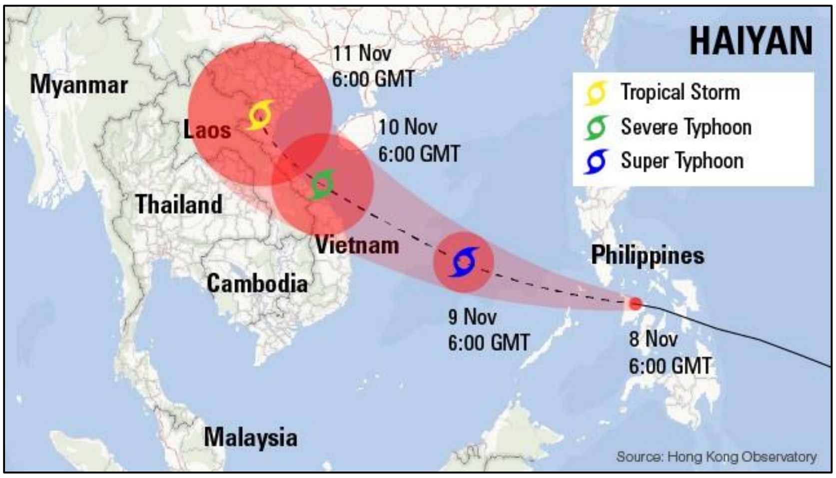
B *The destruction at Tacloban*

Primary effects (impacts of strong winds, heavy rain and storm surge)

- About 6300 people killed – most drowned by the storm surge.
- Over 600 000 people displaced and 40 000 homes damaged or flattened – 90% of Tacloban city destroyed.
- Tacloban airport terminal badly damaged.
- The typhoon destroyed 30 000 fishing boats.
- Strong winds damaged buildings and power lines and destroyed crops.
- Over 400 mm of rain caused widespread **flooding**.

Secondary effects (longer-term impacts resulting from primary effects)

- 14 million people affected, many left homeless and 6 million people lost their source of income.
- Flooding caused landslides and blocked roads, cutting off aid to remote communities.
- Power supplies in some areas cut off for a month.
- Ferry services and airline flights disrupted for weeks, slowing down aid efforts.
- Shortages of water, food and shelter affected many people, leading to outbreaks of disease.
- Many jobs lost, hospitals were damaged, shops and schools were destroyed, affecting people's livelihoods and education.
- Looting and violence broke out in Tacloban.



What were the responses to Typhoon Haiyan?

Immediate responses

- International government and aid agencies responded quickly with food aid, water and temporary shelters.
- US aircraft carrier *George Washington* and helicopters assisted with search and rescue and delivery of aid.
- Over 1200 evacuation centres were set up to help the homeless.
- UK government sent shelter kits (photo **D**), each one able to provide emergency shelter for a family.
- French, Belgian and Israeli field hospitals set up to help the injured.
- The Philippines Red Cross delivered basic food aid, which included rice, canned food, sugar, salt and cooking oil.

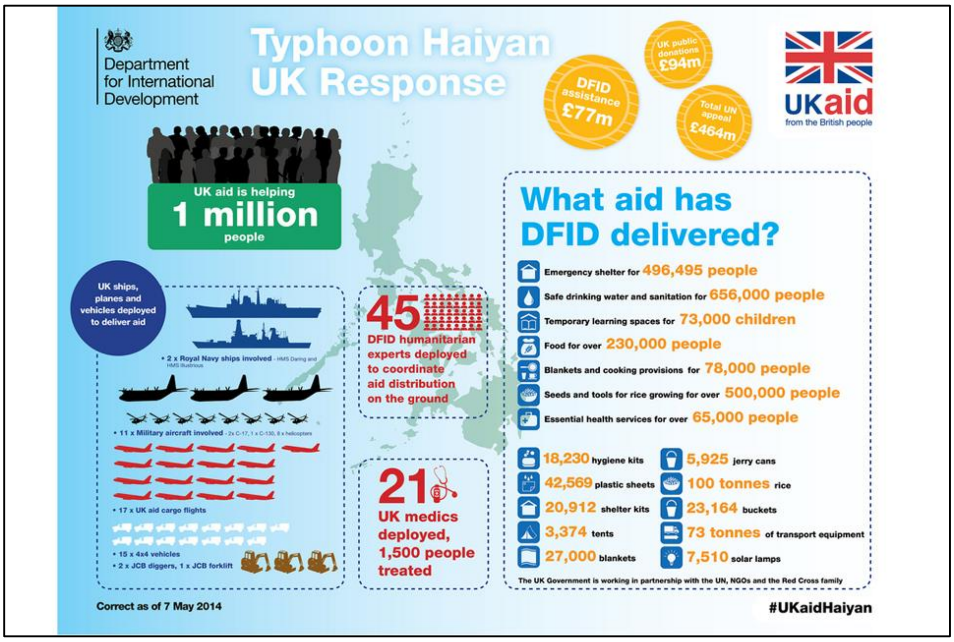
C A survivor in Tacloban

Long-term responses

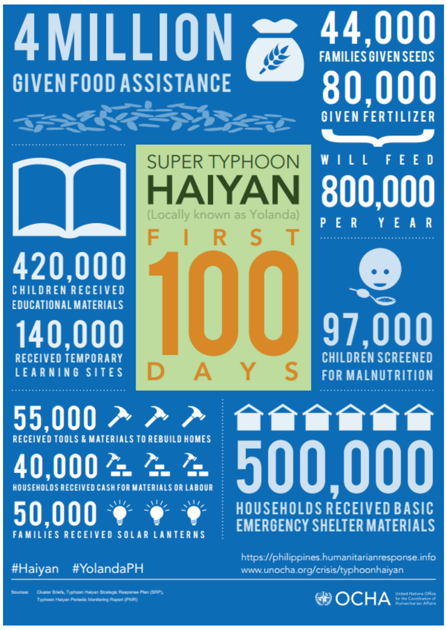
- The UN and countries including the UK, Australia, Japan and the US donated financial aid, supplies and medical support.
- Rebuilding of roads, bridges and airport facilities.
- 'Cash for work' programmes – people paid to help clear debris and rebuild the city.
- Foreign donors, including the US, Australia and the EU, supported new livelihood opportunities.
- Rice farming and fishing quickly re-established. Coconut production – where trees may take five years to bear fruit – will take longer.
- Aid agencies such as Oxfam supported the replacement of fishing boats – a vital source of income.
- Thousands of homes have been built away from areas at risk from flooding.
- More cyclone shelters built to accommodate people evacuated from coastal areas.

D The contents of a Shelter Box

11.5 million
people affected
2.5 million
people in need of food aid
544,606
people displaced
130,074
houses totally destroyed
1,215
evacuation centres set up
Source: OCHA & NDRRMC
AFP

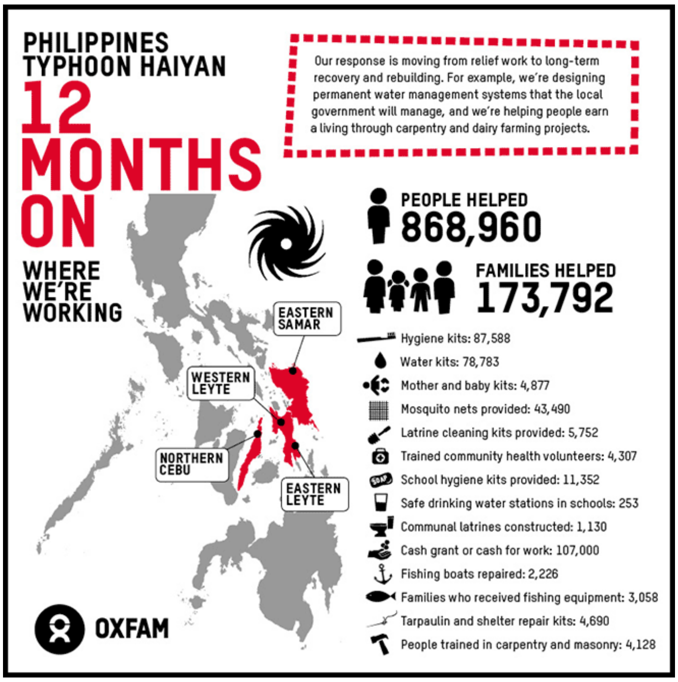


Department for International Development
Typhoon Haiyan UK Response
DFID assistance £77m
UK public donations £94m
Total UN appeal £464m
UKaid from the British people
UK aid is helping 1 million people
UK ships, planes and vehicles deployed to deliver aid
2 x Royal Navy ships involved
11 x Military aircraft involved
17 x UK aid cargo flights
15 x 4x4 vehicles
2 x JCB diggers, 1 x JCB forklift
45 DFID humanitarian experts deployed to coordinate aid distribution on the ground
21 UK medics deployed, 1,500 people treated
What aid has DFID delivered?
Emergency shelter for 496,495 people
Safe drinking water and sanitation for 656,000 people
Temporary learning spaces for 73,000 children
Food for over 230,000 people
Blankets and cooking provisions for 78,000 people
Seeds and tools for rice growing for over 500,000 people
Essential health services for over 65,000 people
18,230 hygiene kits
5,925 jerry cans
42,569 plastic sheets
100 tonnes rice
20,912 shelter kits
23,164 buckets
3,374 tents
73 tonnes of transport equipment
27,000 blankets
7,510 solar lamps
The UK Government is working in partnership with the UN, NGOs and the Red Cross family
Correct as of 7 May 2014
#UKaidHaiyan



4 MILLION
GIVEN FOOD ASSISTANCE
44,000
FAMILIES GIVEN SEEDS
80,000
GIVEN FERTILIZER
WILL FEED
800,000
PER YEAR
SUPER TYPHOON
HAIYAN
(Locally known as Yolanda)
FIRST
100
DAYS
420,000
CHILDREN RECEIVED EDUCATIONAL MATERIALS
140,000
RECEIVED TEMPORARY LEARNING SITES
97,000
CHILDREN SCREENED FOR MALNUTRITION
55,000
RECEIVED TOOLS & MATERIALS TO REBUILD HOMES
40,000
HOUSEHOLDS RECEIVED CASH FOR MATERIALS OR LABOUR
50,000
FAMILIES RECEIVED SOLAR LANTERNS
500,000
HOUSEHOLDS RECEIVED BASIC EMERGENCY SHELTER MATERIALS
#Haiyan #YolandaPH
https://philippines.humanitarianresponse.info
www.unocha.org/crisis/typhoonhaiyan
OCHA

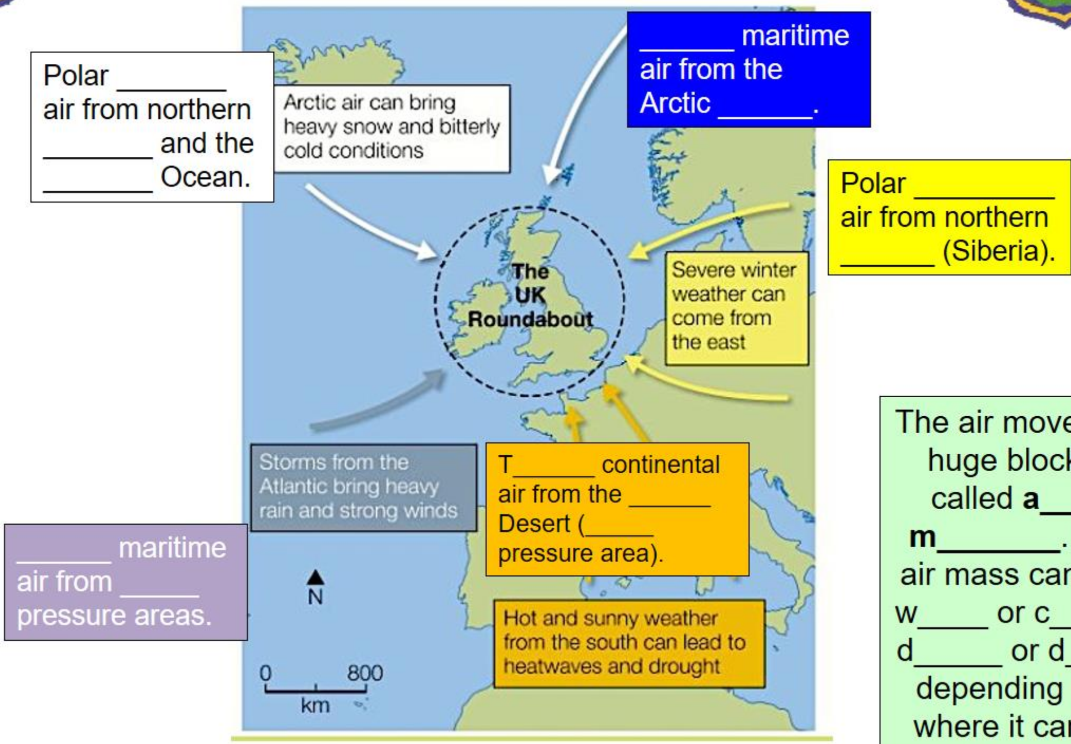
SUPER TYPHOON
HAIYAN
locally known as Yolanda
5
13 MILLION PEOPLE AFFECTED
3,000,000 DISPLACED
US$ 301 MILLION NEEDED
23% FUNDED
1,087 EVACUATION CENTRES
371,000 PEOPLE INSIDE
2,700,000* PEOPLE OUTSIDE
*opted to stay with their friends and families
REGION VI
90%
DAY CARE CENTERS AND PUBLIC SCHOOLS DAMAGED
REGION VIII
1,948
SCHOOLS DESTROYED
1400
SCHOOL PACKS SENT EASTERN SAMAR AND LEYTE
478,343 HOUSES DAMAGED
50% DESTROYED
5 FOREIGN MEDICAL TEAMS IN TACLOBAN
34,095 DSWD/WFP FAMILY FOOD PACKS REACHED 170,475
2.5 MILLION PEOPLE in need of food assistance
4.9M CHILDREN at risk of malnutrition
134,000 HECTARES OF CROPS AFFECTED
40% DESTROYED
28,000 WATER CONNECTIONS RESTORED
(as of 16 November 2013)
#Haiyan #YolandaPH
https://philippines.humanitarianresponse.info
www.unocha.org/crisis/typhoonhaiyan
@OCHAAsiaPac
OCHA



