1) Tectonic Hazards, Weather Hazards and Climate Change

Tectonic Hazards Key Words

- **Crust**: "the outer layer of the earth"
- **Plate**: "a section of the Earth's crust"
- **Plate margin**: "the boundary where 2 plates meet"
- **Mantle**: "the dense (heavy) mostly SOLID layer between the crust and outer core"
- **Inner Core**: " the solid , hot centre of the earth"
- **Outer Core**: "the semi-molten area around the inner core"
- **Convection Currents**: " the circular currents of heat moving around in the mantle"
- **Slab pull theory**: "plates move because of the weight of denser, heavier tectonic plates sinking into the mantle at ocean trenches. This drags the rest of the plate with it.
- **Subduction**: "the sinking of oceanic crust at a destructive margin"
- **Collision**: "the meeting of 2 plates of continental crust. They are both the same type so they meet head on and buckle/bend up or down"
- **Fold Mountains**: " large mountain ranges where rock layers have been crumpled as they have been forced together"
- **Ocean Trenches**: " deep parts of the oceans usually where an oceanic plate is sinking below a continental plate"
- **Composite Volcano**: " a steep sided volcano that is made up of a variety of materials such as lava and ash"
- **Shield Volcano**: " a broad/wide volcano that is mostly made up of lava"
- **Dormant**: an inactive volcano
- **Extinct**: volcano that has not erupted in the last 10 000 years
- **Natural Hazard**: "an occurrence over which people have little control. It poses a threat to people's lives and possessions"
- **Primary hazard**: "are those caused directly by the hazard of volcanic eruption, such as lava flows, ash falls as a result of the volcano erupting."
- **Secondary hazard**: "these are hazards caused as an indirect result of the primary hazard; for volcanoes these include landslides and tsunamis."
- **Primary effect**: the immediate damage caused by a tectonic hazard.

- **Secondary Effect:** the unforeseen consequences of the tectonic hazards such as fires, spread of disease, and food shortages.
- **Aid**: "money, food, training and technology given by rich countries to poor countries to help with an emergency or to help with long term development"
- **Earthquake**: " a sudden and violent movement in rocks (forming the earth's crust) which is felt on the earth's surface"
- **Focus**: " the point in the earth's crust where the earthquake originates"
- **Epicentre**: "the point at the earth's surface directly above the focus"
- **Shock Waves**: " seismic waves created by the earthquake that pass through the earth's crust"
- **Richter Scale**: "a scale used to measure the strength of an earthquake"
- **Mercalli Scale**: " a scale to measure the damage done by an earthquake"
- **Immediate responses**: "how people respond to a disaster immediately after it has happened"
- **Long Term responses**: "how people respond to a disaster, weeks/ months/years after the event"
- **Vent**: "The opening at the top of a volcano from which magma rises"
- **Super Volcano**: "a mega/massive volcano that erupts massive amounts of material"
- **Geothermal**: " water that is heated beneath the ground and comes to the surface in a variety of ways"
- **Tsunami**: " a special and massive type of wave caused by an earthquake under the sea or ocean"

1) Tectonic Hazards

Natural hazards pose major risks to people and property

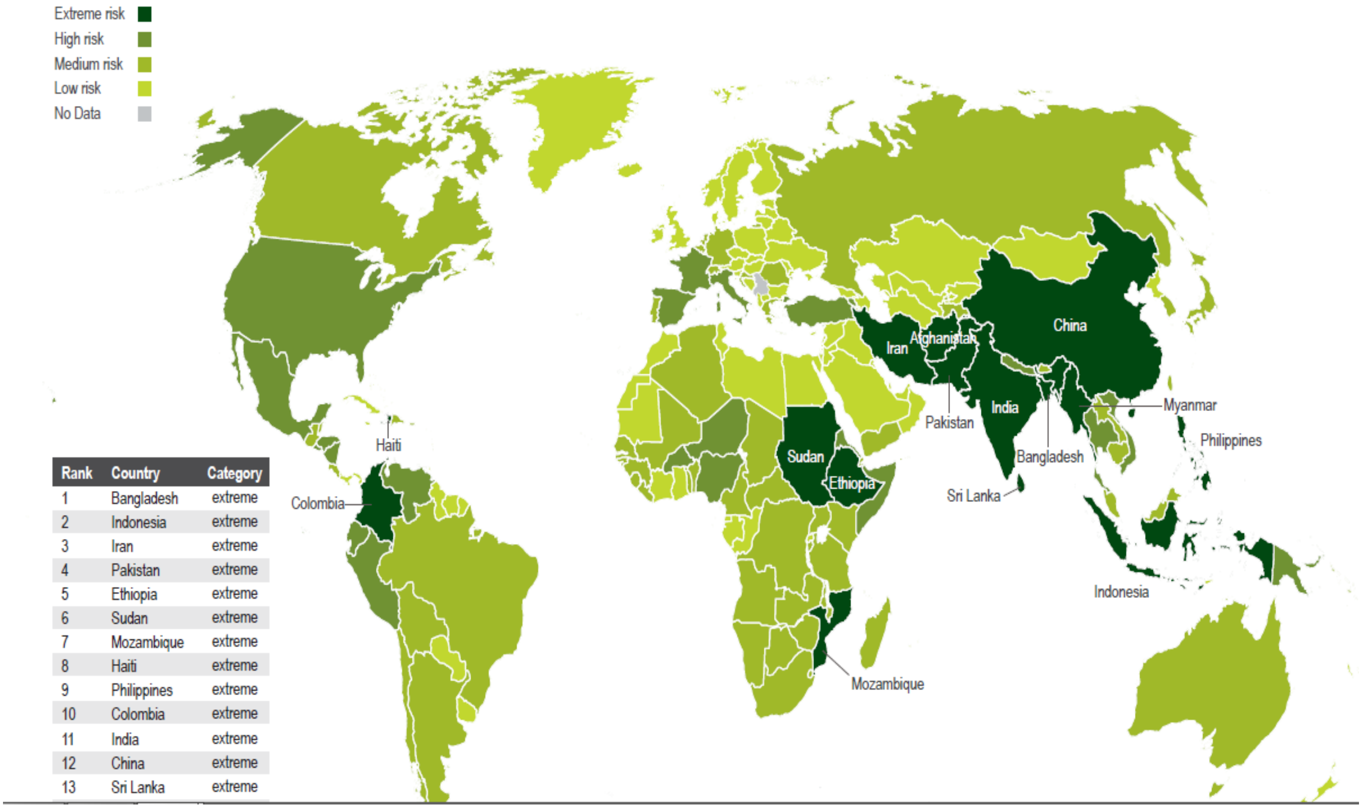
Definition

Natural hazards are naturally occurring events that pose potential risk of damage to property, and loss of life. The more humans come in to contact with natural events, the more the potential risk of natural hazards increases.

