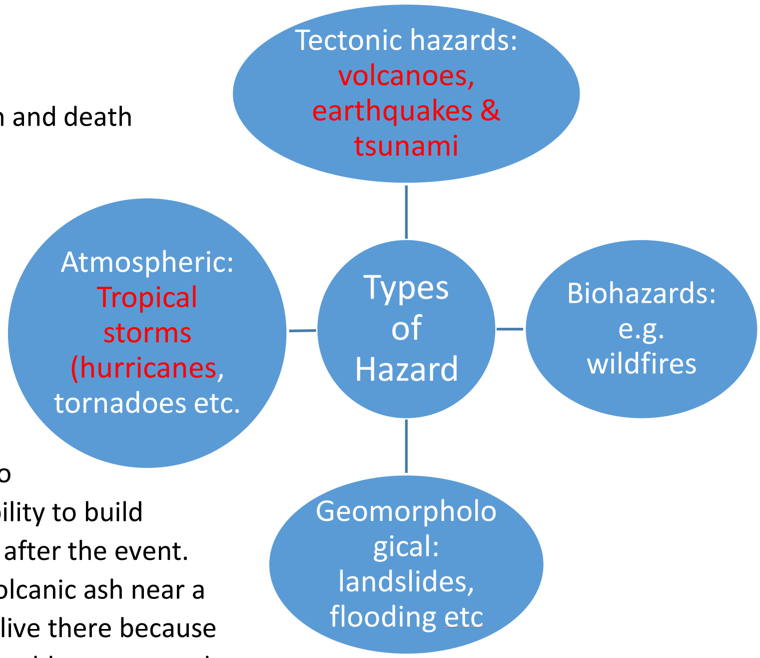
Geography Revision Guide: Natural Hazards

Part A: Hazards definitions

Q1. What is a natural hazard?



A natural event that threatens people
or has the potential to cause damage, destruction and death

Q2. What different hazards are there?

See diagram on the right – the ones in red are the ones that we will focus on.

Q3. What factors will influence the severity of a hazard?

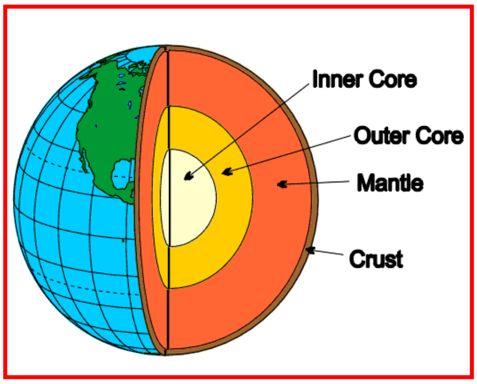
- **Poverty:** Some people have no choice but to live in a particular location. Poor people tend to end up living on unstable slopes (landslides). Inability to build properly to mitigate impacts. Inability to respond after the event.
- **Farming:** Some areas are good for farming (volcanic ash near a Volcano; fertile soil on a river floodplain). People live there because When times are good, then people prosper. The problem comes when the eruption occurs/ flood arrives.
- **Urbanisation:** More people living in close proximity (high population density). This puts people at risk – e.g. Haiti earthquake, 2010.
- **Climate change:** areas are becoming more prone to hazards (floods, droughts, famine etc.)

TIP: KEEP THINKING ABOUT THE DIFFERENCES BETWEEN HIC v. LIC IN A QUESTION SUCH AS THIS.

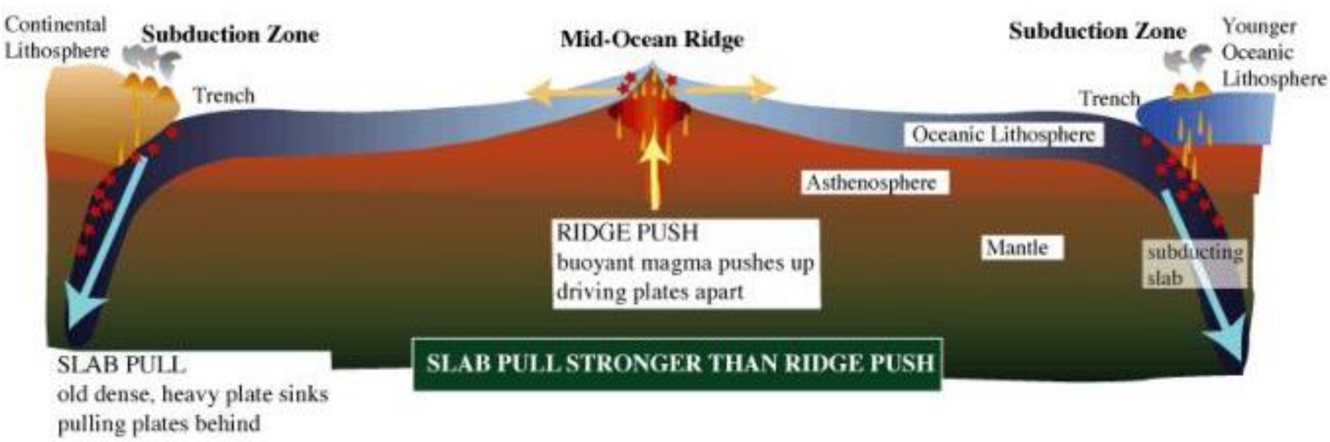
Part B: Plate Tectonic Theory

Q4. Why do we get volcanoes and earthquakes?

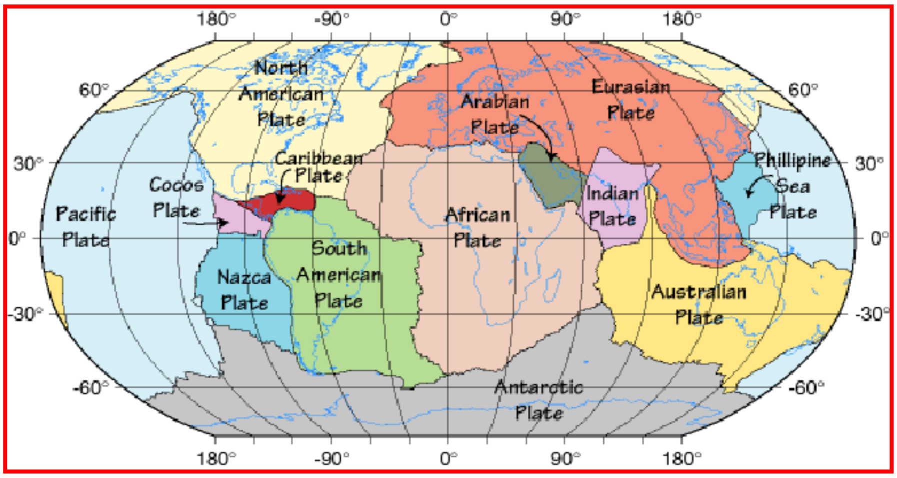
It is all to do with PLATE TECTONICS. This is a relatively new theory (only really been around for 100 years and been universally accepted for the last 40-50 years) and it looks at the structure of the Earth and examines how vast areas of rock or PLATES can move. To understand this theory you need to have an idea of the structure of the Earth. The diagram on the right shows this. The crust floats on the semi-molten rocks of the Mantle. The high temperatures in the Mantle result in **convection currents** that enable the crust to move.



Q5. New tectonic theories (see discussion PTO)



For years, the theory that convection currents powered the movement of plates was widely accepted. However, some scientists now believe that as a plate subducts (see the left and right side of the diagram on the previous page) that the weight of it actually drags the rest of the plate down with it. This is called SLAB PULL. At the ocean ridges (see centre of the diagram on the previous page), the buoyant magma rises up and pushes up a ridge, which is higher than the ocean floor on either side. As the ridge is higher and there is a slope as it moves away, this means that gravity acts upon it. This pushes the slabs apart which causes sea floor spreading – this is called RIDGE PUSH.



Q6. Is the Crust just one piece?

NO! It is split up into a series of PLATES which fit together like a giant jigsaw.

Q7. Are all these plates made of the same material?