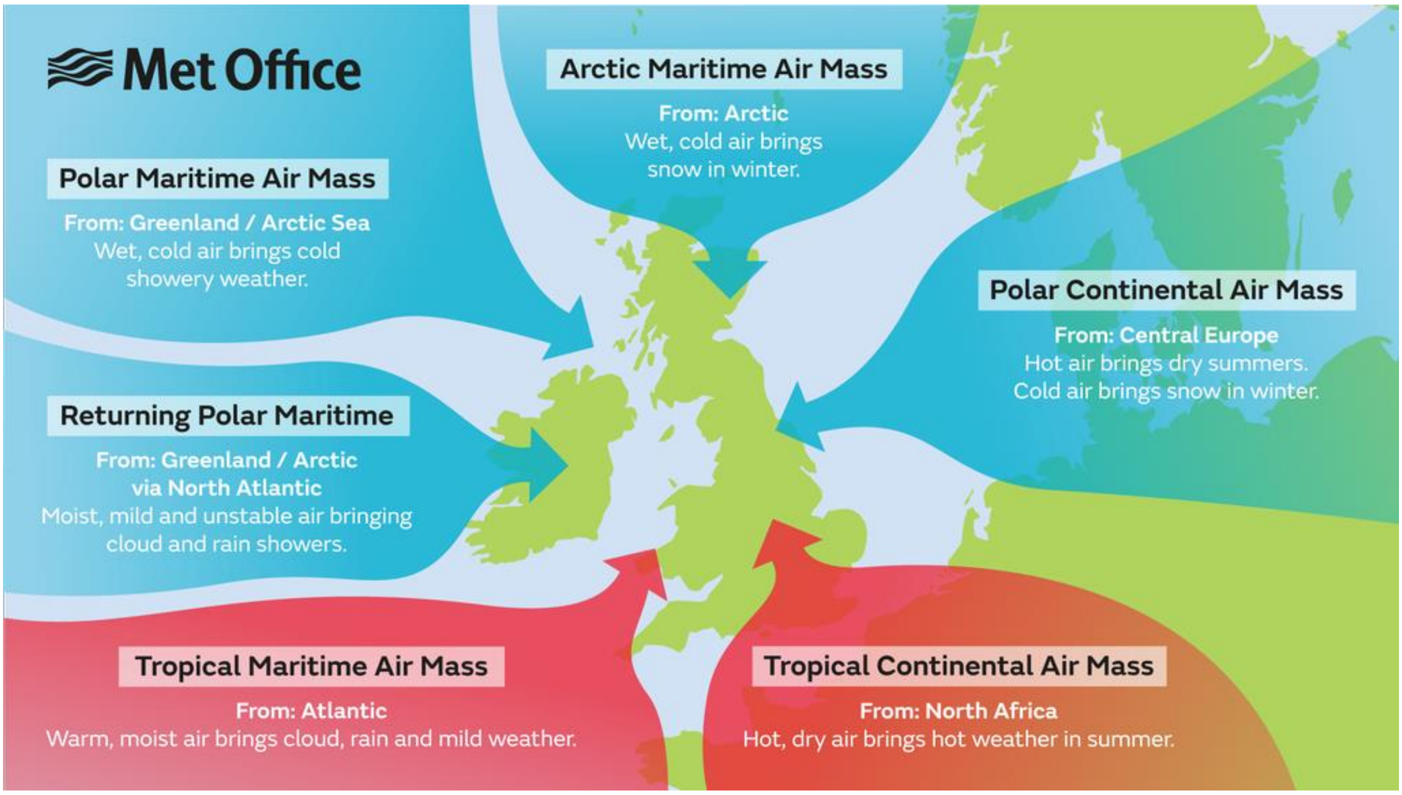
PHILIPPINES TYPHOON HAIYAN
12 MONTHS ON
Our response is moving from relief work to long-term recovery and rebuilding. For example, we're designing permanent water management systems that the local government will manage, and we're helping people earn a living through carpentry and dairy farming projects.
WHERE WE'RE WORKING
EASTERN SAMAR
WESTERN LEYTE
NORTHERN CEBU
EASTERN LEYTE
PEOPLE HELPED 868,960
FAMILIES HELPED 173,792
Hygiene kits: 87,588
Water kits: 78,783
Mother and baby kits: 4,877
Mosquito nets provided: 43,490
Latrine cleaning kits provided: 5,752
Trained community health volunteers: 4,307
School hygiene kits provided: 11,352
Safe drinking water stations in schools: 253
Communal latrines constructed: 1,130
Cash grant or cash for work: 107,000
Fishing boats repaired: 2,226
Families who received fishing equipment: 3,058
Tarpaulin and shelter repair kits: 4,690
People trained in carpentry and masonry: 4,128
OXFAM

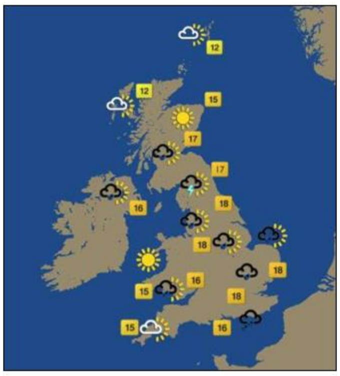
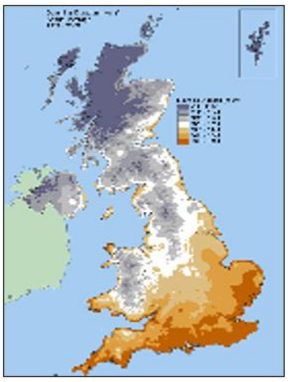
Lesson 14-15: Weather hazards in the UK

PREPARE: The UK's weather roundabout



The air moves in huge blocks called **a**___ **m**_______. An air mass can be w____ or c____, d_____ or d___, depending on where it came from.



The term *Weather* means:	The term *Climate* means:
The ________________________. For example: the day to day conditions like temperature and cloud cover.	The ____________in a place over a long period of time.
	

Weather hazard	Potential effect
Thunderstorms	1. Heavy rain, lightening and strong winds occur during thunderstorms. 2. They are are most common in .... in the .... and .... of the UK.
Prolonged rainfall	1. Too much rain in a short time can cause ...., which can damage homes and possessions, disrupt transport networks and cause death by drowning. 2. .... close and and recovering from flooding can cost ....of pounds.
Drought and extreme heat	1. Sometimes the UK can have long periods of .... This can cause deaths from heat .... or breathing difficulties as pollution builds up in the air. 2. Disruption to transport from rails .... or roads melting can cause .... impacts-<u>but the tourism industry may benefit from better weather.</u> 3. Drought is a lack of precipitation (not enough rain, hail, sleet or snow). 4. Rules to .... water (like banning hosepipe use) have to be introduced.

Heavy snow and extreme cold	1. Snow and ice can cause injuries due to ………………. and deaths due to the cold. 2. Schools and businesses can be forced to shut, and major disruption to road, rail and air travel can occur causing economic impacts. 3. Cold snaps can damage ……………. and other plants.
Strong Winds	1. Strong winds (gales) can damage properties and cause disruption to …………….. 2. ……………. trees and debris can injure or kill people. 3. Forests can be damaged when trees are blown over. 4. Winds are strongest in ………….. areas of the UK, particularly the west coast and in upland areas.

The Somerset level floods 2014

Present: Areas of high flood risk in England and Wales

Construct:

1. Using this map to support you, describe the areas most at risk from flooding in the England and Wales.
2. Where are the Somerset Levels?

Lesson 16 – The Somerset Levels Floods

On this spread you will find out about flooding on the Somerset Levels in 2014

Where are the Somerset Levels?

Somerset is a county in south-west England. The Somerset Levels and the Somerset Moors form an extensive area of low-lying farmland and wetlands bordered by the Bristol Channel and Quantock Hills to the west and the Mendip Hills to the north (map **A**).

The area is drained by several rivers, most notably the Tone and the Parrett, which flow to the Severn Estuary via Bridgwater. Flooding has occurred naturally here for centuries. As the area has been developed for farming and settlement, many people are now at risk from extreme flood events.

A *The Somerset Levels*

What caused the floods in 2014?

There were several factors that led to extensive flooding of the Somerset Levels.

- It was the wettest January since records began in 1910. A succession of depressions (areas of low pressure) driven across the Atlantic Ocean brought a period of wet weather lasting several weeks. About 350 mm of rain fell in January and February, about 100 mm above average.
- High tides and storm surges swept water up the rivers from the Bristol Channel. This prevented fresh water reaching the sea and it spilled over the river banks.
- Rivers had not been dredged for at least 20 years, and had become clogged with sediment.

B *Rescuing a resident from Moorland*

What were the impacts of the flood?

Between December 2013 and February 2014, the Somerset Levels hit the national headlines as the area suffered extensive flooding. It was the most severe flooding ever known in the area.

Social	Economic	Environmental
• Over 600 houses flooded • 16 farms evacuated • Residents evacuated to temporary accommodation for several months • Villages such as Moorland and Muchelney cut off. This affected people's daily lives, e.g. attending school, shopping, etc. • Many people had power supplies cut off	• Somerset County Council estimated the cost of flood damage to be more than £10 million • Over 14 000 ha of agricultural land under water for 3–4 weeks • Over 1000 livestock evacuated • Local roads cut off by floods • Bristol to Taunton railway line closed at Bridgwater	• Floodwaters were heavily contaminated with sewage and other pollutants including oil and chemicals • A huge amount of debris had to be cleared • Stagnant water that had collected for months had to be reoxygenated before being pumped back into the rivers

C *The impacts of the Somerset Levels floods*

/lanaging the floods

Immediate responses

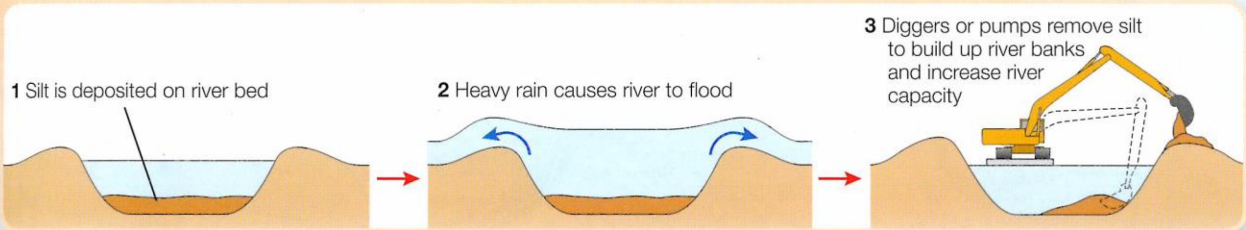
As the floodwaters spread out over the Somerset Levels, homeowners coped as best they could. Villagers cut off by the floods used boats to go shopping or attend school. Local community groups and volunteers gave invaluable support.

The village of Burrowbridge almost cut off by the floods **D**

Longer-term responses

A £20 million Flood Action Plan has been launched by Somerset County Council who will work together with agencies such as the Environment Agency to reduce the risk of future flooding.

- In March 2014, 8 km of the Rivers Tone and Parratt were dredged to increase the capacity of the river channel (diagram **E**).
- Road levels have been raised in places to maintain communications and enable businesses to continue during future flood events.
- Vulnerable communities will have flood defences.
- River banks are being raised and strengthened and more pumping stations will be built.
- In the longer term – by 2024 – consideration will be given to a tidal barrage at Bridgwater.



E *How dredging works*

ACTIVITIES

1 Why do you think the Somerset Levels are prone to flooding (map **A**)?

2 What were the factors contributing to the floods in 2014?

3 a Describe the extent of the flooding (photo **D**).
  b Several roads were flooded. What impact did this have on local people?
  c Suggest the impact of the flooding on farmers in the area.