Types

- Tectonic hazards (volcanic eruptions, earthquakes, tsunamis)
- Atmospheric (Weather) hazards (hurricanes, tornadoes storms)
- Geomorphological hazards (flooding- which occur on the earth's surface)
- Biological hazards (forest fires which include living organisms)

Where do natural hazards occur?



Rank	Country	Category
1	Bangladesh	extreme
2	Indonesia	extreme
3	Iran	extreme
4	Pakistan	extreme
5	Ethiopia	extreme
6	Sudan	extreme
7	Mozambique	extreme
8	Haiti	extreme
9	Philippines	extreme
10	Colombia	extreme
11	India	extreme
12	China	extreme
13	Sri Lanka	extreme

Factors affecting hazard risk

As global population continues to grow, more and more people are living in areas at risk from natural hazards.

Human influences such as **global warming, deforestation** (cutting down of trees) and **urbanisation** (growth of towns and cities) have meant that there are more and more natural hazards occurring.

- **Hazard risk** is often worse in countries that are poorer or developing (these are countries with **emerging economies).**

- This is because they might not have **money** to build protective structures, buildings and **infrastructure** such as flood defences and earthquake proof buildings.

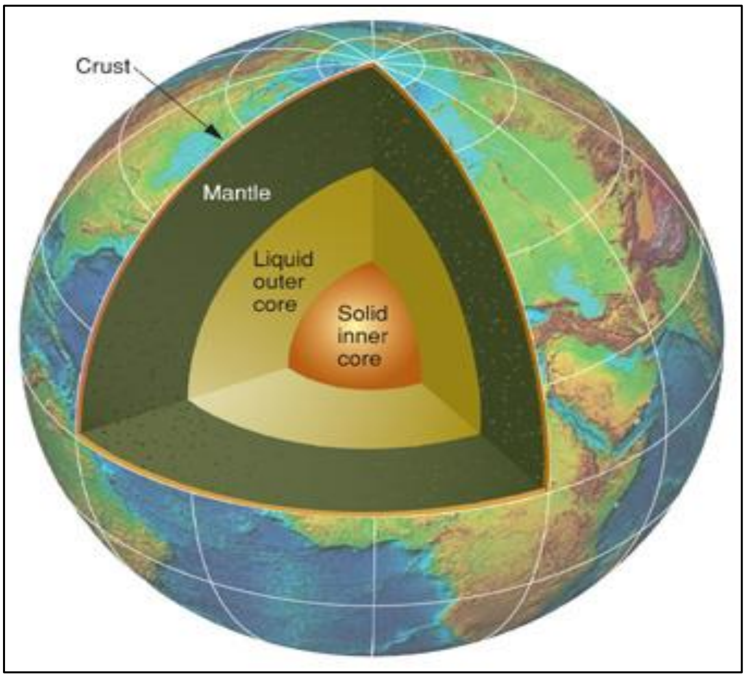
- They might also find it **difficult** to recover and **rebuild** after a natural hazard.

Earthquakes and volcanic eruptions are the result of physical processes

Structure of the Earth

There are 4 sections through the earth:

1. **CRUST**: the very thin outer layer of the earth. It is about 10 kms thick below the oceans and about 60 kms thick over the land.
2. **MANTLE**: this is the thickest section of the earth's crust. It is quite solid but is able to flow very slowly like plasticine. There are convection currents in the mantle which cause the rocks to move around.
3. **OUTER CORE**: the inner core is liquid and can flow
4. **INNER CORE**: this is the centre of the earth. It is thought to be solid with lots of iron there.