No! Some are made of *continental crust* and some are made of *oceanic crust.* It is important to understand this as this will help you understand what happens at the different plate boundaries. This table summarises the differences:

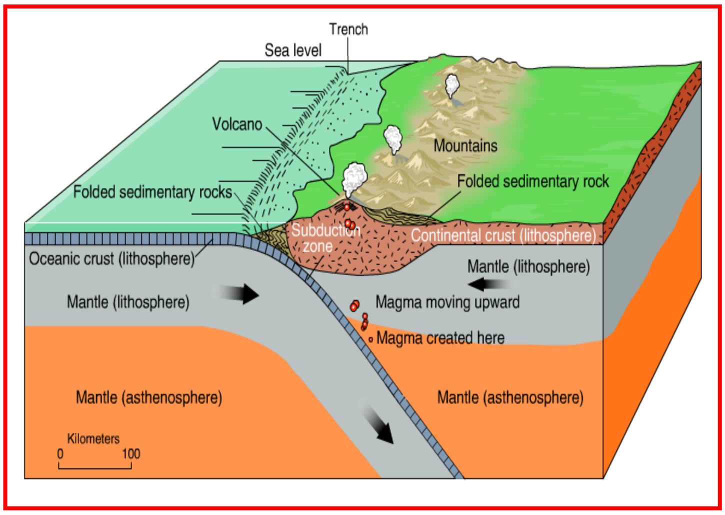
Data / Type	**Oceanic crust**	**Continental crust**
Crust depth	***shallow***, 5 - 12 km	***deeper***, average 40km, 75km beneath young mountain range
Age	Young rocks, less than 200 Million years old	Older, generally over 1500 Million years
Density	3.0 x 10^3 Kg m^{-3} ***DENSE!***	2.6 x 10^3 Kg m^{-3} ***NOT AS DENSE AS OCEANIC CRUST!***
Rock type, geology	Mainly ***basalt***	Range of ***granites*** with thin covering of sedimentary rocks

Q8. So what happens when the plates meet?

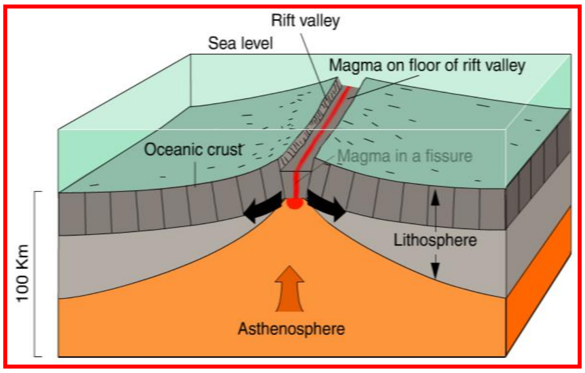
It depends! As I have already said it is determined by the type of crust involved, but also in terms of the direction in which the plates are moving.

DESTRUCTIVE (move towards)

These cause violent volcanoes and earthquakes, as well as deep-ocean trenches and fold mountains. An oceanic plate and continental plate move towards each other. The denser oceanic plate dives under (subducts) the lighter continental one, creating a deep ocean trench. As the oceanic plate goes deeper into mantle it melts in the **subduction zone**, due to friction and the increased temperature. The newly molten rock is lighter that that which surrounds it, so it will rise towards the surface and cause volcanoes on the Earth's surface. The continental crust is crumpled by the collision of the two plates creating Fold Mountains.

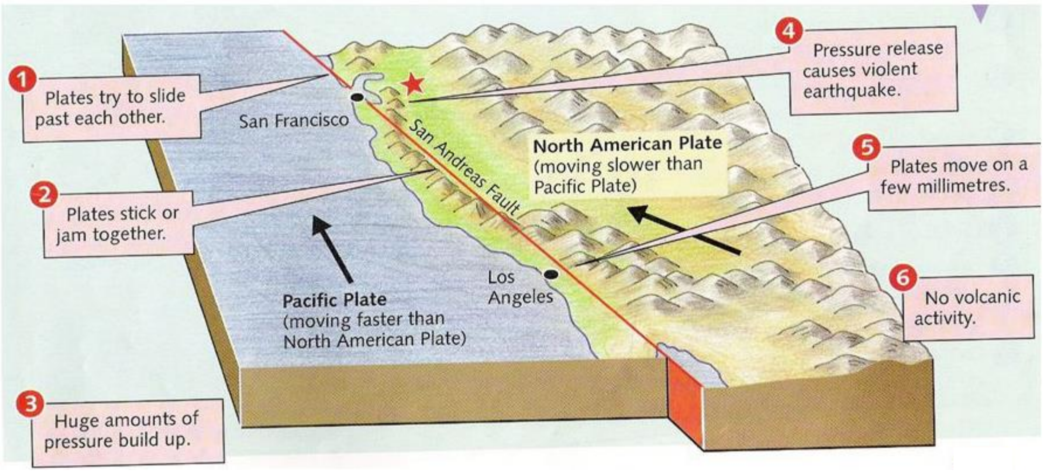


N.B. if two continental crust plates meet, they don't subduct. A collision occurs and the rocks are folded upwards. An example of this would be the Himalayas, where the Indian and Eurasian plates meet.



CONSTRUCTIVE (moving apart)

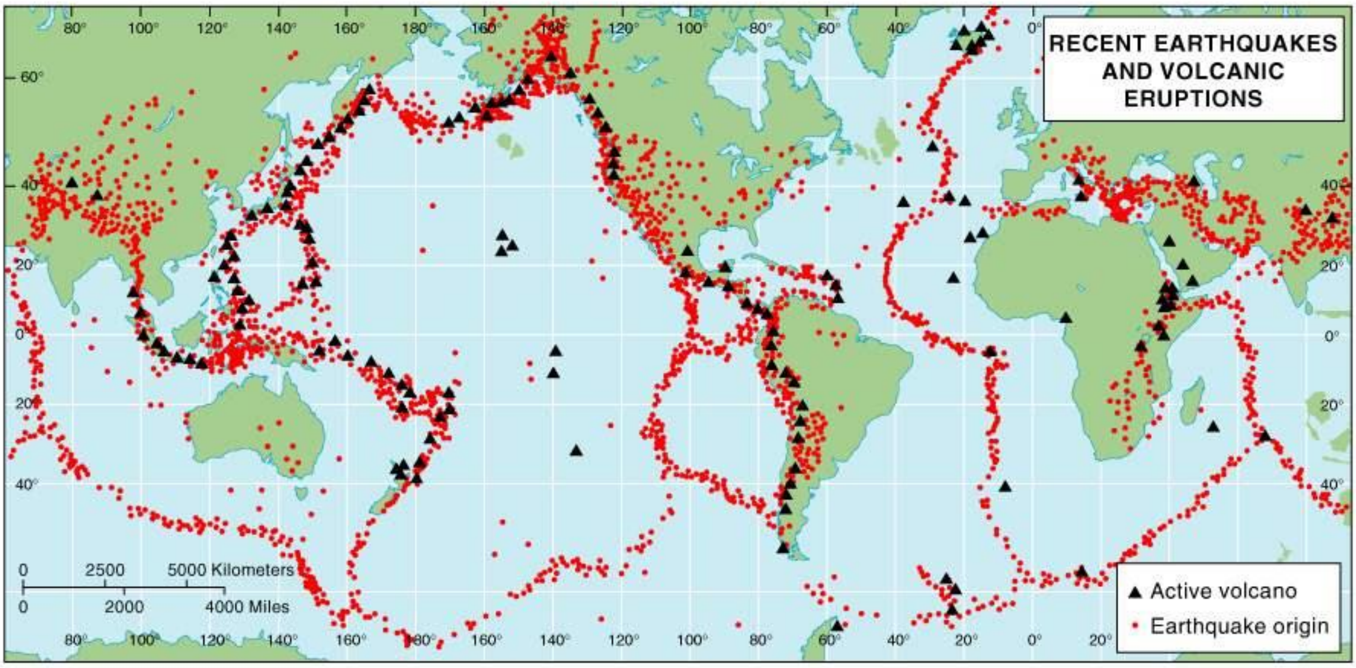
Volcanoes; some earthquakes - Although often not as violent as those on destructive plate boundaries, volcanoes and earthquakes do occur on constructive plate boundaries. They also cause mid-ocean ridges to form. Two plates move away from each other. Molten rock (magma) rises from the mantle to fill the gap between the two plates. This forms a mid-ocean ridge. Volcanoes can also form here, along the edges of the plate boundary, due to the rising magma. These volcanoes are called **shield volcanoes.**



CONSERVATIVE (sliding alongside)

The main effects of a conservative plate boundary are earthquakes, which can be fairly violent and frequent. Two plates slide past each other, without creating or destroying any land. As they move past each other they often get stuck, building up great pressure until finally they jolt past each other. This sudden movement is what causes earthquakes. The best-known example of a conservative plate boundary is the San Andreas Fault, where the North American and Pacific plates are actually moving in the same direction, but at a different speed.