4 Make a copy of diagram **E**. Add labels to describe how dredging can help reduce the flood risk.

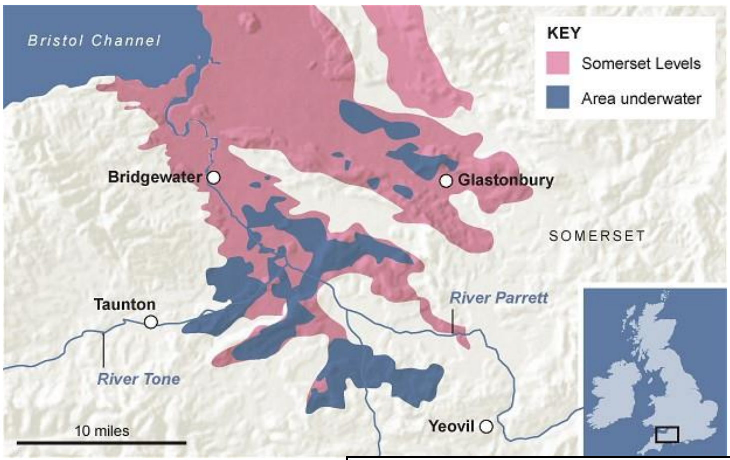
Stretch yourself

Imagine you are a local councillor in Somerset. Analyse research plans to construct a tidal barrage at Bridgwater (they can be found on the internet).

What would this scheme involve and how would it reduce the risk of flooding?

Practice question

Using table **C**, evaluate the main impacts of the flooding of the Somerset Levels. *(6 marks)*



Case study: a UK flood caused by extreme weather conditions

The Somerset Levels, 2014

What are the Somerset Levels?

- The Somerset Levels and Moors is a unique flat landscape that extends for about 170,000 acres (70,000 ha) across parts of the north and centre of the county of Somerset in the West of England.
- It's one of lowest and flattest areas in the country with much of it below high-water level on spring tides, and a maximum altitude of only 25ft (8m) above sea level.
- The wetland is supplied by the rivers Axe, Sheppey and Brue in the north, while to the south, the rivers are the Cary, Yeo, Tone and Parrett.
- It reaches from Clevedon near Bristol in the north to Ilchester in the south. Bridgwater Bay and the tidal Bristol Channel beyond form its western boundary.
- Thousands of years ago the area was covered by the sea, but today it's a landscape of rivers and wetlands - artificially drained, irrigated and modified to allow productive farming.

What caused the floods?

Physical causes

- Prolonged rainfall: In January 2014 in southern England, rainfall totalled 183.8 mm, which is almost 200% higher than average for that month. This combined with hurricane force winds and tidal surges from the Bristol Channel, which prevented the floodwater from being taken to the sea, forcing it to back up the rivers.
- Saturated ground: The long period of rainfall caused the ground to become saturated so that it could not hold any more water.
- Low-lying land: Much of the area lies at, or just a few metres above, sea level, putting it at risk of flooding.
- From mid-December to mid-February 2014, there were twelve major storms in the area

Human causes

- Lack of dredging: Over the years the rivers had become clogged with sediment. The Environment Agency had decided to stop dredging the rivers some time earlier. This process involves digging up weeds and mud from the river bed to deepen the river channel and increases the ability of a river to carry more water. Dredging used to happen every year but cost approximately £4 million.
- Change in farming practices: Much of the land has been converted from grassland to grow maize. This more intensive use of the land means it is less able to retain water, causing it to run over the surface rather than being absorbed.
- Urban developments on the floodplain increased the amount of impermeable surface in the area.

MEDC Flooding: Somerset levels 2014

It began on the Somerset levels by the river Parrett on the 31st January 2014.

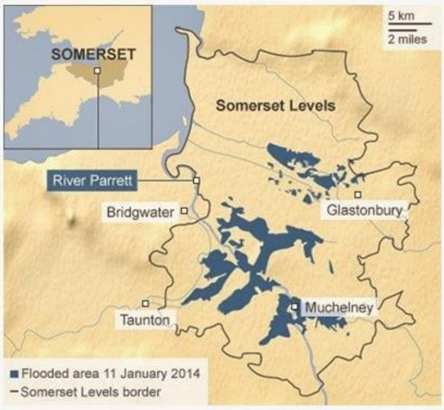
Headline facts/stats

The Somerset levels were part of the sea a few thousand years ago but then were drained by man to build and farm on.

Costs of floods exceed £1 billion in January 2014.

There were no reported deaths.

1,135 homes were flooded.



Primary

Natural - Prolonged rain, **hurricane force wind speeds** and tidal surges caused widespread flooding, power cuts and major disruptions to transport. (183.3 mm of rain which was 151% higher than average).

Secondary

Human/Natural - Somerset has a fair amount of farms with the presence of livestock. This results in floods because the livestock will graze which will reduce the vegetation and reduce the rate of infiltration resulting in more surface run off.

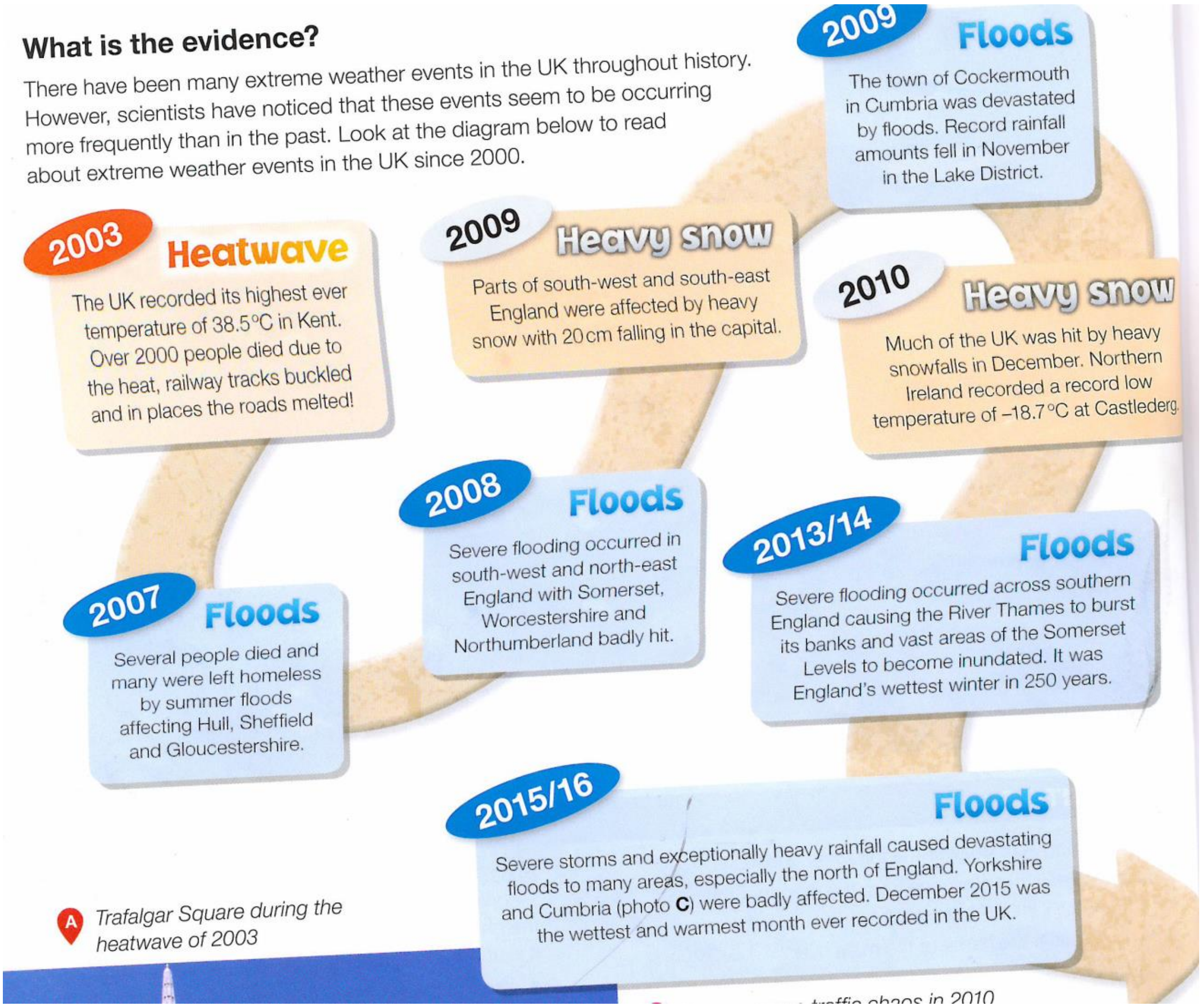
In addition to this, the livestock will trample over the land making it less permeable which increase surface run off.

Human - The ditches where the water would usually drain into were not cleared out. This meant water had nowhere to go meaning that the surface run off increased, leading to floods.

Human - Parts of the Somerset Levels like Bridgwater and Taunton have been urbanised like roads made up of impermeable rock such as tarmac, which results in the increase of overland flow (water is transferred more quickly).

http://www.telegraph.co.uk/news/weather/10607011/Somerset-floods-this-is-a-man-made-disaster.html

Lesson 18 Extreme weather in the UK



The weather in the UK is becoming more extreme.

1. **Temperatures have become more extreme** in recent years. December 2010 was the coldest for over 100 years, with severe snow and ice (see below). But just 4 months later, April 2011 was the warmest April on record.
2. **It's raining more!** More rainfall records have been broken in 2010-2014 than in any decade on record, even after only half a decade. 2013 was one of the wettest years on record, and December 2015 was the wettest month ever recorded.
3. **Major flooding occurs often!** There was major flooding caused by storms and high rainfall in the Somerset Levels during the winter of 2013-2014, in west Wales in 2012, in Cumbria in 2005, 2009 and 2015-2016 (along with large parts of northern England and parts of Scotland.

Case study: An example of Extreme UK weather: November 2010 and December 2010

When: 25 November 2010 to 26 December 2010

What: A long period of heavy snow and very cold weather across the UK

Why: Cold air form northern Europe and Siberia caused two long periods of very cold weather with a brief thaw in between.

Social impacts:

- Several people died from hypothermia or accidents due to losing control on icy roads.
- Lots of water piped froze and burst. When they thawed, the pipes started to leak. 40,000 homes and businesses across Northern Ireland were left without water, in some cases for over a week.
- Schools closed on several occasions, including 7000 schools on the 2 December 2010 meaning many parents had to take time off work (if they could get there) and look after their children.

Economic Impacts

- Transport networks were severely disrupted. Some motorways were shut, the M8 motorway was closed for two days. Some drivers were trapped in their cars for over 15 hours. Trains and flights were also cancelled.
- As a result some people were unable to get to work, affecting the UK's economy.
- The run up to Christmas is a busy time for shops. In 2010 their sales were down as shoppers were put off by the weather.
- The overall economic impact was around £1.6 billion-enough to reduce the UK's GDP by about 0.5%.

Environmental impacts

- Snow covered almost all of the UK on several occasions-to a depth of over 50cm in some hilly locations.
- The frost damaged crops, especially sugar beet.
- Use of gas and electricity was more than double than a normal December, increasing CO_2 emissions.

Management: How did the UK manage the extreme cold?

- **Prediction-** Warning systems gave people time to prepare for the extreme weather. For example, the Met Office first warned about the cold weather at the start of November 2010.
- **Protection-** individuals and local authorities prepared for the extreme weather before it happened. For example, councils stocked up on gritters and salt supplies to keep roads safe and open in cold weather-although there were some shortages as the cold spell went on.
- **Planning-**emergency services and local councils planned how to deal with extreme weather events in advance e.g. They made plans to close schools when it would be too dangerous to get there.

The Beast From The East 2018

Under normal circumstances, winters in the UK are mild compared to some places on the same latitude. This is because of the jet stream, a warm air mass that travels across the Atlantic Ocean from Mexico to the UK. However, a meteorological event called stratospheric warming disturbed the jet stream – allowing cold winds from Russia to travel as far as Great Britain. At this time of year, there is normally a polar vortex – a large mass of cold air – in the upper atmosphere, also known as the stratosphere. This vortex is what causes air to usually move from west to east. However, there was a huge rise in air temperature of around 50C in an area around 18 miles above the Earth in the North Pole. Sudden stratospheric warming caused a weakening of the jet stream. This led to a change in direction of the winds approaching the UK from west to east to east to west, allowing a cold air mass (polar continental air mass) from Russia to cover The UK.

When the air left Siberia, Russia, it was around -50°C. By the time it reached the UK it was just below freezing, though this was still cold for the time of year. The air mass picked up water over the North Sea which resulted in heavy snowfall when it reached The UK.

BBC Weather clip Storm Emma

The Beast from the East meets Storm Emma

Storm Emma was a weather system which originated from the Azores and travelled north to the UK. On 1st March 2018, the weather front brought blizzards, gales and sleet as it hit the cold air brought down by the Beast from the East. The Met Office issued a series of red warnings for southern England. Without the cold air, and if there were normal or average UK temperatures, Storm Emma would instead have caused wet and windy conditions.

Primary impacts of the Beast from the East

•10 people died

•Up to 50cms of snow fell on high ground

•Rural (countryside) areas experienced temperature lows of up to -12°C

Secondary impacts of the Beast from the East

•Hundreds of schools were forced to close

•Thousands of schools were closed across the UK, including more than 125 in North Yorkshire and more than 330 across Kent, and hospital operations were cancelled.

•Many rail services were cancelled.

•British Airways cancelled hundreds of short-haul flights from Heathrow, and London City Airport also cancelled many services.

•The National Grid issued a 'gas deficit warning' prompting fears of a shortage, but households were reassured domestic supplies would not be affected.

•Nearly all train operators warned of cancellations and disruption and hundreds of flights were cancelled.