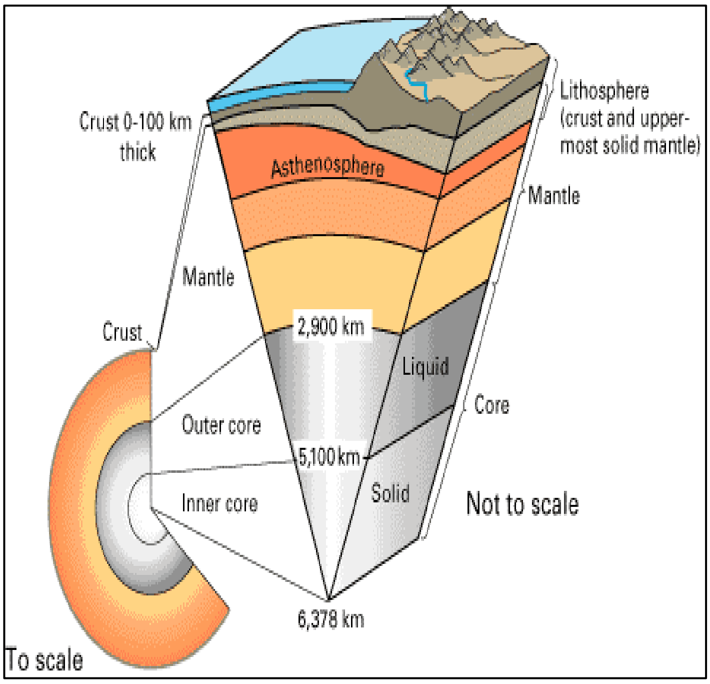


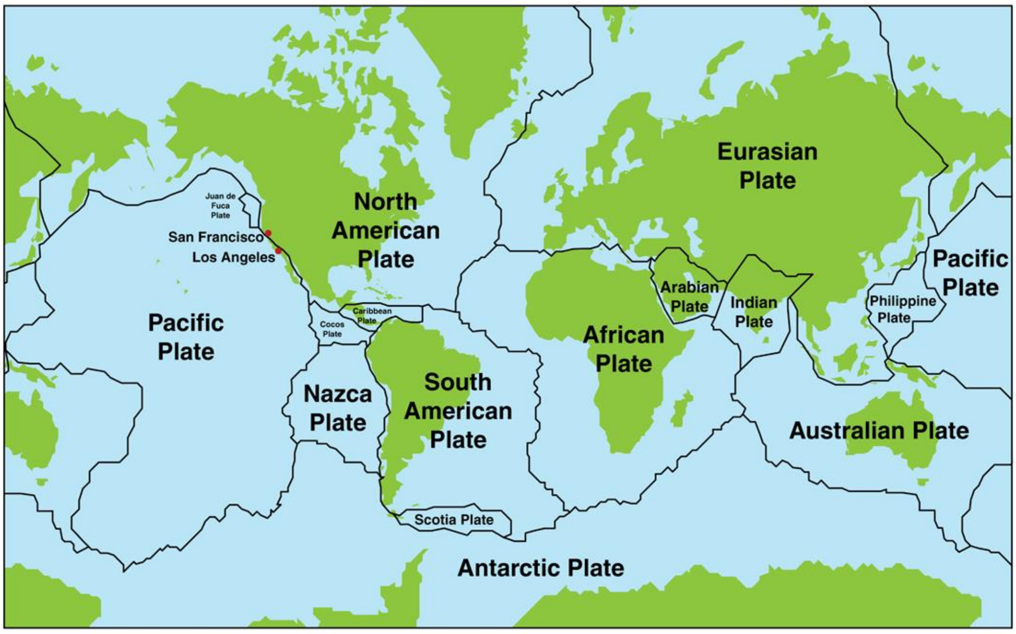
Plate tectonics theory

The theory of Plate Tectonics was introduced by Alfred Wegener. He suggested that North and South America once fitted together with Europe and Africa. It offered an explanation of the existence of similar *fossils* and rocks on continents that are far apart from each other. But it took a long time for the idea to become accepted by other scientists.

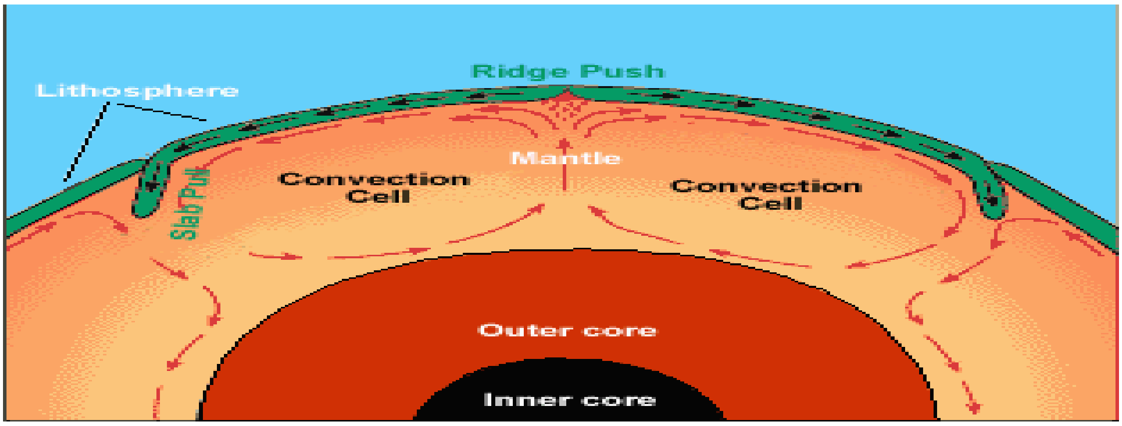
Wegener's evidence for continental drift was that:

- the same types of fossilised animals and plants are found in South America and Africa
- the shape of the east coast of South America fits the west coast of Africa, like pieces in a jigsaw puzzle
- matching rock formations and mountain chains are found in South America and Africa

The crust is not one piece of skin like an apple. Instead it is divided into very large pieces called **PLATES**.

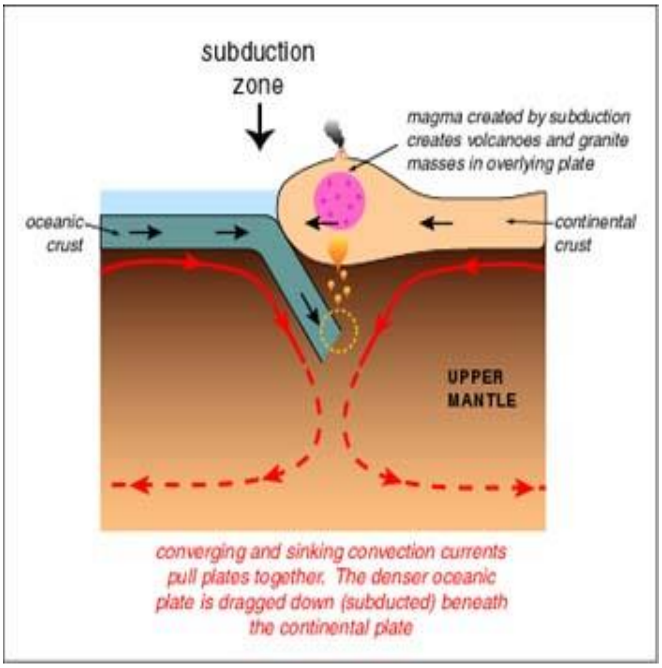


Where the plates meet are called the: **PLATE MARGINS**. At the plate margins the crust moves most. The crust floats on the mantle. Convection currents in the mantle determine whether the plates move apart or move together.



- Convection currents in the mantle is generated by high temperatures, are the driving force that forces the plates to move.
- Now it is thought that the plates move because of the weight of denser, heavier tectonic plates sinking into the mantle at ocean trenches.
- This drags the rest of the plate with it and is called '**slab pull theory**'.

Characteristics of different types of crust



Oceanic crust is found below the oceans. Continental crust is found on/below the ground

The places at these plate margins are areas that are very unstable and we find lots of tectonic hazards here such as earthquakes and volcanoes. Oceanic crust is found below the oceans. Continental crust is found on/below the ground.