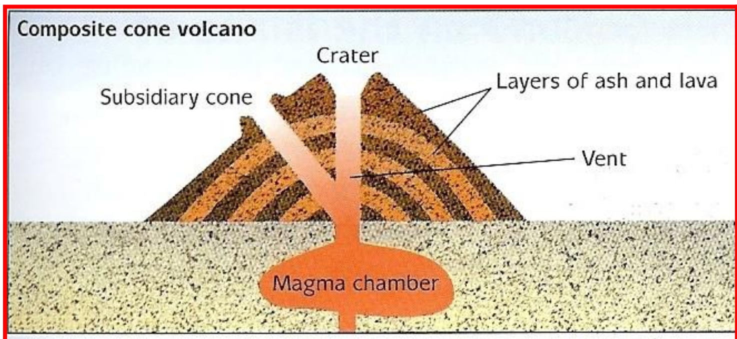
Q9. What is the distribution of volcanoes and earthquakes?



Look back at Q6 – does the activity above mirror the map above? Exam questions tend to focus on describing distribution of volcanoes/ earthquakes. You will see some isolated volcanoes – these can often be caused by HOT SPOTS. For example, Hawaii in the middle of the Pacific Ocean. This is where the crust is thin and magma is able to reach the surface. The hot spot is stationary, but the plates moves over it.

Q10. What are the different volcanoes found at the plate boundaries?

SHIELD and COMPOSITE volcanoes. The differences in their characteristics are due to their location and the type of magma feeding them. Shield volcanoes have BASIC LAVA, whereas Composite volcanoes have ACID LAVA. Basic lava is runny and therefore doesn't allow pressure to build up producing effusive eruptions; acid lava is the opposite as it is rich in silica and therefore is very sticky. Pressure can build up and eruptions are explosive. The diagrams below summarise the differences between the two. COMPOSITE at DESTRUCTIVE boundaries. SHIELD at CONSTRUCTIVE boundaries

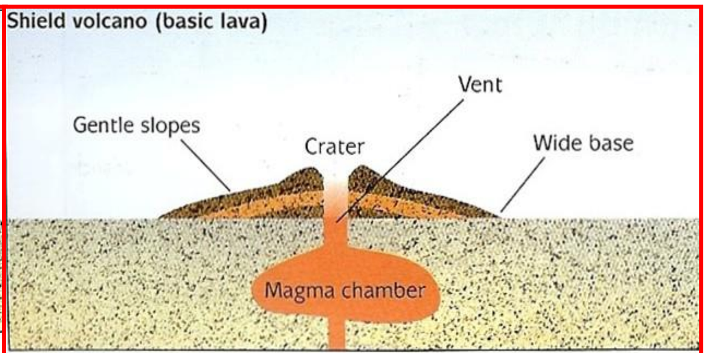


Composite cone volcano

Examples: Mount Etna, Vesuvius, Mount St Helens

Characteristics:

- Steep-sided symmetrical cone shape
- High with narrow base
- Alternate layers of acid lava and ash
- Lava may cool inside the vent – the next eruption is very explosive to remove the plug
- Subsidiary cones and vents form.



Shield volcano (basic lava)

Examples: Mauna Loa and Kilauea, both on the Hawaiian Islands

Characteristics:

- Gentle slopes and wide base
- Frequent eruptions of basic lava
- Lava flows more easily, travels longer distances before cooling
- Usually non-violent.

Part C: The effects/responses of tectonic hazards varies due to economic wealth

Q11. What are the primary and secondary effects of an earthquake?

- **Primary effects** are those that occur immediately as the earthquake happens- they occur due to the immediate shaking of the ground – e.g. damage to roads and building
- **Secondary effects** are the result of primary effects (ground shaking) and can be even more devastating then the primary ones – they include fire, landslides and tsunami.

Q12. What are the immediate and long-term responses to a tectonic hazard?

- **Immediate:** straight away. Things such as search and rescue, providing medical care, food, water and shelter
- **Long-term:** after the event. Rebuilding/ reconstruction – trying to get people's lives back to normal (or better)

Q13. Haiti – an example of Q11 and Q12 in real life in a LIC

When: 12/1/2010

Where: Haiti, with the capital Port-au-Prince hit very badly. Epicentre 13km underground, 25km from Port-au-Prince.

Why: Destructive plate boundary where the Atlantic plate subducts the Caribbean plate, but the earthquake was actually along a fault line cause by this pressure. In fact, the earthquake was a strike-slip event, which is like what happens at a Conservative margin.

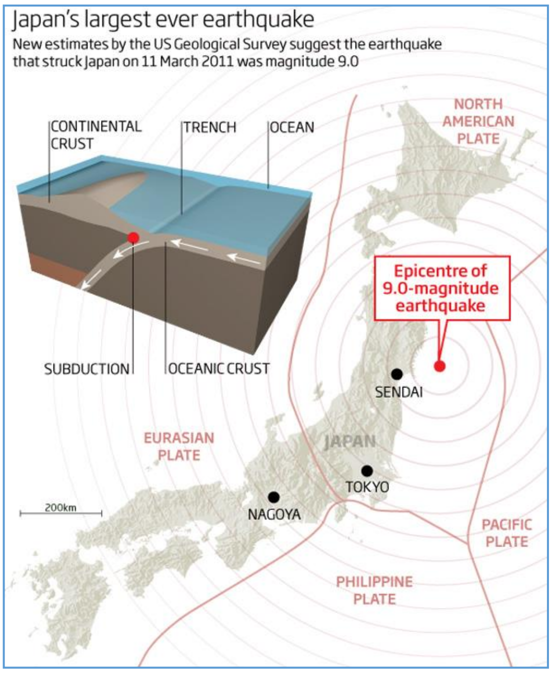
What were the effects?:

Haiti Primary	Haiti Secondary
• 220,000 killed (approx) • Port damaged, roads blocked • 8 hospital collapsed or damaged • 200,000 houses damaged and about 1.3 million people displaced	• 2 million without food and water • Looting – police force collapsed • Damage to port and road prevented medical supplies being distributed effectively • Disease in tented camps. Mass graves as people were left on the streets • Power cuts

What was the response?:

Short term: The port was destroyed and the airport couldn't cope. Supplies weren't distributed effectively. American engineers tried to clear the worst of the debris in the port so that ships could unload the aid. The USA also sent 10,000 troops and £100 million in aid. Bottled water and purification tablets were provided.

Longer-term response: Rebuild homes to a better standard. Rebuild port. Still reliant on overseas aid.



Q14. Japan (Tohoku) – an example of Q11 and Q12 in real life in a HIC

When: 11/3/2011

Why: Destructive boundary. Pacific plate subducting Eurasian plate

Where: roughly 70km from the Japanese coast, east of Tohoku

Focus: 32km deep. 9 on the Richter scale – HUGE!

Impacts: 128,00 buildings destroyed, 4,000 roads damaged, 78 bridges destroyed. 15,800 killed and 3,300 missing. Shipping disrupted due to damage to ports. Tohoku's agriculture impacted – 3-4% of rice production impacted by salt water on fields. Fukushima nuclear power plant damaged and exploded – 200,000 evacuated. Estimated damages of $300 billion.

Responses:

Immediate	Longer-term
Within 30 minutes of the earthquake, 11 military aircrafthad responded and identified communities cut off. The JSDF (the Japan Self-Defence Force) moved in on the ground and within two days all debris had been cleared and emergency goods could be delivered twice a day.	The 11 March earthquake wiped 5–10% off the value of Japanese stock markets, and there has been global concern over Japan's ability to recover from the disaster. The priority for Japan's long-term response is to rebuild the infrastructure in the affected regions and hence restore and improve the health of the economy as a whole.
Within 2 seconds of the earthquake being detected on 11 March 2011, and a full 1 minute 20 seconds before the main tremors hit, all 27 Shinkansen trains in the area had stopped without derailment, and with no injuries or deaths.	After the rescue and treatment of survivors, the priority was the repair and re-opening of transport links. About half – 347 km out of 675 km – of the Tohoku Expressway which links the region to Tokyo was damaged. By 24 March this had been repaired and re-opened.