•Hundreds of motorists on the M80 near Glasgow reported being stuck for up to 13 hours, with some spending the night in their cars, and others abandoning their vehicles. Around 1,000 vehicles were at a standstill, tailing back eight miles in both directions.

•There was a shortage of food in some supermarkets

•Drifting snow led to the isolation of a number of villages

Response

•Red weather warnings were issued covering parts of Scotland, Devon, Somerset and South Wales and prompted Devon and Cornwall police to declare a major incident. The red weather warming was just the third in seven years.

•Flood warnings were issued by the Environment Agency for parts of Cornwall's south coast. Residents were told to expect tides to be around 400mm

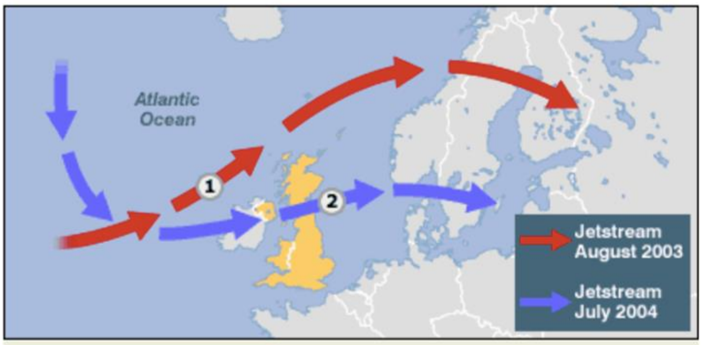
•The Royal Air Force was drafted in to help relief efforts in snow-hit Lincolnshire. Ten RAF vehicles and their crews transported doctors and stranded patients after local police admitted they were struggling to cope.

•High on the Pennines on the M62, the military was called in to help rescue vehicles.

•In Edinburgh, soldiers were deployed to help transport about 200 NHS clinical and support staff to and from the Western General Hospital and Edinburgh Royal Infirmary.

Beast From The East vs Storm Emma

Present: Impact of the Jet Stream



- **1** Jetstream passing north of the UK bringing settled, dry and warm weather
- **2** Jetstream passing further south, causing weather that is unsettled and cool for the time of year

- Weather systems cross the UK from west to east, driven by winds from the jet stream.
- The jet stream moves between north & south of the UK.
- Sometimes the jet stream gets 'stuck' giving the UK a long period of the same weather.

Sometimes a large area of high pressure over northern Europe can 'block' the movement of weather systems across the UK too.

Why might extreme weather events be on the increase?

Recent extreme weather events have also occurred elsewhere in the world. There have been devestating floods in Pakistan (2010), intense heatwaves in Russia (2010) and severe droughts in western USA (2014).

No single extreme weather event can be blamed on climate change. However, scientists believe that a trend over many years could be linked to a warming world.

- More energy in the atmosphere could lead to more intense storms.
- The atmospheric circulation may be affected, bringing floods to normally dry regions and heatwaves to normally cooler areas.

In 2011 the Intergovernmental Panel on Climate Change concluded that extreme weather would become more common as global warming heats the planet.

<u>Could our weather patterns be getting stuck?</u>

Weather systems cross the UK mainly from west to east, driven by winds from the *jet stream* (see above). The jet stream moves north and south but can 'stick' in one position, resulting in a long period of the same type of weather, such as heavy rain or drought. A large areas of high pressure over Northern Europe can block the easterly movement of weather systems and have a similar effect on UK weather.

In 2014 scientists in Germany published a report. It suggested that in recent years weather patterns have become 'stuck' for long periods of time. This has resulted in prolonged periods of high temperatures (heatwaves and droughts) and heavy rain (floods).

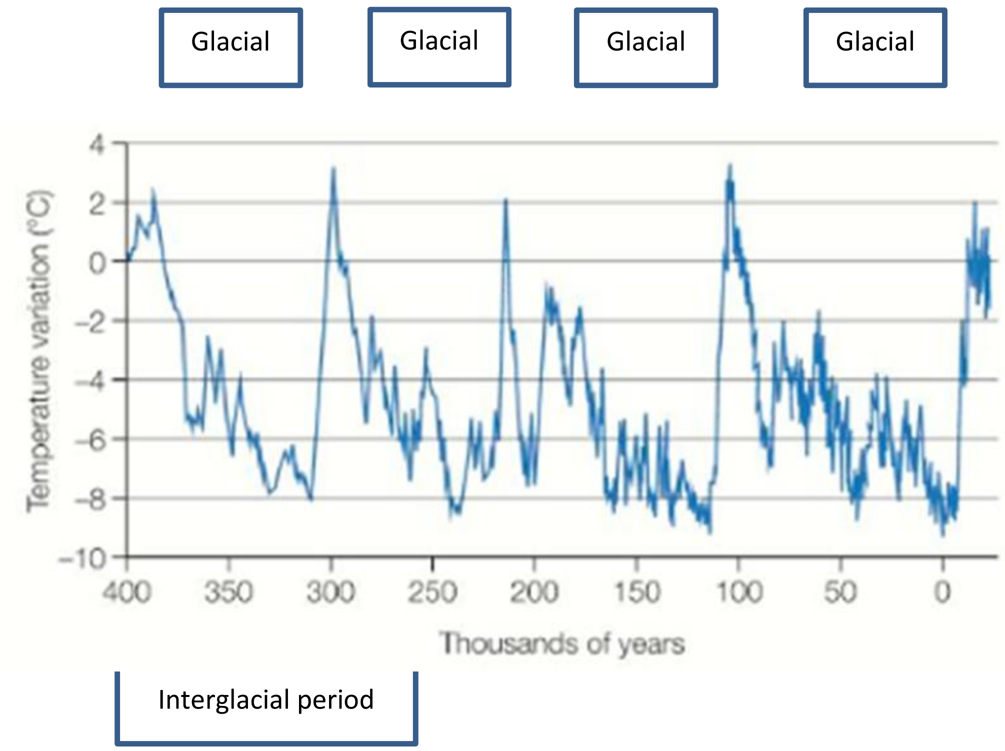
These periods seem to have become more frequent in recent years and this could be due to climate change. A warming Arctic, for example, may slow down the atmospheric circulation in the northern hemisphere mid-latitudes resulting in the weather 'sticking' for long periods of time. This could explain the recent heatwaves and floods.

<u>Lesson 19 Evidence for Climate Change</u>

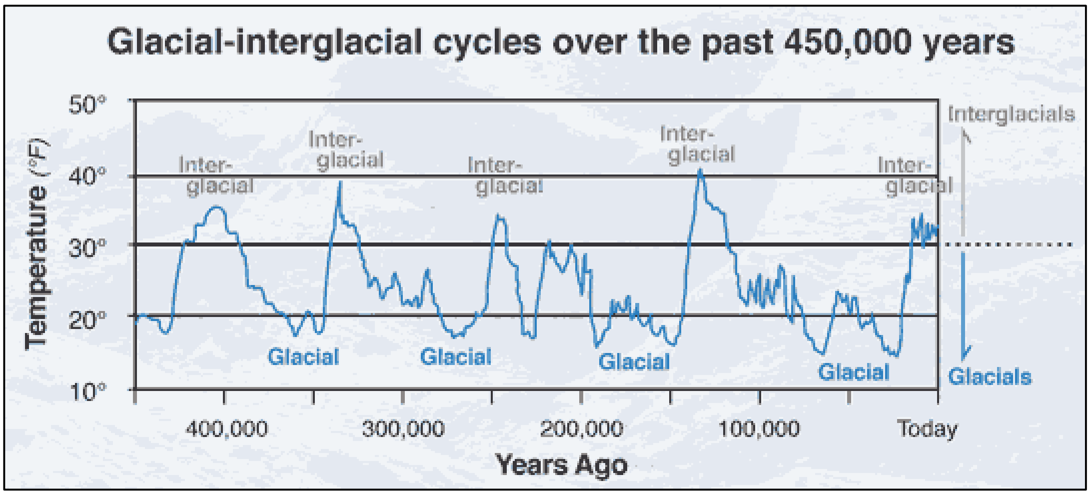
The Earth is getting warmer.

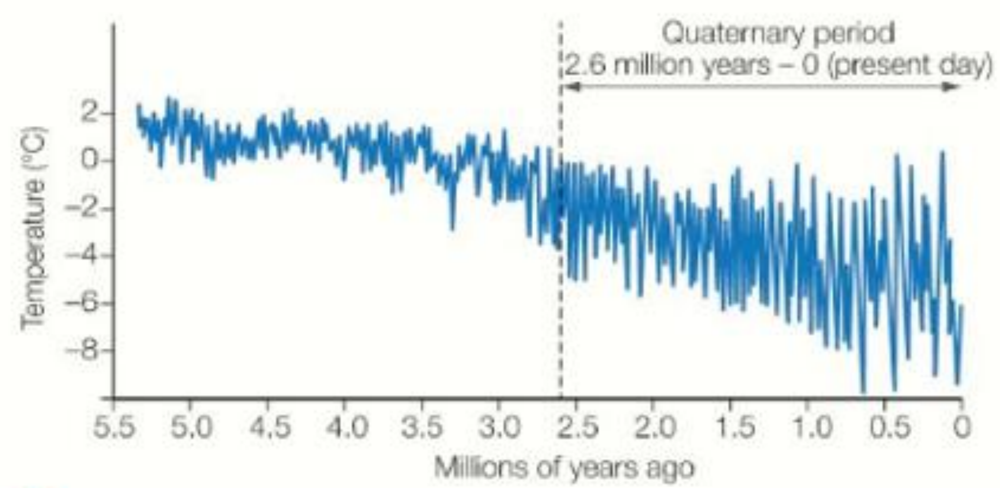
Measuring global temperatures:

- We can estimate average global temperatures going back 5.5 million years
- The Earth formed 4600 million years ago though!
- The last 2.6 million years is called the Quaternary period
- During this period global temperatures have fluctuated a lot but overall there is a gradual decline in temperatures
- The cold spikes are *glacial periods* when Europe & North America were covered in snow and ice
- The warm spells are called *inter-glacial periods*
- We are in one of these periods now
- However average global temperatures are higher now than most of the Quaternary period so far
- In the past 130 years global temperatures have gradually risen by 0.85°C



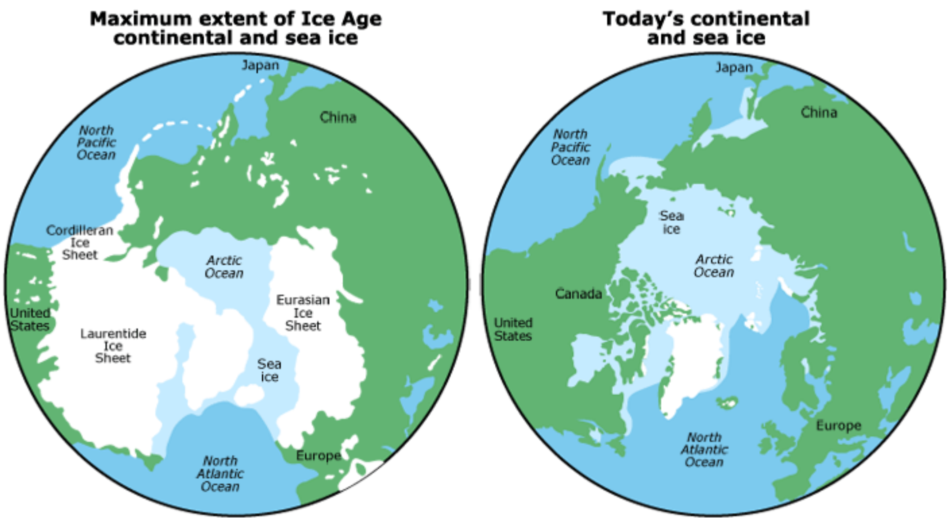
This graph shows the last 400,000 years but the glacial-interglacial cycles have been repeating throughout the Quaternary period. But, there have been a least 20! During the Quaternary global temperature has shifted between cold glacial periods that last for around 100,000 years, and warmer interglacial periods that last for around 10,000 years.





A *Average global temperatures for the last 5.5 million years using information from sediment cores*

Graph A shows the pattern of global temperatures for the last 5.5 million years. It may seem like a long time but remember that the Earth was formed 4600 million years ago! In the period before the Quaternary the Earth's climate was warmer and quite stable, then things changed a lot. There is a decline in temperature during the **Quaternary** Period from about -1°c to -4°c (compared to 0°c representing today's average). This trend was most marked for the first **1.5** million years. During the last million years temperatures **level out**. Within these trends there are significant **peaks** and troughs, most marked during the last million years (peaks to 0° c and **troughs** to -6°c).



Evidence for climate change comes from many sources!

Scientists can work out how the climate has changed over time using a range of methods.

Figure 1Extracting Ice cores from the Antarctic Ice sheet.

Ice and Sediment Cores

As you can see, ice and sediment cores play an important role in understanding what has happened before.

1. Ice sheets are made up of layers of ice, one layer is formed each year.
2. Scientists drill into the ice sheets to get long cores of ice.
3. By analysing the gases trapped in the layers of ice, they can tell what the temperature was each year.
4. One ice core from Antarctica shows the temperature changes over the last 400 000 years.
5. The remains of organisms found in cores taken from ocean sediments can also be analysed. These can extend the temperature record back at least 5 million years.