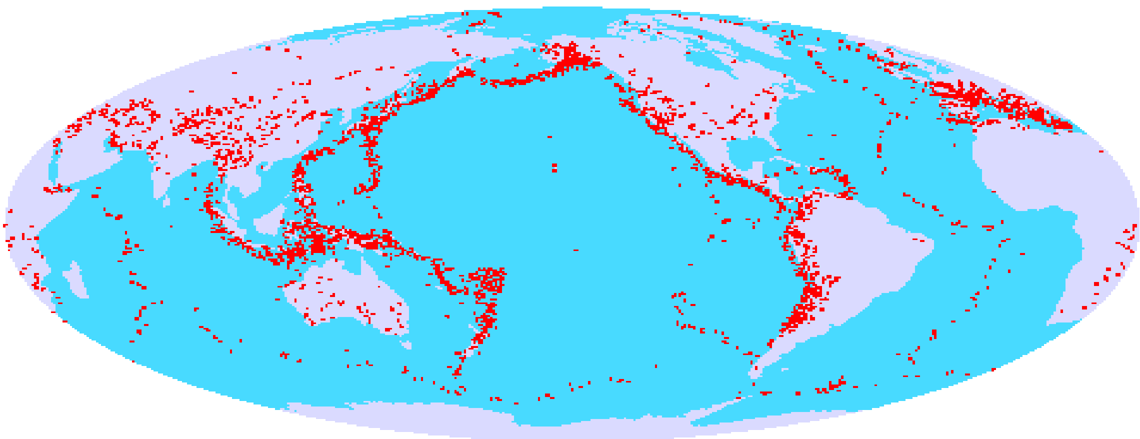
	Continental crust	**Oceanic Crust**
Thickness	30-90 km thick	5-10 km thick
Oldest rock in years	4 billion years old	200 million year old
Main rock type	Granite	Basalt
Density	It cannot sink (less dense) Cannot be renewed or destroyed	It is heavier(denser) It can be renewed and destroyed

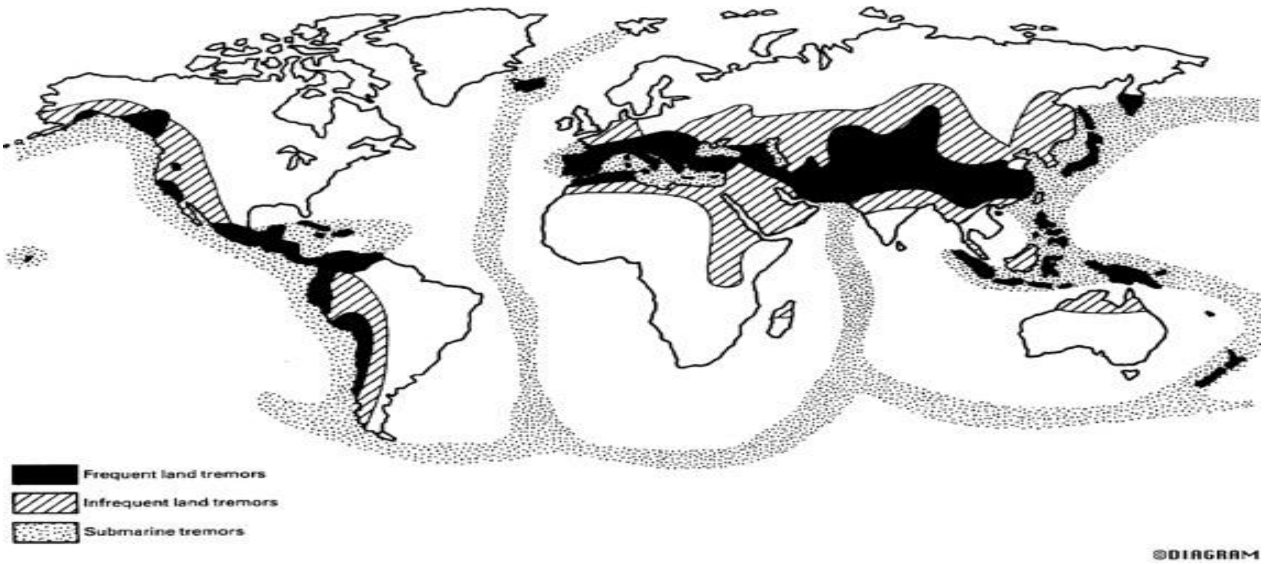
Global distribution of earthquakes and volcanoes

The Global Distribution of Volcanoes

- Volcanoes are a "**NATURAL HAZARD**"
- They are located around the **plate margins**
- Lots are around the Pacific Ocean. The area is called **"The Pacific Ring of Fire"**
- Now and again volcanoes are found away from the plate margins e.g. Mauna Loa in the middle of the Atlantic Ocean

The Global Distribution of Earthquake



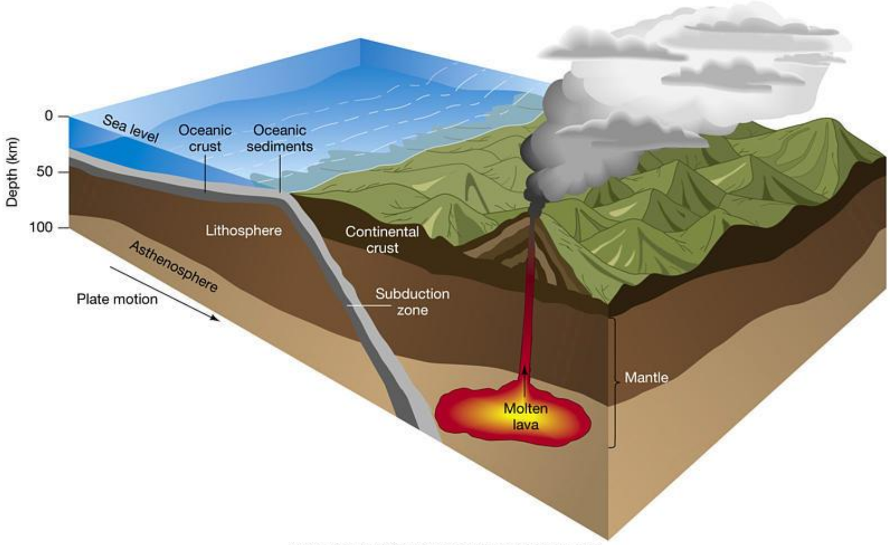


- In **linear clusters** (grouped together in lines)
- Mostly found on **plate boundaries**
- Especially located along **destructive and conservative** plate margins e.g. where Pacific plate meets North American Plate
- Most common around the edge of the Pacific Plate known as "**Pacific Ring of Fire**
- Few located away from plate boundaries e.g. very few in Northern Europe or Central Africa

Plate margins (constructive, destructive and conservative)

There are 3 different types of plate margin. They are:

1. **Destructive plate margins**

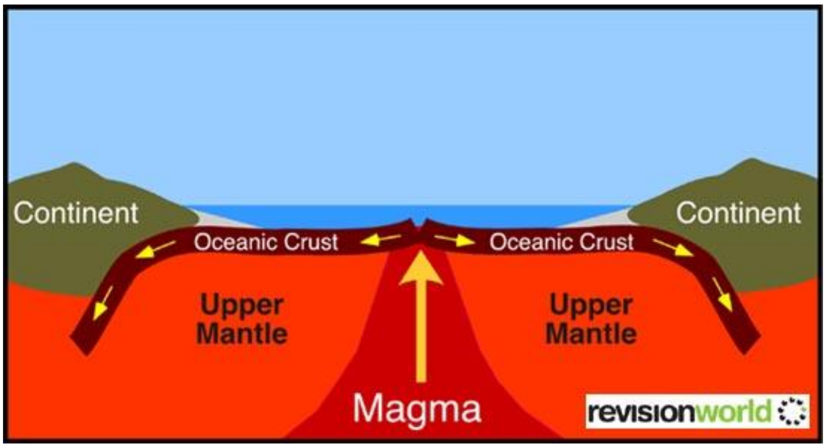


- Convection currents in the mantle cause plates to move together.
- The denser (heavier) oceanic plate moves under the continental plate. This process is known as **SUBDUCTION**
- Pressure and friction cause the oceanic plate to melt and form **MAGMA.**
- Magma rises to the earth's surface because it is hotter and less dense than the surrounding rock.
- Magma builds up to eventually form volcanoes.

Collision Zones

- 2 continental plates collide together. When they collide they push the Earth's crust upwards forming fold mountains, for example, the Himalayas.
- When 2 oceanic plates meet, subduction will happen. The cooler, denser plate is subducted under which results in volcanic eruptions that form a chain of volcanic islands. This is known as islands arcs. An example is The Mariana Islands in the Western Pacific Ocean. This happens because the pacific plate is forced under the Mariana plate.

2. Constructive plate margins

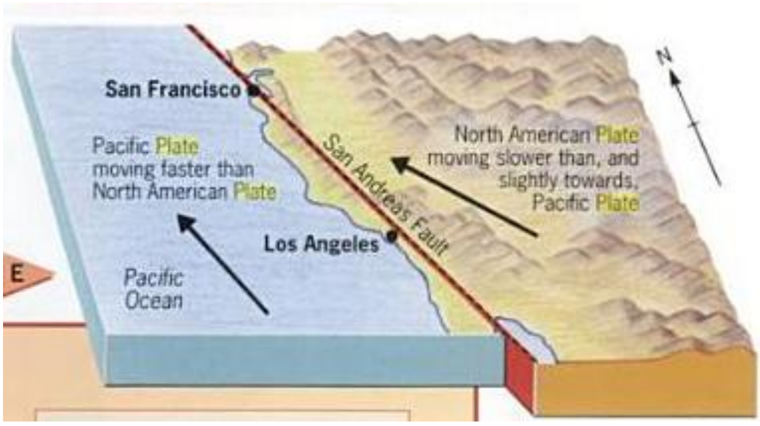


- When plates move apart, a constructive plate boundary results.
- This often happens under oceans
- Cracks form between the plates and magma forces its way up through the crack. This results in new sea floor being created along the Mid Atlantic ridge.
- When the magma reaches the surface it forms volcanoes (under water). The can rise above the water causing volcanic islands to form.
- New land e.g. Iceland has been formed in this way
- Earthquakes also occur here along Transform faults.

Rift Valleys

When to continental plates are moving apart a rift valley can form. Rift Valleys are relatively narrow compared to their length, with steep sides and a flat floor.

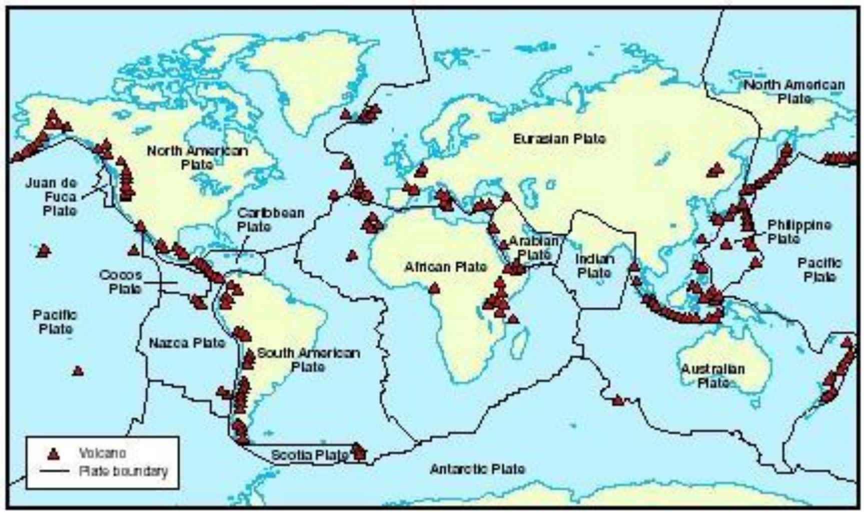
3. <u>Conservative plate margins</u>



- At conservative plate margins plates slide past each other
- They move in a similar direction but at slightly different angles and different speeds.
- These differences in speeds and directions cause them to get stuck
- Pressure builds up, the plate 'jerks' forward and a release in pressure results in an earthquake occurring.
- LA and San Francisco are found close to the SAN ANDREAS FAULT (part of the conservative plate margin)
- There are no volcanoes at this plate margin.
- Crust is not being destroyed or created.