However, the sheer scale of the disaster meant that emergency response teams were overstretched and inadequately supplied and trained.	The Sendai airport the runway was restored and re-usable by 29 March.
Electricity supplies and phone systems were damaged, so co-ordination of rescue teams was difficult.	By November 2011, 100% of expressway, the Shinkansen and airport facilities had been restored. However, the port was operating at only 68% capacity.
Due to the destruction of homes, an estimated 452,000 people were in evacuation shelters within days of the disaster. However, many of these were inadequate in terms of comfort and provision of blankets and food.	As of November 2011, 96% of the electricity supply had been restored, 98% of the water supply and 99% of the landline network.

Q15. Japan was impacted badly, but why did Haiti suffer more from a much smaller earthquake (9.0 v 7.0)?

Prediction, Planning and Preparation! HIC v LIC!!

Prediction: See above about sensing the initial waves in Japan – trains stopped, automatic warning on TV etc. This didn't happen in Haiti.

Planning: In 2008, the Japan Self-Defence Force (JSDF – the name of the Japanese army) carried out a massive earthquake emergency training drill called 'Michinoku ALERT 2008'. The drill was based around an earthquake of magnitude 6 occurring off the coast of Sendai accompanied by a tsunami. It involved 18,000 participants in 22 towns throughout the Tohoku region. The drill highlighted the danger of communities being isolated by the tsunami. Haiti had no such drills. Japan does this each year in Tokyo on 1st September to prepare for an earthquake.

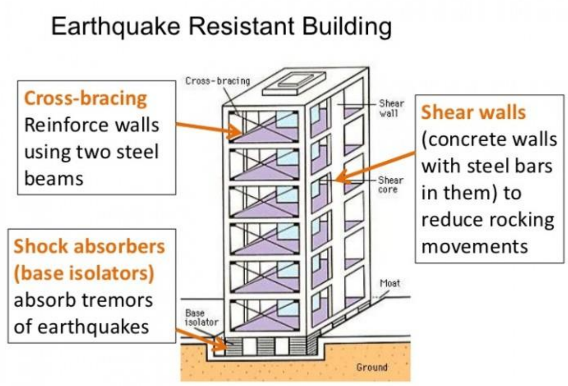
Preparation: People educated and know what to do. Buildings are built correctly – cross bracing, sprinkler systems, reinforced concrete, magnets on foundations, deep foundations, building codes (laws for the minimum quality of buildings) etc. All things that Japan had, but Haiti did not. Emergency services trained. Equipment and supplies ready to cope with a disaster in place BEFORE the event. Japan had this, but Haiti did not.

Part D: How can management reduce the risk of hazards?

Q16. What are the reasons why people continue to live in areas at risk from a tectonic hazard?

- No choice – poverty
- Eruptions/earthquakes don't happen often – no threat?
- Better monitoring – people feel safe?
- Fertile soil for farming
- Mineral deposits – gold etc.
- Geothermal power – e.g. Iceland – Blue Lagoon
- Tourism – e.g. Iceland – Blue Lagoon. Volcanic eruptions – Eyjafjallajokull in Iceland.

Q17. How can monitoring, prediction, protection and planning can reduce the risks from a tectonic hazard?



There are 3 main ways:

1. Monitoring/prediction – scientific equipment to detect warning signs. Use historical records.
2. Planning – identifying areas at risk and making plans to reduce impact
3. Protection – designing building to withstand the potential impacts.

MONITORING

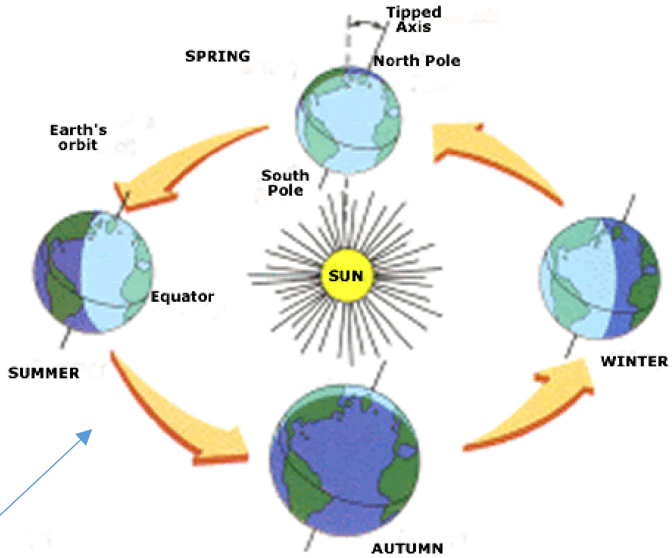
- **Volcanoes:** Remote sensing (satellites to detect changes in shape). Seismicity (seismographs record earthquakes – magma rising). Gas (magma rising). Ground deformation (changes in shape of volcano).
- **Earthquakes:** not great! They generally occur without warning. However, you can look at recurrence intervals to plot historical earthquakes. This can give an indication of areas that are at potential risk.

PLANNING

- **Volcanoes:** hazards maps. This shows what areas could be hit by pyroclastic flows etc. This enables planners to work out evacuation routes or restrict where building can occur.
- **Earthquakes:** hazards maps can be created. This shows areas where building could be at risk – these could then be strengthened.

PROTECTION

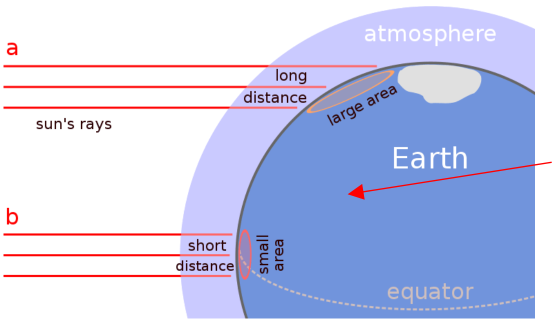
- **Volcanoes:** Divert lava flows away from areas at risk – e.g. Heimaey, Iceland and Etna, Sicily. There is not much you can do when faced with a pyroclastic flow though!
- **Earthquakes:** see diagram on previous page for what you can do to buildings. Also, sprinkler systems, counterbalance on roof and automatic windows shutters etc.



Part E: Weather Hazards – atmospheric circulation

Q18. Why do different places receive more sunlight than others?

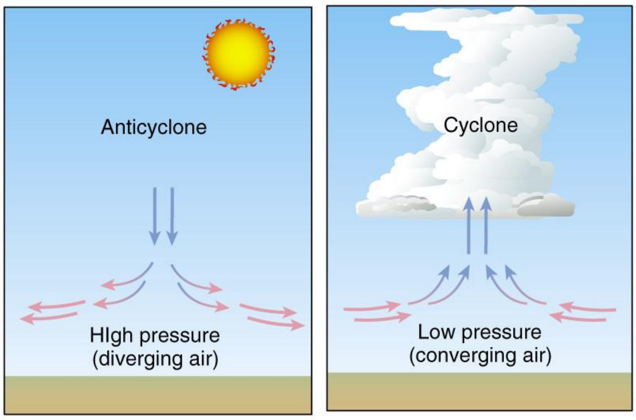
The tilt of the Earth will influence how much INSOLATION a location receives during the course of the year.

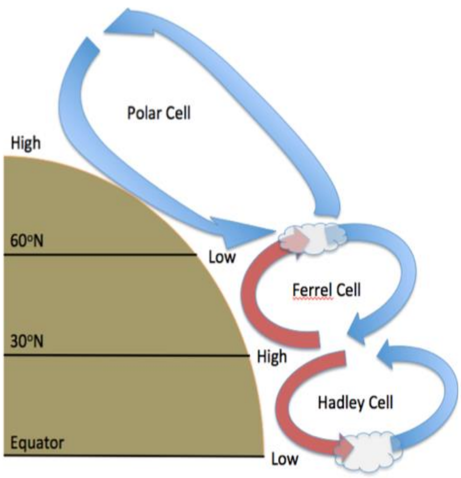


The curvature of the Earth also influence how much insolation a place receives too. See the diagram on the left.