Temperature Records

1. Since the 1850's global temperatures have been measured accurately using thermometers. This gives a reliable but short-term record of temperature change.
2. Historical records (e.g harvest dates, newspaper weather reports) can extend the record of climate change a bit further back.

Pollen Analysis

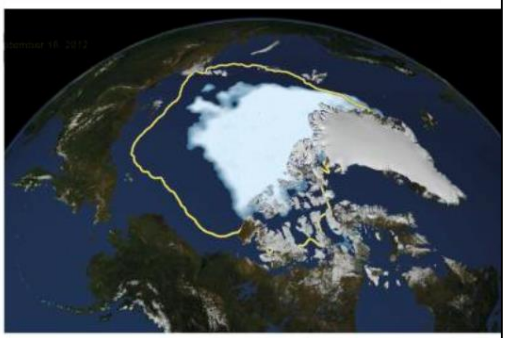
1. Pollen from plants preserved in sediment , e.g at the bottom of the lakes or in peat bogs.
2. Scientists can identify and date the preserved pollen to show which species were living at the time.
3. Scientists know the conditions that plants live in now, so preserved pollen from similar plants shows that climate conditions were similar.

What is the recent evidence for climate change?

Shrinking glaciers and melting ice
Glaciers throughout the world are shrinking and retreating. It is estimated that some may disappear completely by 2035. Arctic sea ice has thinned by 65 per cent since 1975 and in 2014 its extent was at an all-time low (photo **E**).

Rising sea level
According to the Intergovernmental Panel on Climate Change (IPCC), the average global sea level has risen between 10 and 20cm in the past 100 years. There are two reasons why sea levels have risen.
- When temperatures rise and freshwater ice melts, more water flows to the seas from glaciers and ice caps.
- When ocean water warms it expands in volume – this is called thermal expansion.

Seasonal changes
Studies have suggested that the timing of natural seasonal activities such as tree flowering and bird migration is advancing. A study of bird nesting in the mid-1990s discovered that 65 species nested an average of 9 days earlier than in the 1970s. Could this be evidence of a warming world?



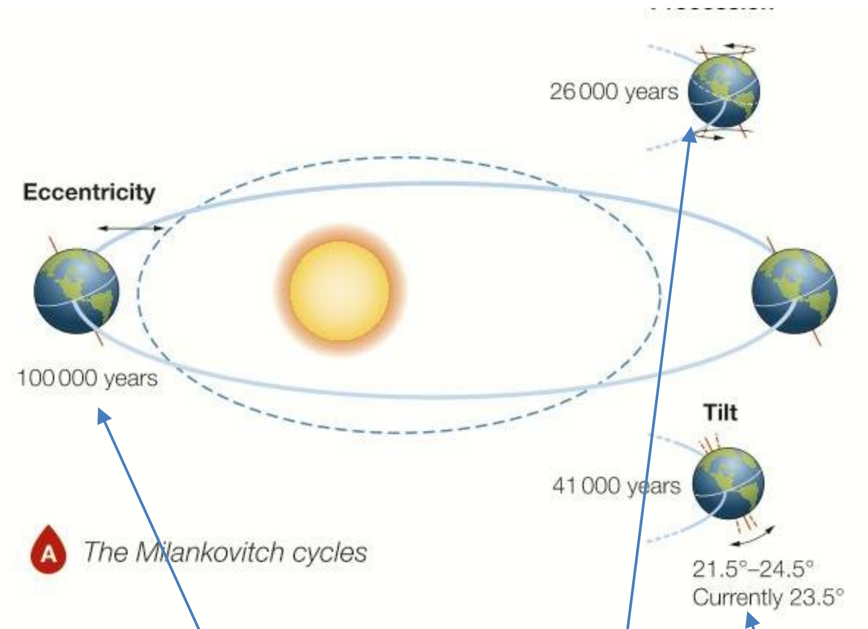
E *Shrinkage of Arctic sea ice, 1979–2012 (yellow line indicates extent in 1979)*

Lesson 21-What are the natural causes of climate change?

Climate change goes back long before humans roamed this Earth. Some natural factors cause climate change but in the last 150 years or so human activities have begun to change the climate change too. Scientists believe that there are several natural causes for climate change. These include:

Orbital changes-Milankovitch cycles

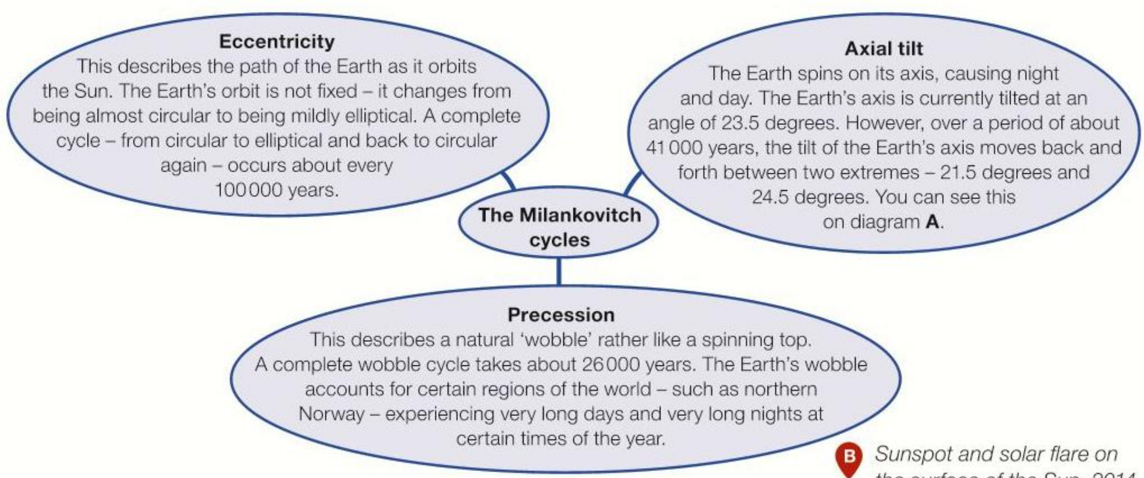
1. The way that the Earth moves around the sun changes. For example the path of the Earth's orbit changes from an almost perfect circle to an ellipse (an oval) and back again every 100,000 years.
2. These changes affect the amount of solar radiation (how much energy) the Earth receives. If the Earth receives more energy it gets warmer.
3. Orbital changes may have caused the glacial and interglacial cycles of the quaternary period.



A The Milankovitch cycles

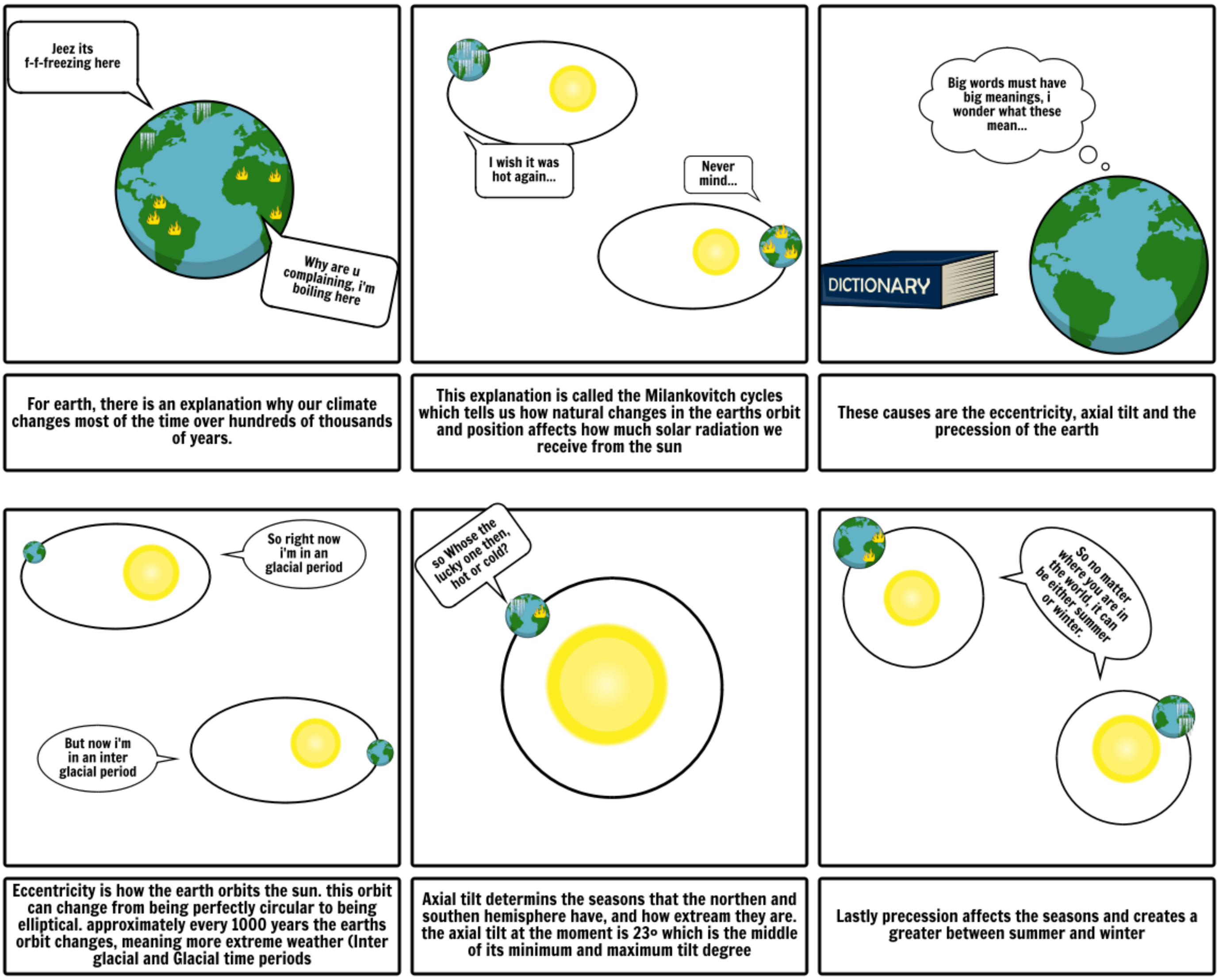
Milutin Milankovitch was a Serbian geophysicist and astronomer. He studied the Earth's orbit and identified three distinct cycles that he believed affected the Earth's climate. These are known as the Milanokovich cycles (source A and B) .

Scientists believe that these cycles affect the timings and seasons of the Earth's climate. In particular, the 100,000-year eccentricity cycles coincides closely with the alternating cold (glacial) and warm (inter-glacial)periods in the quaternary period.



B Sunspot and solar flare on the surface of the Sun, 2014

Solar activity



Volcanic Activity:

1. Major volcanic eruptions eject large quantities of material into the atmosphere.
2. Some of these particles (a conversion of sulphur dioxide to sulphuric acid) reflect the Run's rays back out into space like little mirrors, so the Earth's surface cools.
3. Volcanoes also release CO2 (a greenhouse gas-see below) but not enough to cause warming.
4. Volcanic activity may cause short-term changes in climate e.g the cooling that followed the eruption of Mount Pinatubo in 1991.
5. The cooling of the lower atmosphere and reduction of surface temperatures is called a volcanic winter.

Eruption of Mount Tambora, 1915

In 1815 there was a massive volcanic eruption of Mount Tambora in Indonesia (image **D**). It was the most powerful eruption in the world for 1600 years! Ash and sulphuric acid caused average global temperatures to fall by 0.4 °C–0.7 °C and 1816 became known as 'The year without a summer'.

Across the world harvests failed. There were major food shortages throughout North America and Western Europe, including the UK. Food prices rose sharply and there were riots and looting in European cities. It was the worst famine in Europe in the nineteenth century, resulting in an estimated 200 000 deaths.

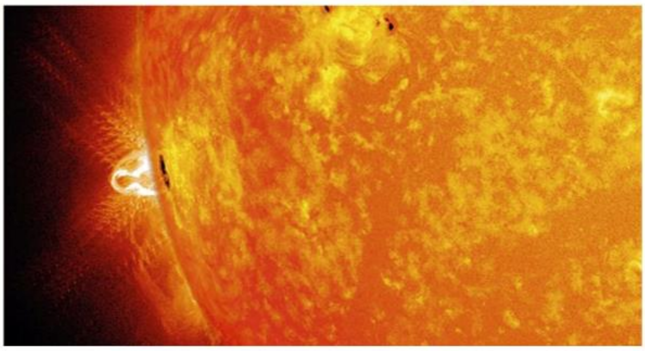
Solar Output:

1. The sun's output of energy isn't constant. It changes in short cycles about every 11 years, and possibly in longer cycles of several hundred years. This is linked to the presence of sunspots. A sunspot is a dark patch that appears from time to time on the surface of the sun (photo B).
2. There are times when the sunspots are at their maximum and this is when the sun gives off more heat. Large explosions occur on the surface of the sun resulting in solar flares.

times of the year.

C A 'Frost Fair' on the River Thames during the 'Little Ice Age'

B Sunspot and solar flare on the surface of the Sun, 2014



3. Periods when the solar output is reduced may cause the Earth's climate to become cooler in some areas. For example, very few sunspots were observed between the years 1645 and 1715. This coincided with the coldest period during the so-called 'Little Ice Age', when Europe experienced a much colder climate with severe winters (photo C).
4. Most scientists think that changes in solar output don't have a major effect on climate change.