<u>Why is volcanic activity found near plate margins?</u>

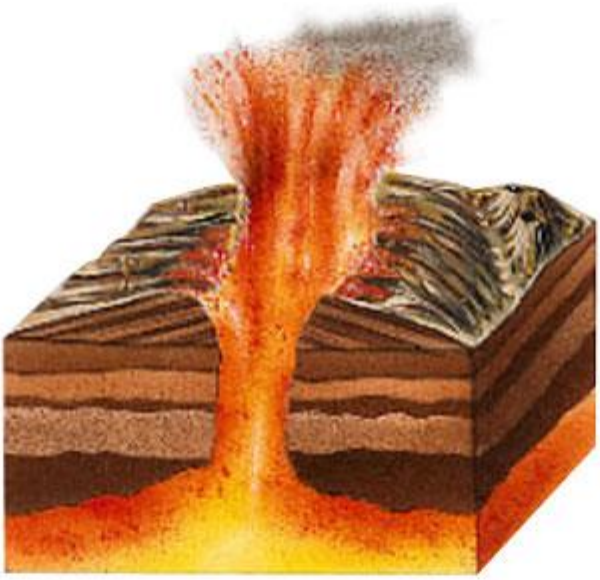
- There are more than 500 active volcanoes in the world and more than half of them are found around the Pacific Ocean.
- They occur where molten rock and ash erupts from inside the earth.
- Most volcanic activity occurs near plate margins where the earth's crust is unstable.
- Volcanic hotspots are places points along the Earth's crust where it is thin and Magma can reach the surface easily. Hawaii has formed because of this.



Inactive volcanoes are said to be dormant. If it has not erupted in the last 10000 years, it is thought to be extinct.

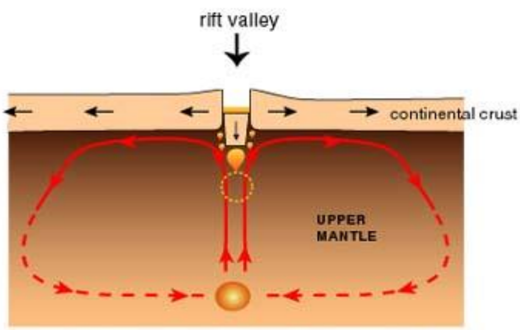
Hot springs and geysers tell us there may have been tectonic activity in the past. These occur when underground water is superheated by hot rocks close to the earth's surface.

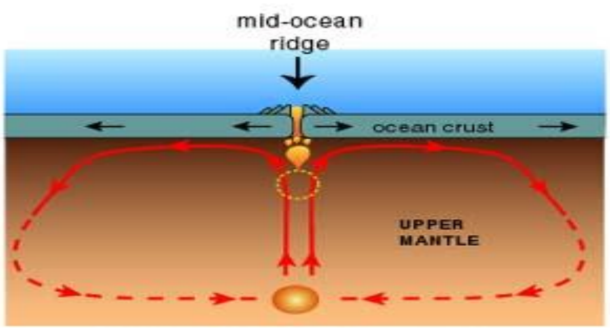
Shield Volcano



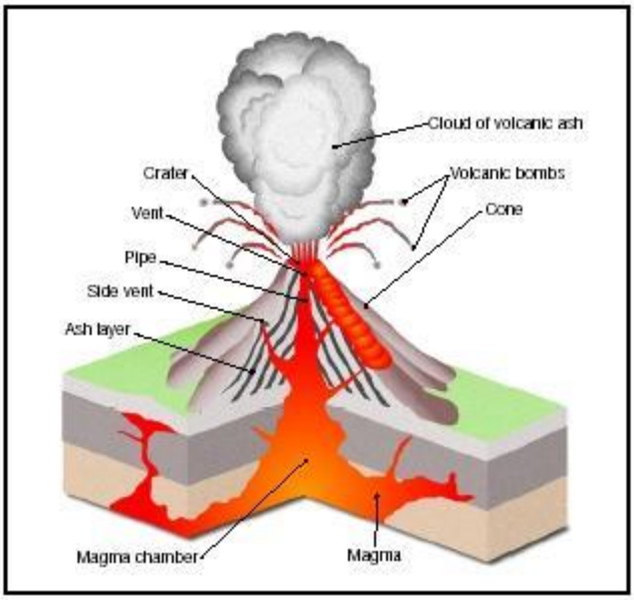
Layer of lava, runny lava travels long distance

- Shield volcanoes form at constructive plate margins where the plates move apart from each other. Molten magma rises up from deep inside the mantle and melts the upper mantle.
- This adds new crust to the sea floor and volcanoes below the sea form (submarine volcanoes).
- Like hot spot volcanoes, the magma rising up from the mantle is very hot and therefore very fluid. The main hazards linked with volcanoes at constructive margins are lava and ash. The magma runs down the sides of the volcano creating a low, wide shape.





Composite Cone Volcano



Layers of ash and lava, viscous lava travels short distance

- Oceanic and continental crust are pushed together at destructive plate margins, this is called subduction. As the oceanic crust is subducted friction and heat melts the plate and generates magma.
- The magam is then forced to the earth's surface and erupts violently.
- Volcanoes become steep sided and eruptions are very explosive, this results in rocks, lava and ash exploding from the volcano, this mixes with gas and steam and caues pyroclastic flows.
- Layers of lava and ash gather around the vent and this creates a composite volcano.

Features	**Composite Volcanoes**	**Shield Volcanoes**

Plate Boundaries location (**destructive/constructive**)	Destructive plate boundaries	Constructive plate boundaries
Slope type (**steep/gentle**)	Steep slopes Tall, cone shaped	Gentle slopes Low cone with wide flanks
Base of volcano (**narrow/wide**)	Narrow base	Wide base
Made of........ (**lava/lava and ash**)	Alternative layers of ash and lava	Made of lots of lava flows
Lava type	Volcanic gases do not escape the lava easily Viscous, less hot and slow flowing Flows in short distances	Volcanic gases remain dissolved in the lava Low viscosity, hot and runny Flows over long distances.
Frequency of eruptions (**regular and frequent/ irregular & long dormant spells**)	Irregular eruptions Long dormant spells (doesn't erupt vert often)	Regular Frequent eruptions (happens often)
Force of Eruption (**Violent/gentle**)	Violent	gentle
Examples	Krakatoa in Indonesia Mount St Helens, USA	Mauna Loa in Hawaii Heimaey in Iceland

Why do Earthquakes occur near plate margins?

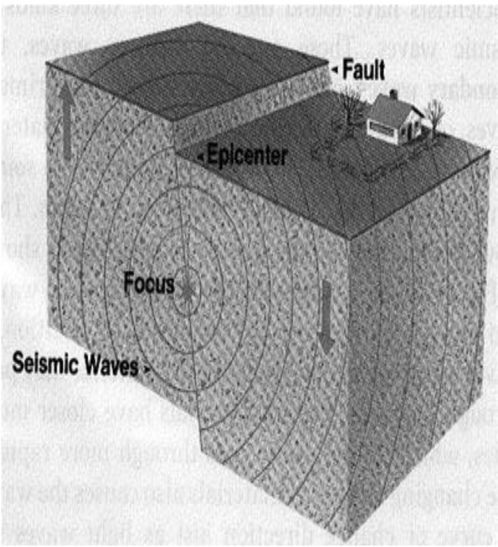
Definition of Earthquakes

Earthquakes are the sudden or violent movement (shockwave) within the Earth's crust. It is caused by the release of built-up pressure.