Q19. How does pressure influence weather?

High pressure means air is descending and produces dry and calm weather. Low pressure means air is rising, which causes windy weather and creates wet weather.

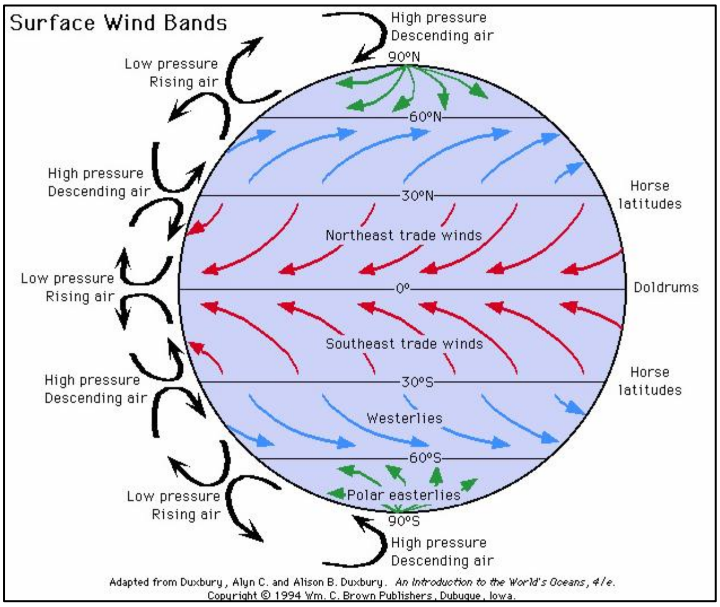




Winds blow from areas of high pressure to areas of low pressure.

Q20. Are there certain areas where high and low pressure dominates?

Yes, the TRI-CELLULAR model of atmospheric circulation shows how energy is transferred away from the equator. Winds are distorted on the ground due to the rotation of the Earth, which can be seen on the diagram over the page.



Can you work out why the rainforests are where they are?

Why is it hot and dry about 30 degrees north or south of the equator?

Why do we often experience cloudy and wet weather in the UK?

These questions can be understood by looking at questions 18-20.

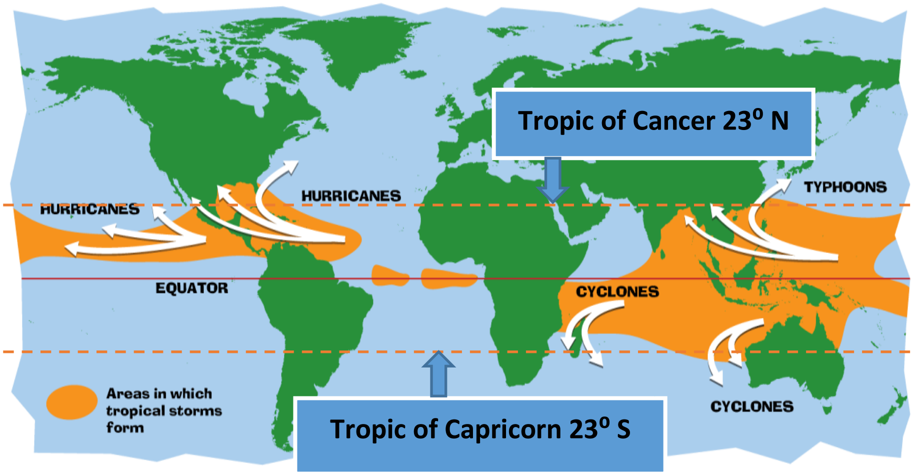
Part F: Tropical storms

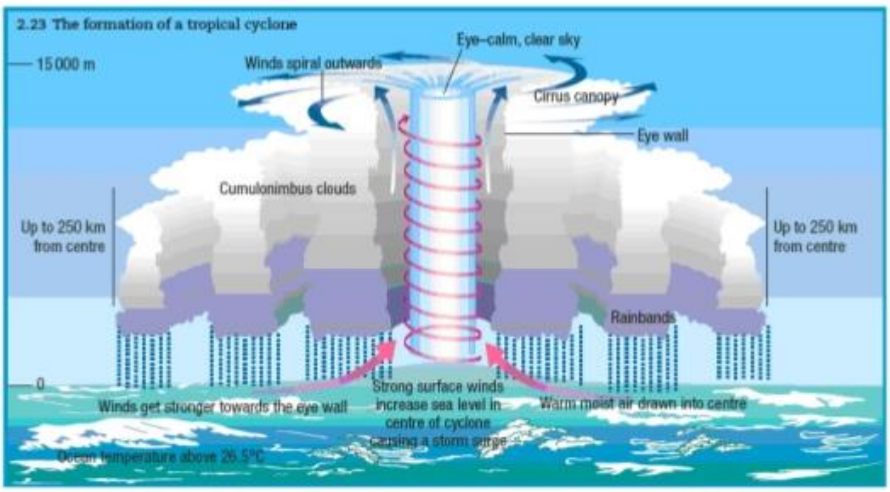
Q21. Where are tropical storms located?

See the World map below. Note that they have different names in different parts of the World.

Q22. How do tropical storms develop?

- Air on surface of ocean (water temp of 27°C) is heated (it also contains lots of moisture)
- Hot, humid air rises, cools and condenses. Clouds form.
- Rising air creates low pressure. Air rushes in to fill gap left by rising air.
- Rotation of the earth means winds do not blow straight. Winds circle towards the centre.
- The storm continues to feed itself.
- Whole system moves westwards (due to spin of the Earth (Coriolis force) towards land, where it has really strong winds and dumps huge amounts of rainfall.
- When the system crosses the land it loses its source of heat and moisture. The tropical storm losses its energy and dies out.



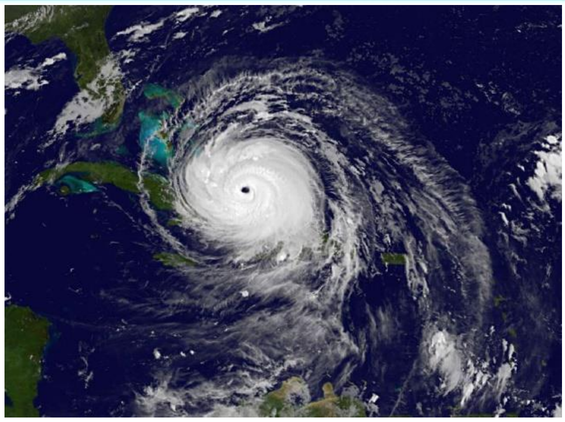


In the southern hemisphere tropical storms spin in a clockwise direction and in the northern hemisphere they spin anti-clockwise.

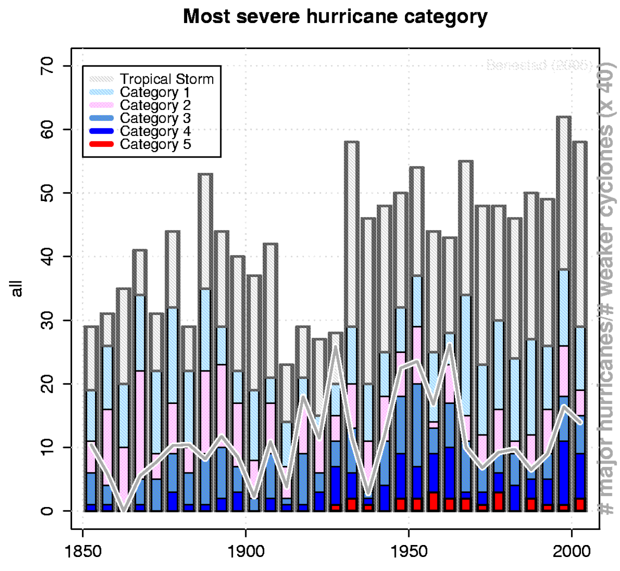
Q23. What is the structure of a tropical storm? – see diagram above and the picture on the right.

Things to notice:

- Central eye – low pressure
- Eyewall – worst weather
- Spiral rain bands
- 500km across?
- Low pressure creates a storm surge



Q24. How will climate change affect tropical storms?