Stretch yourself:

Carry out some **research** about **1816 'The year without summer'**.

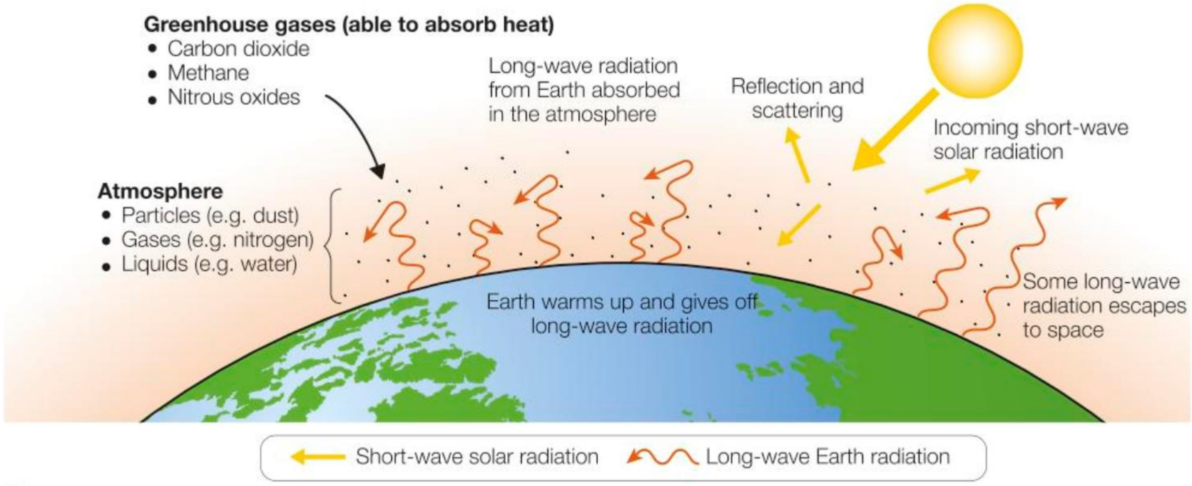
Find more information about the impacts of the eruption of Mount Tambora. Could this happen again in the future?

<u>Lesson 22- Human causes of climate change</u>

What is the greenhouse effect?

Like a greenhouse , the atmosphere allows most of the heat form the sun (short-wave radiation) to pass straight through it to warm up the Earth's surface (diagram B). However, when the Earth gives off heat in the form of long-wave radiation, some gases such as carbon dioxide (CO2) and methane are able to absorb it. These gases are called greenhouse gases.

In the same way that glass traps heat inside a greenhouse, the greenhouse effect keeps the earth warm. Without this 'blanketing' effect it would be far too cold for life to exist on Earth.



B How the greenhouse effect works

Humans are increasing the concentration of greenhouse gases by:

<u>Burning Fossil Fuels</u>

CO_2 is released into the atmosphere when fossil fuels like coal, oil, natural gas and petrol are burnt e.g in thermal power stations or in cars.

<u>Farming</u>

1. Farming of livestock produces a lot of methane and cows break wind a lot. We breed many cows for dairy and meat purposes. Many people in HIC's expect to have meat at least once a day which has led to a huge amount of livestock around the world.
2. Rice paddies contribute to global warming, because flooded fields emit methane.

<u>Cement Production</u>

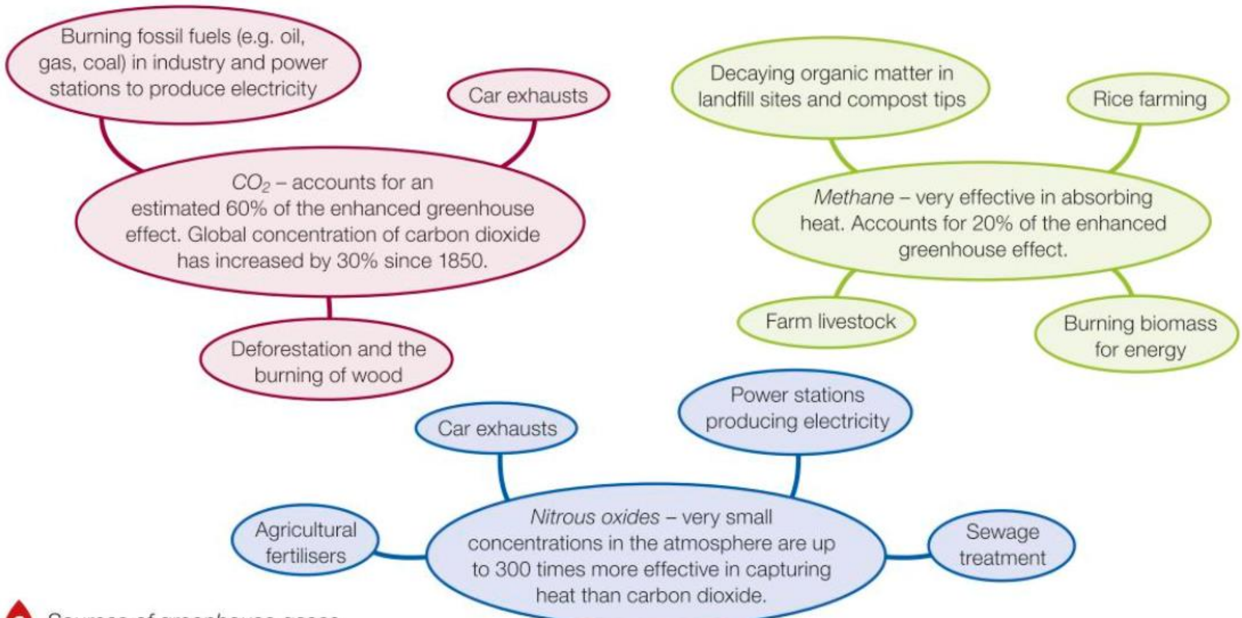
Cement is made from limestone, which contains carbon. When cement is produced lots of CO_2 is released into the atmosphere.

<u>Deforestation</u>

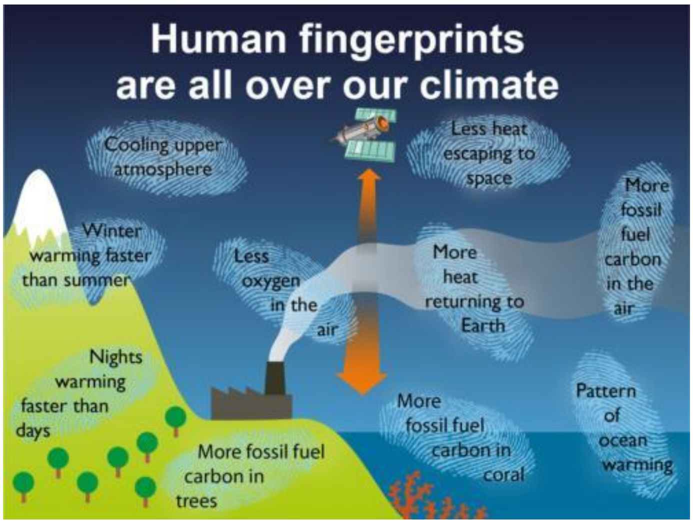
1. Plants remove CO_2 from the atmosphere and convert it into organic matter using photosynthesis.
2. When trees and plants are chopped down, they stopped taking in CO_2.
3. CO_2 is also released into the atmosphere when the trees are burnt as fuel or to make way for agriculture.

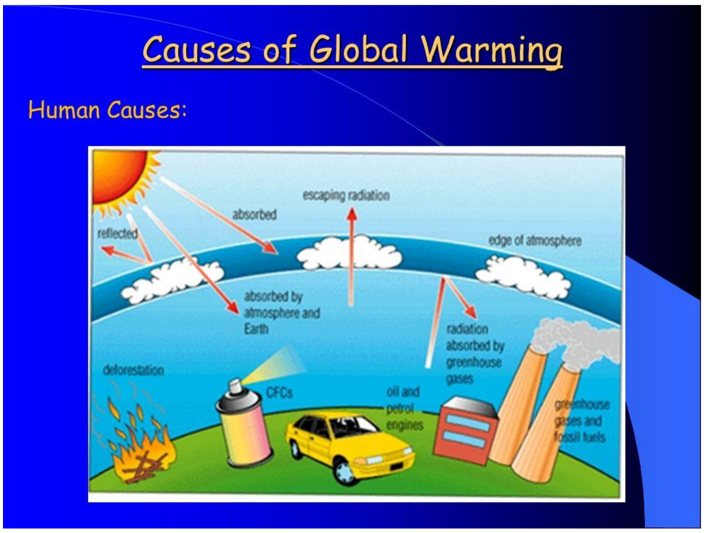
The human impact

In recent years, the amounts of greenhouse gases in the atmosphere have increased. Scientists believe that this is due to human activities (diagram **C**).



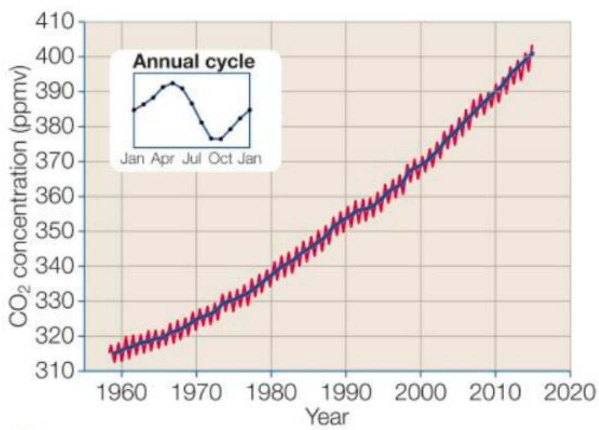
C *Sources of greenhouse gases*





Graph **D** shows the recorded changes in carbon dioxide since the 1960s. The trend of this graph is identical to that of average global temperatures. Many scientists believe that this provides clear evidence that human activities are affecting global climates.

It is the increased effectiveness of the greenhouse effect – the so-called *enhanced greenhouse effect* – that scientists believe is causing recent global warming. For the first time in history, human activities appear to be affecting the atmosphere with potentially dramatic effects on the world's climate. By the end of the century average global temperatures could rise by 1.8–4 °C. This could lead to a rise in sea level of 28–43 cm.



D *Increase in CO_2 obtained from direct readings at the Mauna Loa Observatory, Hawaii*

ACTIVITIES

Lesson 23-The effects of climate change

Environmental effects:

1) Warmer temperatures are causing glaciers to shrink and ice sheets like Greenland to melt. The melting of ice on land, especially the Greenland and Antarctic ice sheets means that water stored on land as ice returns to the oceans. This causes sea levels to rise.
2) Sea ice is also shrinking, leading to the loss of polar habitats.
3) Rising sea levels means low-lying and coastal areas, like the Maldives, will be flooded more regularly. Coastal erosion will increase with sea level rise and some coastal areas will be submerged, so habitats will be lost.
4) Other species are declining due to warming, e.g. some coral reefs are suffering from bleaching due to increasing water temperatures.
5) Precipitation patterns are changing-warming is affecting how much rain areas get.
6) The distribution and quantity of some species could change and biodiversity could decrease:
    a. Some species are now found in higher latitudes due to warming temperatures.
    b. Some habitats are being damaged or destroyed due to climate change-species that are especially adapted to these areas could become extinct.