Causes of Earthquakes

- Tension builds up at the plate margins
- **At Destructive margins**: tension builds up when one plate gets stuck as it is moving down past the other into the mantle (subduction)
- **Conservative margins**: tension builds up when plates are grinding past each other. They are **moving in similar** (not the same) **directions** but **at different speeds. Pressure builds up** as the **plates stick** together
- Suddenly the plates **become unstuck** causing them to **jerk past each other** sending out **shock waves** (vibrations through the earth's crust).

Features of an Earthquake

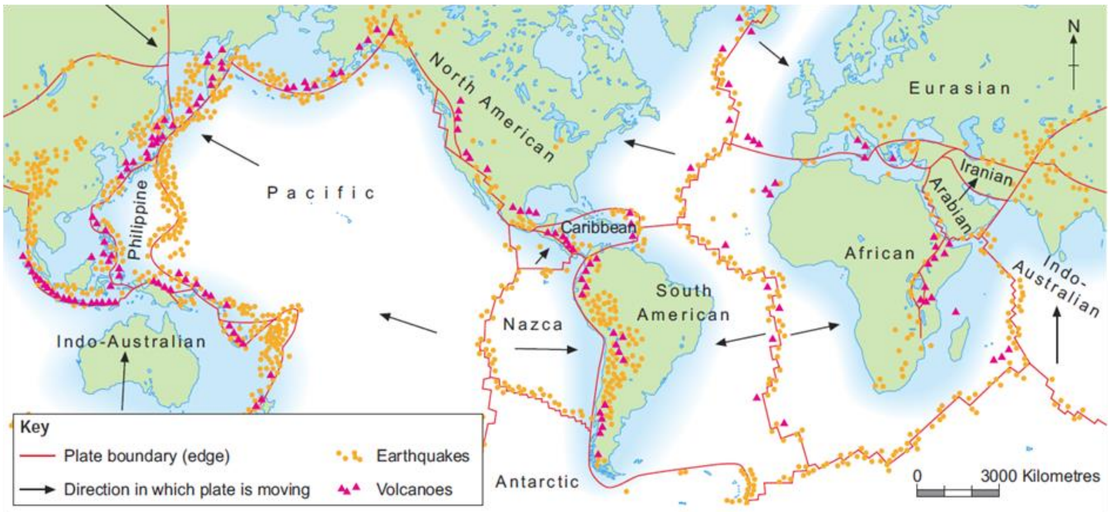


- As the plates jerk past each other they send out **shock waves** (vibrations through the earth's crust).
- These vibrations are the earthquake and move in all directions like the ripples on water when you throw a stone into the water.

- The shock waves spread out from the **focus** (the point in the earth's crust were the earthquake originates)
- The nearer the focus the stronger the waves and the more the damage

- The **epicentre** is the point on the earth's surface straight above the focus
- Weak earthquakes happen quite often, strong earthquakes are rare.

Where do they occur?



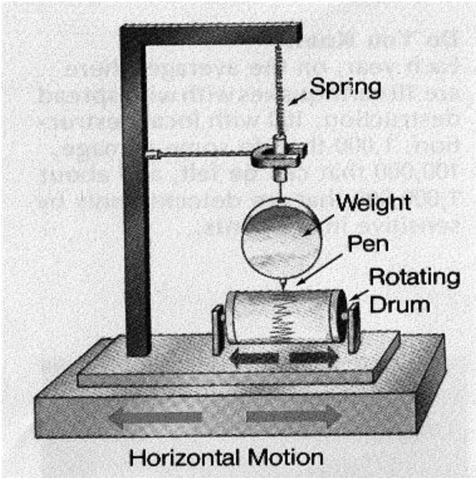
Every year there are over 20,000 earthquakes. Most of these are small in magnitude and go undetected, but some are very powerful.

They are concentrated in long narrow belts that follow plate boundaries.

One belt follows circles around the Pacific plate. Indonesia, Japan China and Fiji and the Philippines are located along this area (seismic zone) and they experience a lot of the earthquakes.

How are earthquakes measured?

Earthquakes are measured using instruments called **seismographs**. These instruments measure the vibrations travelling through the earth's surface.



There are **2 scales** used to measure the strength of an earthquake

1. **Richter Scale**
2. **Mercalli Scale**

Richter scale

- The scale goes from 1(weak) to 10+ (massive). There is no upper limit to this scale.
- It **measures the amount of energy released** by the earthquake
- The scale is logarithmic which means an earthquake measuring 5 is 10 times more powerful than an earthquake measuring 4 on the scale

Richter scale no.	No. of earthquakes per year	Typical effects of this magnitude
< 3.4	800 000	Detected only by seismometers
3.5 - 4.2	30 000	Just about noticeable indoors
4.3 - 4.8	4 800	Most people notice them, windows rattle.
4.9 - 5.4	1400	Everyone notices them, dishes may break, open doors swing.
5.5 - 6.1	500	Slight damage to buildings, plaster cracks, bricks fall.
6.2 6.9	100	Much damage to buildings: chimneys fall, houses move on foundations.
7.0 - 7.3	15	Serious damage: bridges twist, walls fracture, buildings may collapse.

7.4 - 7.9	4	Great damage, most buildings collapse.
> 8.0	One every 5 to 10 years	Total damage, surface waves seen, objects thrown in the air.