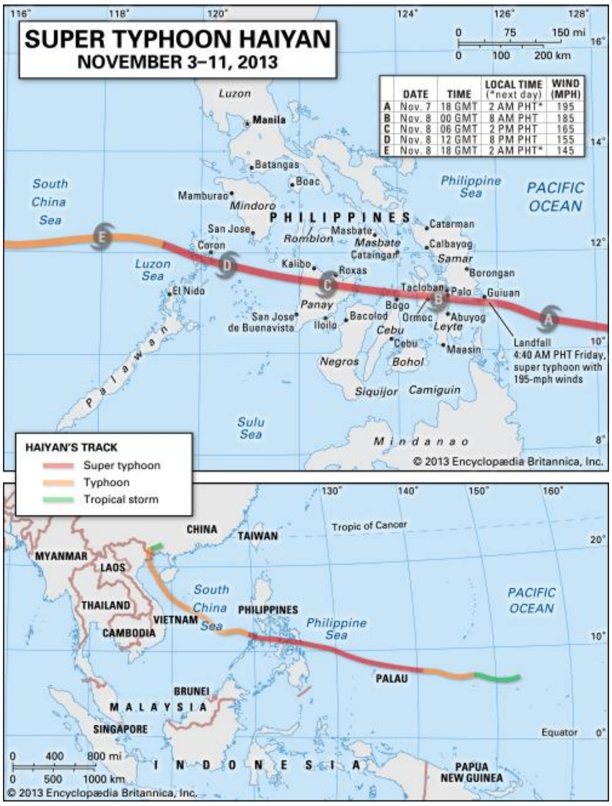
data: http://www.aoml.noaa.gov/hrd/hurdat/hurdatTAB.txt

An increase of temperatures due to global warming provides more heat in the atmosphere. In theory, this should lead to more evaporation, which fuels further tropical storm activity.

You can see from the graph on the right that the most intense storms have been on the increase. Many believe that category 4 and 5 storms will increase by 2-11% by 2100. However, many think that the total **frequency** of tropical storms will not change greatly – it will simply be case of a greater **intensity**. Some believe that rising sea temperatures further from the equator could mean that tropical storms could impact new areas.

Some believe that tropical storms go in cycles and get more intense/ less intense naturally – some would argue that humans have nothing to do with storms, but I don't agree with that.

Q25. What example of a tropical storm can you use?



Typhoon Haiyan, Philippines – November 2013.

It was a category 5 storms (the worst on the Saffir-Simpson scale). 170mp/h winds and 15m storm surge.

Q26. What were the **primary** (straight away) effects of Haiyan?

- Approximately 6,300 killed (drowned – storm surge)
- 600,000 displaced; 40,000 homes destroyed
- 90% of Tacloban destroyed
- Tacloban airport damaged
- 400mm or rain – flooding

Q27. What were the **secondary** (longer-term – after the event) effects of Haiyan?

- 14 million homeless
- 6 million lost source of income
- Power supplies impacted
- Ferry and airline services affected – slowing down aid efforts
- Shortage of food, water and shelter – disease
- Looting an violence in Tacloban

Q28. What were the immediate responses to Haiyan?

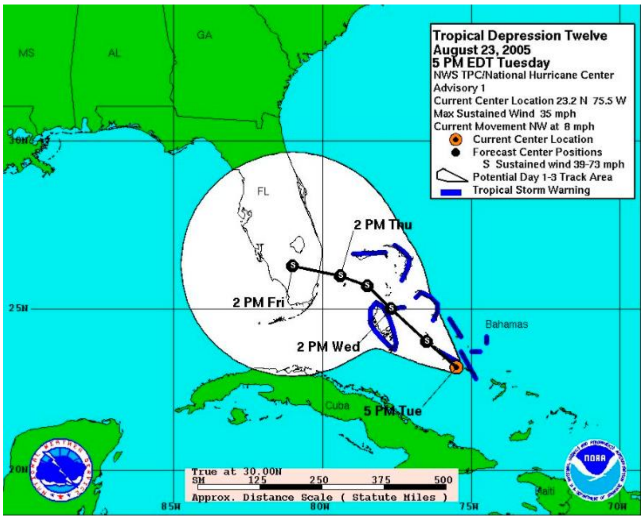
- Aid agencies responded quickly
- US aircraft carrier George Washington assisted with search and rescue and aid delivery
- 1200 evacuation centres set up
- UK government sent shelter kits
- French & Belgian field hospitals set up
- Red Cross delivered basic aid

Q29. What were the long-term responses to Haiyan?

- Rebuild roads, airports and bridges
- Aid agencies (Oxfam) supported delivery of new fishing boats
- Cyclone shelters built in coastal areas

- ‘cash for work’ programmes – people paid to clear the debris in the city
- The UN and other countries

Q30. How can you reduce the impact of a tropical storm?



There are number of strategies: monitoring, prediction, protection and planning

Monitoring/Prediction

The development and movement of tropical storms are closely monitored by agencies such as the National Hurricane Center and the Joint Typhoon Warning Centre. Warnings are issued to places where a tropical storm is likely to strike. Forecasts are available for residents to access on the Internet. The forecast map includes an area or ‘cone’ of uncertainty, where the hurricane may strike within a 3-day or 5-day period (see diagram – right) – accuracy not great!

Planning

This is all about raising awareness so that communities know how to prepare/ respond. This can be done by:

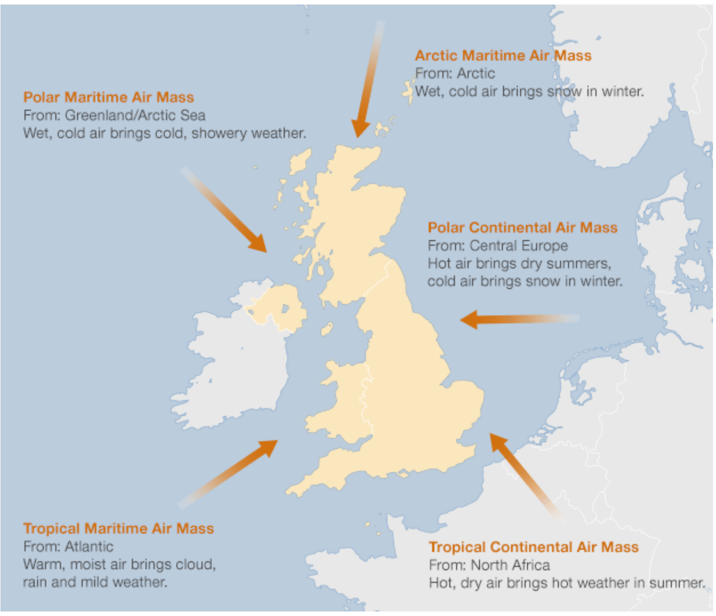
- Education programmes (school lessons, posters, leaflets)
- Preparing emergency ‘survival’ kits
- Authorities should restrict where new building is allowed (i.e. coastal location where there is a threat of storm surge)
- In the USA, there is a ‘National Hurricane Preparedness Week’ to raise awareness

Protection

This is really to do with actually building structures. Top right is a house built in a HIC. The picture below right is a cyclone shelter built in Bangladesh. Structures can include:

- ✓ Reinforce windows, walls and roofs
- ✓ Sea walls to protect against storm surge
- ✓ Build houses on stilts
- ✓ Storm drains – to remove water after the storm

Part G: UK weather hazards



Q31. Where does the UK’s weather come from?

The UK gets its weather from a number of directions. The map shows the direction of where the air masses come from and what types of weather are associated with it.

The UK is often described as being in the middle of a weather ‘roundabout’.

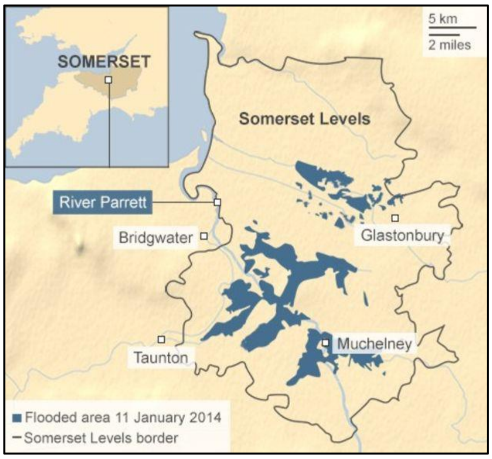
Q32. What sort of extreme weather does the UK experience?