Effects on people:

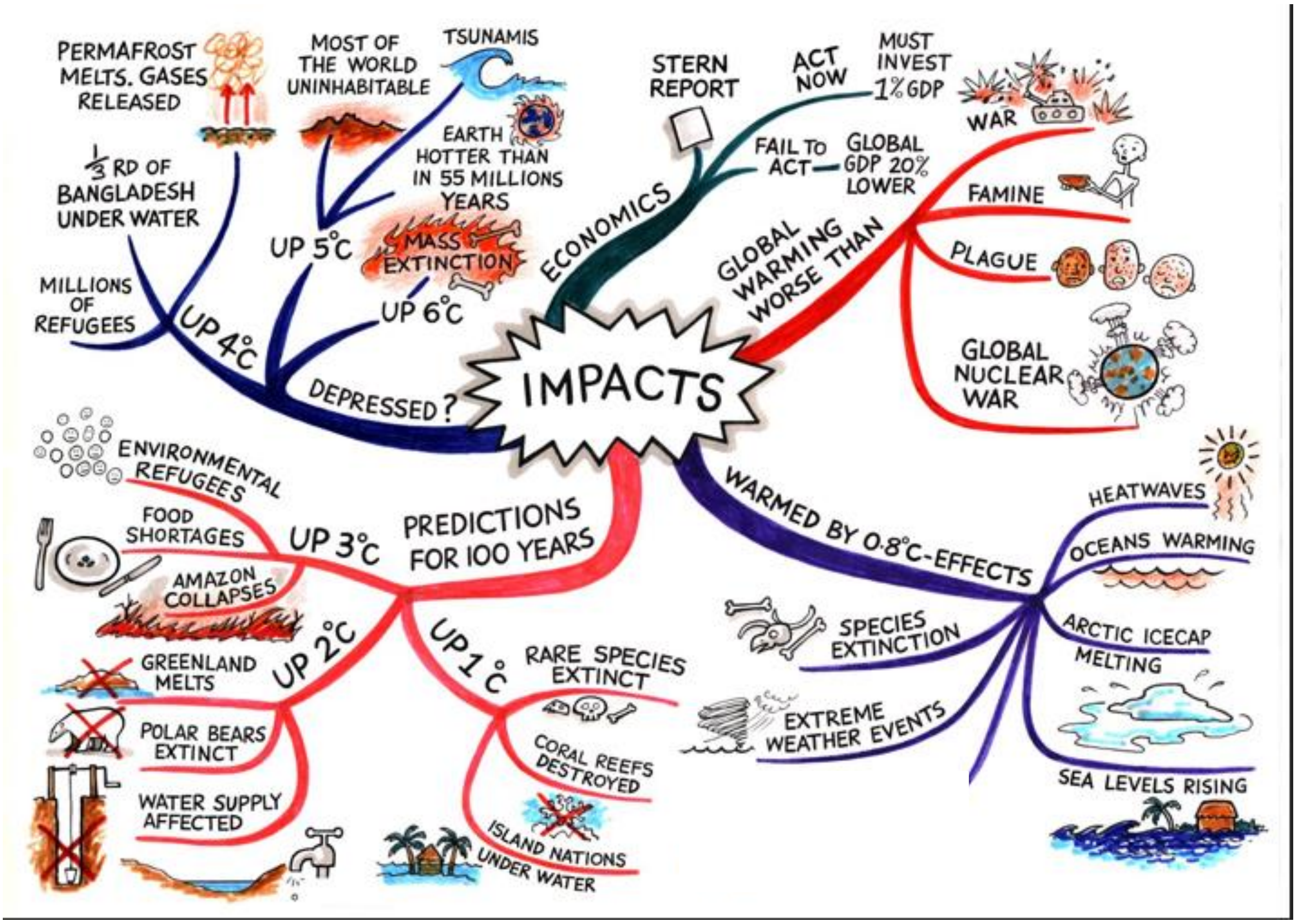
1) In some places deaths due to heat have increased-but deaths due to cold have decreased.
2) Some areas could become so hot and dry that they're difficult or impossible to inhabit. Low lying areas could be lost to the sea or flood so often that they also become impossible to inhabit. This could lead to migration and overcrowding in other areas.
3) Some areas are struggling to supply enough water for their residents due to problems with water availability caused by changing rainfall patterns. This can lead to political tensions, especially where rivers cross borders. .
4) Climate change is affecting farming in different ways around the world:
    a. Globally some crops have suffered from climate change (e.g. maize crops have got smaller due to warming recent years).
    b. But some farmers in high latitudes countries are finding crops are benefiting from warmer conditions (e.g. vineyards in the UK).
5) Lower crop yields could increase malnutrition, ill health and death from starvation, particularly in lower latitudes.
6) Climate change means the weather is getting more extreme. This means that more money has to spent on predicting extreme weather events, reducing their impacts and rebuilding after them.

Figure 1: Future impacts across the world.

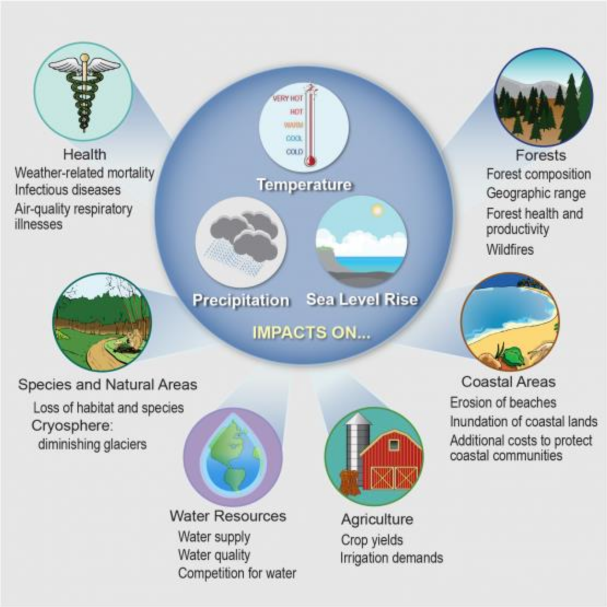
- Frozen regions of the world such as Siberia and northern Canada may be able to grow crops in a milder climate
- Canada's North-west Passage may become ice-free and can be used by shipping
- Energy consumption may go down as temperatures increase in densely populated parts of the world such as north-west Europe
- Fewer deaths or injuries due to cold weather
- Longer growing season in rich agricultural areas such as Europe and North America will increase food production

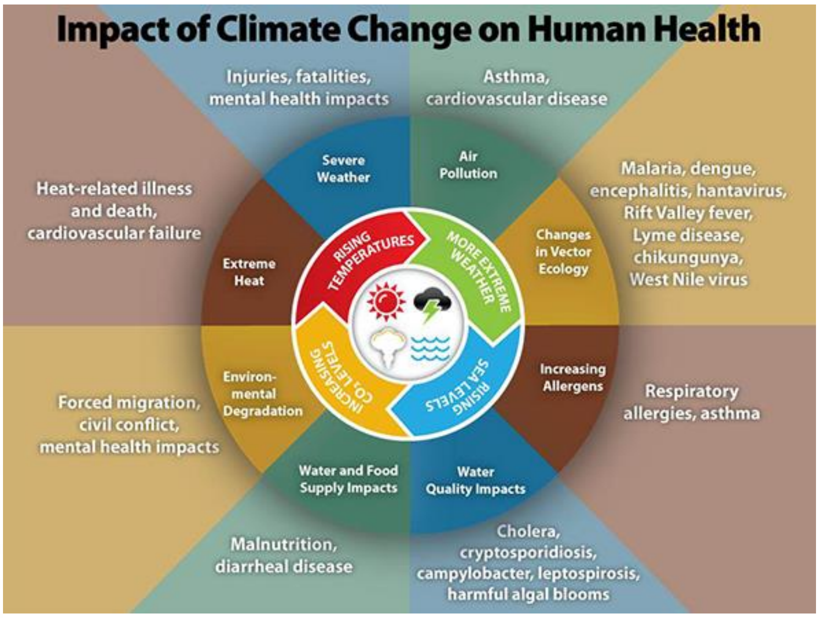
- Higher sea levels may flood low-lying areas such as Bangladesh, Myanmar and the Netherlands, threatening the lives of 80 million people
- Islands such as the Maldives and Tuvalu may completely disappear as sea levels rise
- Parts of Africa may become drier and more prone to droughts, leading to starvation and civil war
- Cereal yields are expected to decrease in Africa, the Middle East and India
- An additional 280 million people may be at risk from malaria, particularly in China and central Asia

- Tropical storms affecting the Caribbean and the USA may increase in magnitude
- Loss of glaciers (fresh water) in the Himalayas may threaten agriculture and water supply in India, Nepal and China
- Hazards such as landslides, floods and avalanches may become more common in mountainous areas such as the Alps
- Arctic ice may melt completely
- Some species, whose habitat changes, may become extinct – there is considerable concern about polar bears in the Arctic
- Alpine ski resorts may be forced to close due to lack of snow



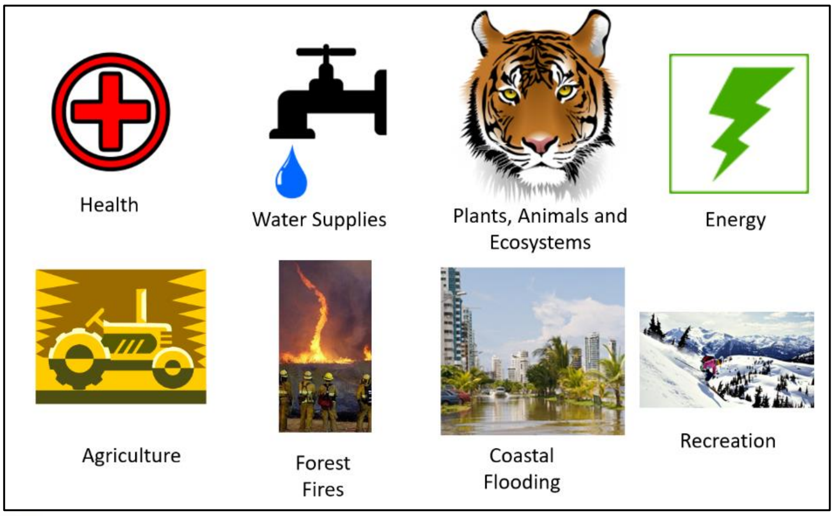
Potential Effects of Climate Change

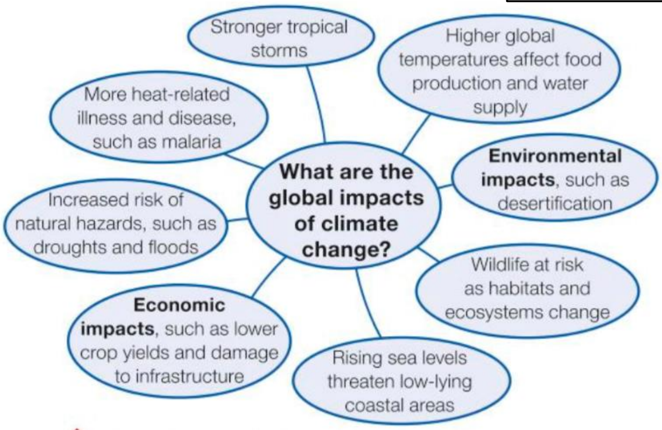




Climate change: The future

Using the information above and resources provided in the lesson, create a mind map to include the following:





C *Global impacts of climate change*

Lesson 23- Managing the impacts of climate change-how can climate change be managed (mitigated)?

Mitigation-To reduce the effects of something

The burning of fossils (coal, oil and gas) to produce electricity, fuel vehicles and power industry contributes 87% of all CO2 emissions. The rest comes from land use changes-mostly deforestation (9%) and industrial processes like making cement (4%).

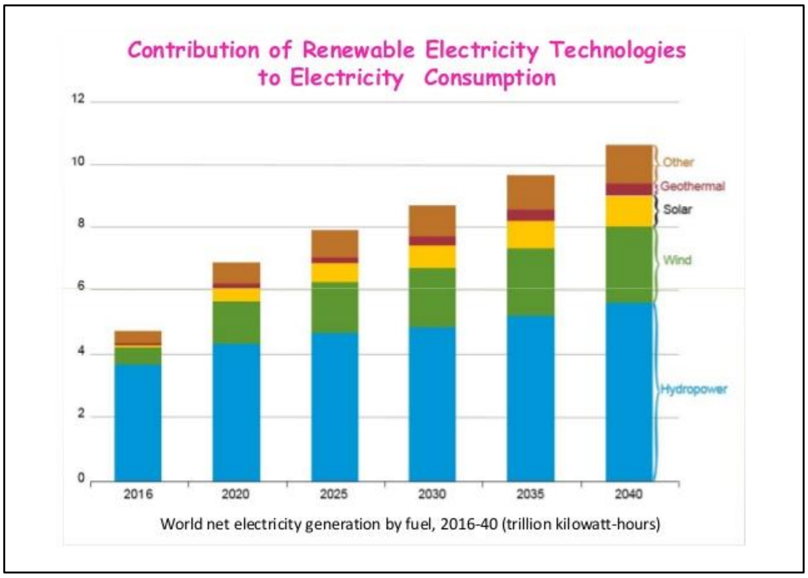
The 4 mitigation options include:

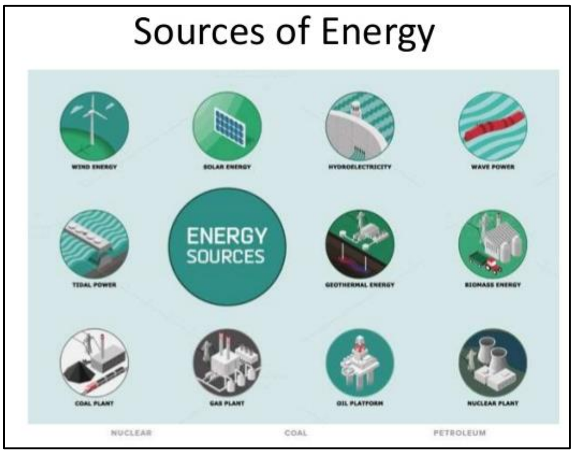
- Alternative energy production (renewables)
- Carbon Capture
- Planting Trees
- International Agreements.

To help reduce carbon emissions many countries are turning to alternative sources of energy such as:

- Hydro-electricity
- Nuclear power
- Solar, wind and tides

These do no emit large amounts of CO2. Some are also renewable and will last into the future. Nuclear power uses uranium to generate electricity but does not emit CO2 as a by-product.