Storms: A series of strong depressions caused damage due to high winds in late 2013. During the St. Jude storm of 28th October, 160km/h winds killed 4 people, felled trees and toppled lorries. In 2004, flash flooding occurred in Boscastle, Cornwall. Storms can often be the remnant of hurricanes that drift from the USA.

Cold weather: In lessons we told you about 1946/47 and 1962/63. However, I'm sure you remember the 'Beast from the East' in 2018? Cold air from Siberia (east) drifted across the UK bringing widespread snow and freezing temperatures. This caused widescale travel disruption and school closures.

Prolonged rainfall: We can experience wet conditions for a long period of time – see Somerset floods in Q33.

Drought/ Extreme heat: Drought is when rainfall levels fall well below the average for the region. The 2003 drought affected large parts of Europe, where it is believed to have caused 20,000 deaths. 38°C was recorded in Faversham, Kent – the highest on record in the UK.



Q33. What example can be used for a UK extreme weather event? – Somerset Floods, Dec13-Feb14.

Causes of the flooding

Wettest January since records began in 1910. A series of depressions (low pressure) driven across the Atlantic Ocean brought a period of wet weather lasting several weeks. About 350mm of rain fell in January and February, about 100mm 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 burst the river banks. The rivers had not been dredged for at least 20 years, which had become clogged with sediment.

Impacts of the floods

Social	Environmental	Economic
• 600 homes flooded • Power supplies cut off • Villages cut off – Muchelney, for example • Residents evacuated	• Contaminated floodwater • Debris • Stagnant water	• £10 million clear up cost – Somerset CC • 1000 livestock evacuated • Local roads cut off – bad for business • Railway line closed

Management of the flood

Short term	Long term
• Locals used boats to get around • Local community groups offered support • Temporary accommodation (e.g. guest houses)	• £20 million Flood Action Plan – Somerset County Council and Environment Agency to help reduce the risk of future flooding • Rivers Tone and Parratt dredged • Road levels heightened • Flood banks raised and more pumping stations built • Flood defences for vulnerable communities

Q34. Is the UK weather becoming more extreme? (Remember the David Attenborough video?)

This is a difficult one, as there have been many extreme events in the UK. However, there is a suggestion that these events are becoming more frequent than in the past. There is evidence to suggest that the amount of winter rainfall has increased 1910-2015 – particularly since the 1980s. UK temperatures have increased by about 1°C since 1980. However, these have necessarily coincided with periods of low rainfall, so droughts have not always occurred. Scientists believe that these trends are in line with what can be expected as a consequence of global warming – the

Atlantic Ocean is warmer and this has provided more energy for the depression weather systems. Lower pressure is created which intensifies the winds and increased the amount of rainfall.

In the future, Scientists believe the following will happen:

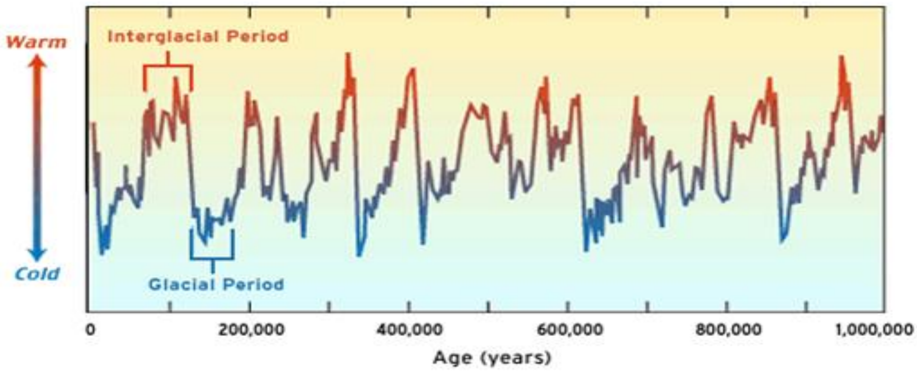
- Rain will become more seasonal, but totals will be broadly similar
- River flow (discharge) will increase, with my floods
- Evaporation will increase (higher temperatures) increasing the risk of drought

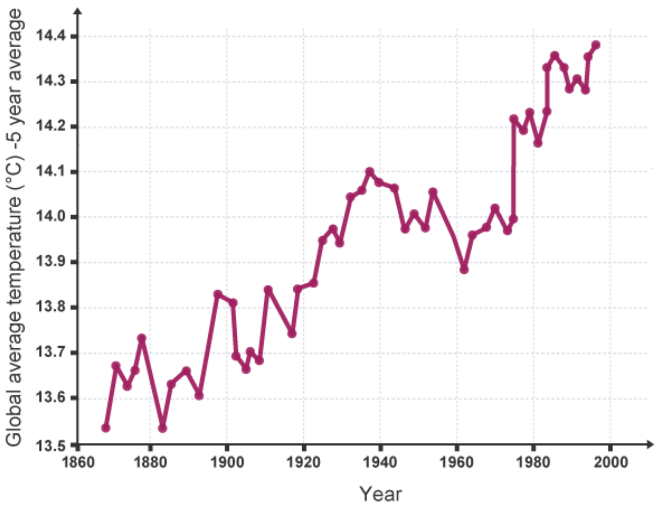
However, there is still uncertainty. Warming could melt ice in the Arctic which will mean that the Atlantic could get cooler, which could promote more extremes of cold weather. Some believe that our weather could be getting 'stuck' as the jet stream stays in one position for a longer periods of time. This can cause the long periods of drought/heatwaves or cold, depending on the season.

Part H: Climate change

Q35. What is the evidence for climate change in the Quaternary period?

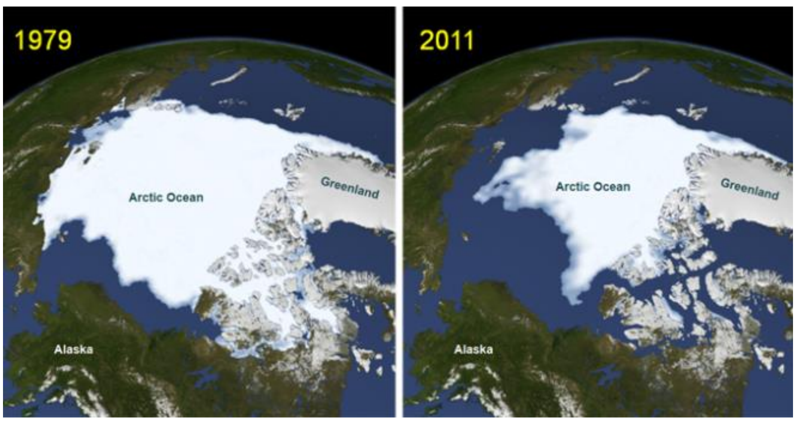
The quaternary period is about the last 2 million years – during this time we have had a series of warm and cold periods. This period of time is sometimes called the Pleistocene era. The graph below shows this cyclical pattern of warm and cold periods.





We know the climate has changed due to **TEMPERATURE RECORDS**. We have accurate records in the UK from about 1650, which shows that temperatures have increased. We also use **ICE CORES** – this is where we drill down in ice sheets and can look back in time. Gas bubbles trap a record of the atmosphere from a previous time in history. Study of the gases (Oxygen isotope analysis) enables scientists to extrapolate what the climate was like. We can also look at the **FOSSIL EVIDENCE** – finding animals that live in certain climatic conditions found in historic sediments enables scientist to suggest what the climate must have been like there (e.g. 'African' animals in Trafalgar Square from about 110,000 years ago).

Q36. What evidence is there to suggest that the climate is changing more recently?



The Polar Ice is melting – see satellite image (left)

Glaciers are retreating around the World (right)


A view of Muir glacier, Alaska, in 1941

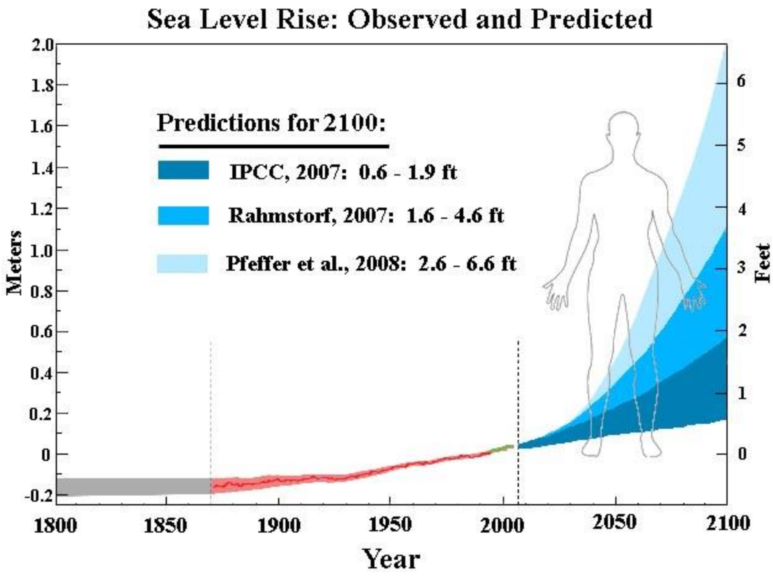

A view of Muir glacier in 2004

Seasonal changes - In recent years there have been signs of a seasonal shift - spring arrives earlier and winters tend to be less severe. These seasonal changes affect the nesting and migration patterns of wildlife.

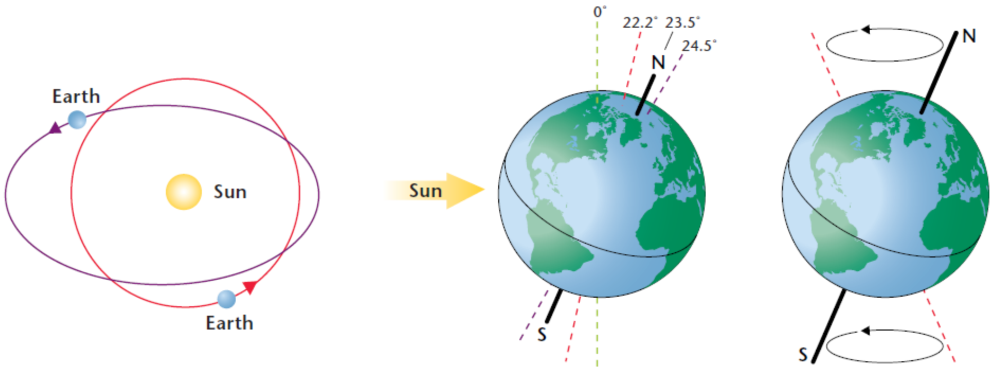
Sea levels are rising - Between 1901 and 2010, average global sea level rose by 0.19 m.

- When temperatures rise and freshwater ice melts, more water flows into the seas from glaciers and ice caps.

- When ocean water warms it expands in volume (taking up more space) – this is called thermal expansion.



Q37. What are the natural (physical) causes of climate change?



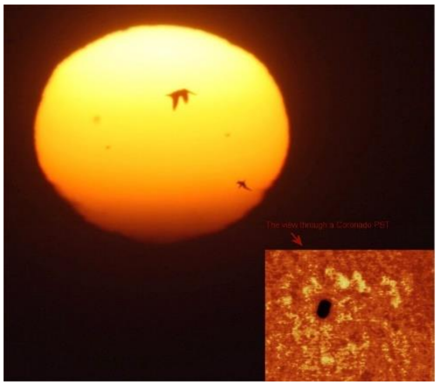
Eccentricity Earth encounters more variation in the energy that it receives from the sun when Earth's orbit is elongated than it does when Earth's orbit is more circular.

Tilt The tilt of Earth's axis varies between 22.2° and 24.5°. The greater the tilt angle is, the more solar energy the poles receive.

Precession A gradual change, or "wobble," in the orientation of Earth's axis affects the relationship between Earth's tilt and eccentricity.

Milankovitch cycles to do with the **changing orbit of the Earth**. The Earth has natural warming and cooling periods caused by Milankovitch cycles or variations in the tilt and/or orbit of the Earth around the Sun – see diagram on the left.

Variations in solar activity - there can be fluctuations in the amount of radiation from the sun. If there is high amount emitted there will be an increase in Earth's temperatures. Sunspots: High sunspots = warmer. Low sunspots = colder.



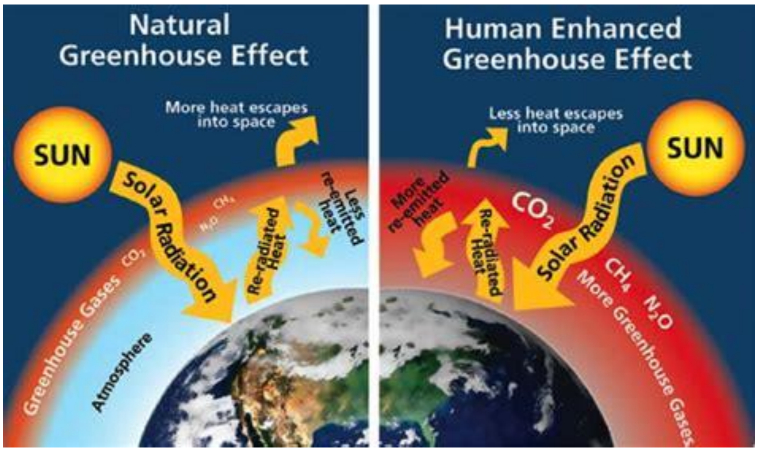
Few sunspots between 1645-1715 – 'Little Ice Age'. The Thames froze over!

Volcanic activity – This is Tambora in Indonesia. **Tambora, 1815:**

- 0.4-0.7ºC global temperature reduction
- 1816 – 'Year without a Summer'
- Harvest failed
- 200,000 deaths estimate

In the long run, volcanoes emit CO_2, which increases temperatures.

Q38. What are the human causes of climate change?



Human can create an 'enhanced greenhouse effect'. This is where gas emissions (CO2 & methane) absorbs the infrared radiation that has been reflected from the Earth when the UV light has come in from the Sun. These greenhouse gases trap the heat and has a blanket effect.

The gases are coming from a variety of sources:

- CO2 (60% of greenhouse effect): Burning fossil fuels for industry and electricity. Deforestation through the burning of wood. Car exhaust.
- Nitrous oxide (x300 more powerful than CO2!): Sewage, Fertilisers, Car exhausts and Power stations
- Methane (20% of greenhouse effect): Farm livestock, burning biomass for energy, landfill (rubbish) tips

Scientists believe that temperatures could rise anywhere between 1.8-4.0°C before 2100.

Q39. What are the impacts of climate change?

- Stronger tropical storms – Haiyan, for example?
- Droughts and floods increase
- Desertification
- Rising sea levels – Maldives?
- Changes in weather could impact the ability of farmers to grow crops

Q40. How can climate change be managed?

There are two main approaches: mitigation and adaptation

Methods to mitigate (manage the causes of climate change)			
Carbon Capture	**Planting trees**	**Alternative energy production**	**International agreements**
CO2 is captured when fossil fuels are burned. 90% can be captured and injected in rocks below ground 'geological reservoirs'.	Trees remove CO2 through the process of photosynthesis. UK invested £25 million encourage reforestation in Brazil.	Hydro-electric, solar, wind, nuclear (e.g Hinkley Point in Somerset), tidal etc. No carbon emissions – renewable (not nuclear).	Global solutions – 2005 Kyoto protocol. 170 countries agreed to reduce their CO2 by 5.2% compared to 1990 levels. 2009 Copenhagen – pledge to further reduce CO2 and help developing nations (not legally binding though) 2015 Paris Agreement – legally binding climate deal 195 countries.

Methods to adapt to climate change

- **Reduce risk from rising sea levels** – sea walls (3m high in Maldives); sand bags elsewhere. Raise land height like they did in the Maldives. Raise buildings up. Relocate people – people from the Maldives to Sri Lanka or even Australia?
- **Adapt farming** – change what you grow. Colder climates may be able to grow wheat. UK could grow more 'Mediterranean' crops. Change the time of the year when you grow things. Increase irrigation?
- **Managing water supplies** – artificial glaciers in Ladakh, India (divert water into artificial canals where it freezes). Water Strategy in London. People offered a free retrofit package of water efficient devices such as shower timers 12, 78 litres each year and dual flushes which save 17, 155 litres each year and Aerator showerheads which save 10, 950 litres each year. Desalinisation of water to increase water supply – e.g. Beckton on the River Thames.