ENERGY RESOURCE OPTION	ADVANTAGES	DISADVANTAGES
Solar	Potentially infinite energy supply. Single dwellings can have own electricity supply.	Manufacture and implementation of solar panels can be costly.
Wind	Can be found singularly, but usually many together in wind farms. Potentially infinite energy supply.	Manufacture and implementation of wind farms can be costly. Some local people object to on-shore wind farms, arguing that it spoils the countryside.
Tidal	Ideal for an island such as the UK. Potential to generate a lot of energy. Tidal barrage can double as a bridge, and help prevent flooding.	Construction of barrage is very costly. Only a few estuaries are suitable. Opposed by some environmental groups as having a negative impact on wildlife. May reduce tidal flow and impede flow of sewage out to sea.
Wave	Ideal for an island country. More likely to be small local operations, rather than done on a national scale.	Construction can be costly. May be opposed by local or environmental groups.
Geothermal	Potentially infinite energy supply. Used successfully in some countries, such as New Zealand and Iceland.	Can be expensive to set up and only works in areas of volcanic activity. Geothermal and volcanic activity might calm down, leaving power stations redundant. Dangerous elements found underground must be disposed of carefully.
Hydrological or Hydroelectric Power (HEP)	Creates water reserves as well as energy supplies.	Costly to build. Can cause the flooding of surrounding communities and landscapes. Dams have major ecological impacts on local hydrology.
Biomass	It is a cheap and readily available source of energy. If replaced, biomass can be a long-term, sustainable energy source.	When burned, it gives off atmospheric pollutants, including greenhouse gases. Biomass is only a renewable resource if crops are replanted.
Wood	A cheap and readily available source of energy. If the trees are replaced, wood burning can be a long-term, sustainable energy source	When burned it gives off atmospheric pollutants, including greenhouse gases. If trees are not **replanted** then wood is a non-renewable resource.

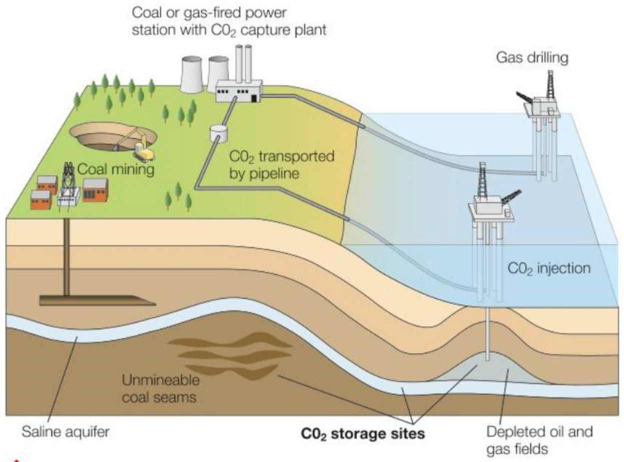
The UK aims to produce 15% its energy from renewable sources by 2020. There has been an investment in renewable energy projects like wind power. A new nuclear power reactor is being built at Hinkley Point in Somerset (photo A).

Photo A-An artist's impression of the new Hinkley Point nuclear reactor.

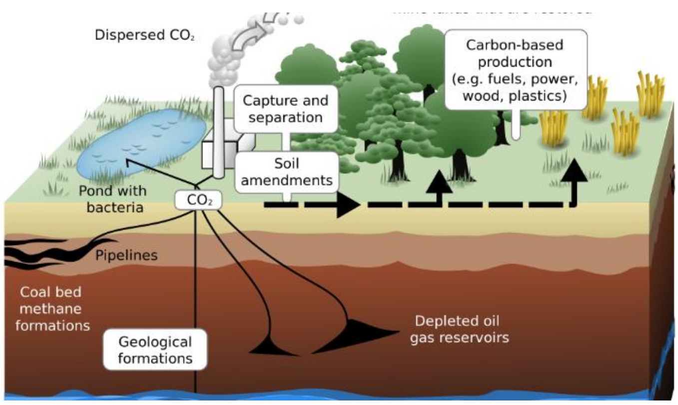
Carbon capture.

Coal is the most polluting of all fossil fuels. China gets 80% of its electricity from burning coal, India 70% and the USA 50%. But how can coal be used continue to be used in a less damaging way?

Carbon capture and storage (CCS) uses technology to capture CO2 produced from the use of fossil fuel in electricity generation and industrial processes. It is possible to capture up to 90% of the CO2 that would otherwise enter the atmosphere.



B Carbon capture and storage

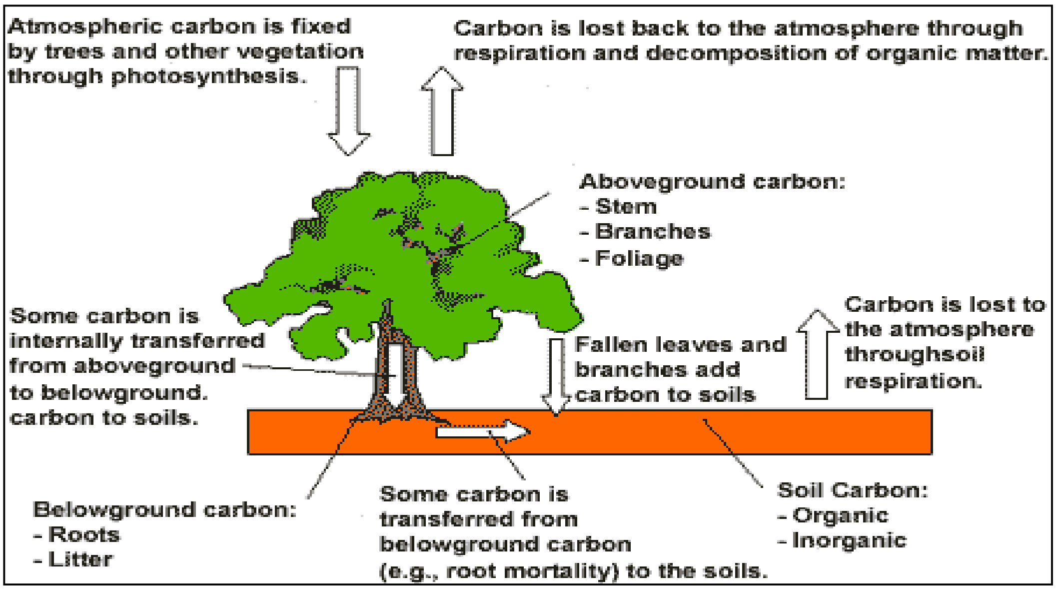


Carbon capture technology: Using technology to capture CO2 produced from fossil fuels in electricity generation and industrial use. We can capture up to 90% of this. Once captured it is compressed and transported in a pipeline to an injection well. It is injected as a liquid and stored underground in geological reservoirs. The UK is a world leader in this.

Diagram B shows how carbon capture works. Once captured, the carbon gas is compressed and transported by pipeline to an injection well. It is injected as a liquid into the ground to be stored in suitable geological reservoirs.

Planting trees.

Trees act as carbon sinks, removing C02 from the atmosphere by the process of photosynthesis. They also release moisture into the atmosphere. This has a cooling effect by producing more cloud, reducing incoming solar radiation. Tree planting is well established in many parts of the world. Plantation forests can absorb CO2 at a faster rate than natural forests and can do so effectively for up to 50 years.



International agreements

Climate change is a global issue and requires global solutions. Carbon emissions spread across the world and affect everyone.

2005

- **The Kyoto protocol**-the first international treaty became law. Over **170 countries** agreed to reduce carbon emissions by an average of 5.2% below their 1990 levels by 2012. Of the major greenhouse gas emitters, only the **USA** and **Australia refused** to sign the treaty.

2009

- World leaders met in Copenhagen to consider to consider international agreements on tackling climate change beyond 2012. The outcome was the **Copenhagen Accord**. It was pledged to **reduce emissions** with **financial support** for **developing nations** to help them **cope** with the **impacts of climate change**. But there was **no legally binding agreement**!

2015

- **Paris agreement 2015-195** countries adopted the **first ever universally binding global climate deal:**
- ---To curb greenhouse gas emissions as soon as possible and achieve a balance between sources and sinks of greenhouse gases in the second half of this century.
- ---To keep **global temperature increase below 2℃ and limited to 1.5℃** above pre-industrial levels.
- ---To review progress every 5 years.
- ---**US$100 billion a year to support climate change inititiatives in developing countries** by 2020, with further finance in the future.
- *The have been critisims that many of these agreements are 'promises' or aims and not firm commitments.*

Paris agreement update:

On the 1st June 2017 **United States** President Donald Trump announced that the USA would **cease all participation in the 2015 Paris Agreement** on climate change mitigation. President Trump stated that *"The Paris Accord will undermine (the U.S) economy,"* and *"puts (the U.S) at a permanent disadvantage."*

The USA cannot withdraw from the agreement before 4th November 2020 as part of the agreement signed by the former President (President Obama). Therefore the White House has confirmed that it will abide by the rules and maintain its' commitment until the 2020 exit.

Lesson 24-How can we adapt to climate change?

Adaption: This means responding or adjusting to change.

We face a very uncertain future and we will expect to see a change in agricultural systems, countries managing their water supply and efforts to reduce the risk from rising sea levels.

Scientists believe that climate change will have a huge impact on agricultural systems across the world. As discussed earlier in the document:

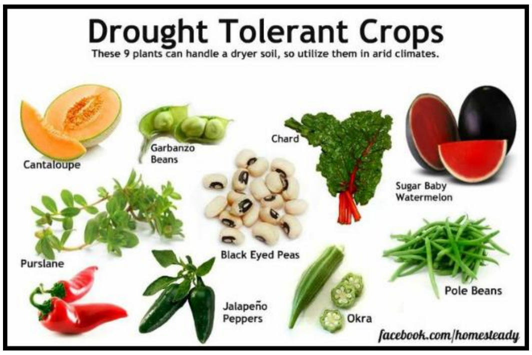
- Patterns of rainfall and temperature will change
- Extreme weather events such as heat waves, droughts and floods will become more common.
- The distribution of pests and diseases will change.

Farmers need to adapt to these changes.

Agricultural adaptation in low latitudes.

Scientists think that the greatest changes to agriculture will occur in the low latitudes. Southern Africa's maize crop could fall by 30% by 2030 and the production of rice in South Asia could fall by 10%. There are several adaptations that could be made (photo A).

A Irrigating crops in the Gambia



Agricultural adaptation in the middle latitudes.

A warmer climate in Europe and North America could lead to an increase in production of certain crops such as wheat. In the UK, Mediterranean crops such as vines (photo B) and olives may thrive.

B Vineyards such as this one in West Sussex may become more widespread in the UK

Managing water supply

Climate change is already causing more severe and more frequent droughts and floods. Unreliable rainfall and periods of water shortage require careful management. Future climate change will affect the current patterns of water supply, impacting on the quantity and quality of our water. It is the most vulnerable, particularly in rural parts of poorer countries, who are likely to be affected the most.

Mini case study: The Himalayas-managing the water supply

Millions of people in Asia depend on rivers fed by snow and glacial melt for their domestic and agricultural water supply. In the Himalayas most of the 16000 glaciers are receding rapidly due to global warming. This threatens the long-term security of water supply in the region.

C *Creating artificial glaciers to provide water for villages*

By 2100 sea

Photo C shows an artificial glacier project that will supply water supply to villages in Ladakh, India. Water is collected in winter through a system of diversion canals and embankments and it freezes. When the 'glacier' melts in spring it will provide water for the local villages.

Mini case study: The Maldives-Managing rising sea levels

https://www.youtube.com/watch?v=AxRWM2EZXWM

Location:
- A group of 1,196 islands with a population of 395,000 people.
- Situated in South East Asia.
- To the South West of India.
- Some islands are below sea level

Causes of Sea Level Rising:
- Global temperature increase due to climate change
- Thermal expansion of sea water (arctic sea ice in particular).
- Melting mountain glaciers.
- Melting polar ice sheets.
- 'North Pole decreased 30% in size over the last 30 years'.

Impacts - Economic (Money)
- Many tourists visit, visitor numbers would decrease due beach erosion and damage to coral reefs.
- Loss of income for the tourism industry (hotels, dive schools, sea taxis, sea plane companies, food importers, caterers and entertainers for example)
- The government will lose money (income) from the taxation of tourist companies and individual Maldivian workers employed in the tourism industry. This money is normally used to pay for services like schooling and healthcare for local people. Without money coming in, services will have to be cut or removed entirely.

• Fishing – The change in the water temperature and sea level could kill coral and loss of fish stocks.

Impacts - Social
• Many people would be forced to leave their homes because of floods and less jobs.
• Coastal (beach) erosion would eventually destroy houses.
• At the current rate of sea level rise, it is expected that a mass 'evacuation' will be required by 2070 when sea water is set to engulf the islands completely.

Impacts - Environmental
• Coastal erosion is going to destroy many beaches. The white sandy beaches are the main attraction for visitors.
• Stronger storm surges occur because of the warming of the oceans (resulting in stronger storm intensity).
• Coral has been destroyed because of the increase in storms. Sea level rises will negatively affect the amount of sunlight reaching the coral. Fish habitats are lost due to coral dying.
• 80% of the 1,196 islands in the Maldives are only 1m above sea level.
• Oceans are rising up to 9mm a year.
• In 50 years, hardly any of the islands will remain.

Impacts - Political (Decision Making)
• Money is needed for island management to prevent erosion. The President has actively been seeking new land to buy for his people. Sri Lanka and India are distinct possibilities.

Management
• Reclaiming land- there are plans to increase island height to 3 metres on 7 islands in 7 different zones.
• $63 million paid for 3m high sea wall around Male and Japan paid 99% of it. It took 14 years to build.

- Efforts are being made to re-grow coral in some areas as it is a natural sea defence.
- Introduce mangrove forests.
- Buy new land and ask everyone to migrate (a possibility).