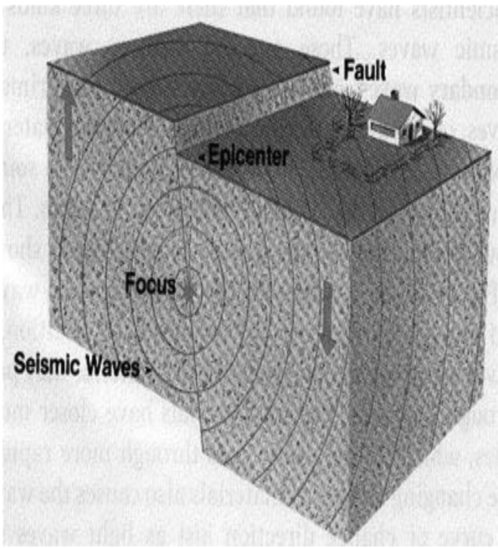
Mercalli Scale

- This **measures the <u>effects</u>** of an earthquake
- Its measured by asking eye witnesses for observations of what has happened
- Its scale is 1 to 12

Mercalli Scale	Equivalent RichterMagnitude	Witness Observations
I	1.0 to 2.0	Felt by very few people; barely noticeable.
II	2.0 to 3.0	Felt by a few people, especially on upper floors.
III	3.0 to 4.0	Noticeable indoors, especially on upperfloors, but may not be recognized as an earthquake.
IV	4.0	Felt by many indoors, few outdoors. May feel like heavy truck passing by.
V	4.0 to 5.0	Felt by almost everyone, some people awakened. Small objects moved. trees and poles may shake.
VI	5.0 to 6.0	Felt by everyone. Difficult to stand. Some heavy furniture moved, some plaster falls. Chimneys may be slightly damaged.
VII	6.0	Slight to moderate damage in well built, ordinary structures. Considerable damage to poorly built structures. Some walls may fall.
VIII	6.0 to 7.0	Little damage in specially built structures. Considerable damage to ordinary buildings, severe damage to poorly built structures. Some walls collapse.
IX	7.0	Considerable damage to specially built structures, buildings shifted off foundations. Ground cracked noticeably. Wholesale destruction. Landslides.
X	7.0 to 8.0	Most masonry and frame structures and their foundations destroyed. Ground badly cracked. Landslides. Wholesale destruction.
XI	8.0	Total damage. Few, if any, structures standing. Bridges destroyed. Wide cracks in ground. Waves seen on ground.
XII	8.0 or greater	Total damage. Waves seen on ground. Objects thrown up into air.

What are the impacts of earthquake on people and places?

Physical factors	Human Factors
Location of epicentre: if near urban areas, more people and more buildings are affected.	**Population density**: more deaths and damage occur in earthquakes which strike densely populated areas.
Depth of focus: friction causes less energy from deep-focused earthquakes to reach the Earth's surface.	**Level of development**: wealthy countries can afford to reduce the impact of earthquakes through prediction, protection and preparation.
Time of day/week: more deaths can happen if people are inside poorly designed buildings; fewer deaths occur if people are outside and far away from these buildings.	**Prediction:** trying to forecast when and where an earthquake might strike can provide time for people to evacuate to safety
Geology: sedimentary rock such as clay and sand will amplify shockwaves and cause buildings to collapse.	**Building standards**: using earthquake resistant design reduces the number of deaths.



The Effects of Earthquakes and Responses and how responses to them depends on the wealth of the country they affect

L'Aquila in Italy 2009 (an earthquake in a rich country)

Place: L'Aquila in Italy
Date: 6th April 2009 at 3.32 am
Magnitude: 6.3 on Richter scale

1. **CAUSES** of the earthquake
   - African plate collides with the Eurasian plate: "Destructive Margin"
   - The African plate moves under the Eurasian plate

2. **PRIMARY EFFECTS**
   - about **308** deaths mostly from collapsed buildings
   - **1500** injured and **67,500** were made homeless.
   - About 10,000 – 15,000 buildings were damaged or destroyed including;
     -**Churches, medieval buildings and monuments** with a lot of **cultural** value.
     -The **Basilica of St Bernardino**, National Museum and Porta Napoli.
     -**San Salvatore Hospital** (patients had to be evacuated as it could not cope with victims)
     L'Aquila University buildings were damage with some students dying.

   - A bridge just outside the town collapsed and a mains water pipe was broken in the area.
   - Overall the EU reported over US$11,000 million of damage to L'Aquila.

3. SECONDARY EFFECTS

- Aftershocks triggered landslides and rock falls which caused damage to housing and transport.
- This also hampered rescue efforts and they caused more damage.
- A landslide and mudflow caused by a burst main water supply pipeline near the town of **Paganio.**
- Less students attended the university.
- The lack of housing for all residents meant house prices and rents increased.
- **Fires** in some collapsed buildings caused more damage.
- Much of the centre was cordoned off due to unsafe buildings. Some of the '**RED' zones** still exist, which reduced the amount of business, tourism and income.

4. IMMEDIATE RESPONSES

- **Camps sites (40,000 tents)** were set up for homeless people with water, food and medical care. Hotels also provided shelter. Some train carriages were used as shelters.
- The prime minister even offered some of his homes as shelter.
- **Within an hour**, the **Italian Red Cross** were searching for survivors. They were helped by **7 dog units**.

- **36 ambulances**, fire engines and the army were sent in to rescue survivors.
- Cranes and diggers were used to remove rubble
- International rescue teams with rescue dogs were sent in to look for survivors
- Money was provided by the government for people to pay rents on homes

- Gas & electricity bills were suspended by government. **The Italian Post Office** offered **free mobile calls**, raised donations and gave free delivery for products sold by small businesses.
- The **British Red Cross raised £171,000 in support.**
- L'Aquila declared a state of emergency which sped up international aid (help from other countries). The **EU provided US$552.9 million** for rebuilding to take place.
- The **Disaster Emergency Committee (DEC),** a UK group, **did not provide aid** because it considered Italy a more developed country which had resources to provide help, and also had help from the EU.

5. **LONG TERM RESPONSES**
    - Torch Lit procession which took place with a Catholic Mass on the anniversary, as remembrance.
    - Residents didn't pay taxes during 2010.
    - Students were given free transport, discounts on educational equipment and they were exempt from university fees for 3 years.
    - Homes took several years to be rebuilt. Historic centres to take around 15 years to be rebuilt.
    - The Italian prime minister promised to build a new town to replace L'Aquila.
    - In 2012 six scientists and one government official were found guilty of manslaughter as they had not predicted the earthquake. They were accused of underestimating the risks. They were sent to prison for 6 years. In November 2014 the verdict was overturned for the 6 scientists.
    - An investigation is going on to look at why the modern buildings weren't built to withstand the earthquake.

6. **PREDICT, PROTECT and PREPARE**

- New laws on the construction of buildings to stand up to earthquakes
- They train volunteers to help with earthquake rescues

Earthquake in Gorkha, Nepal (2015)

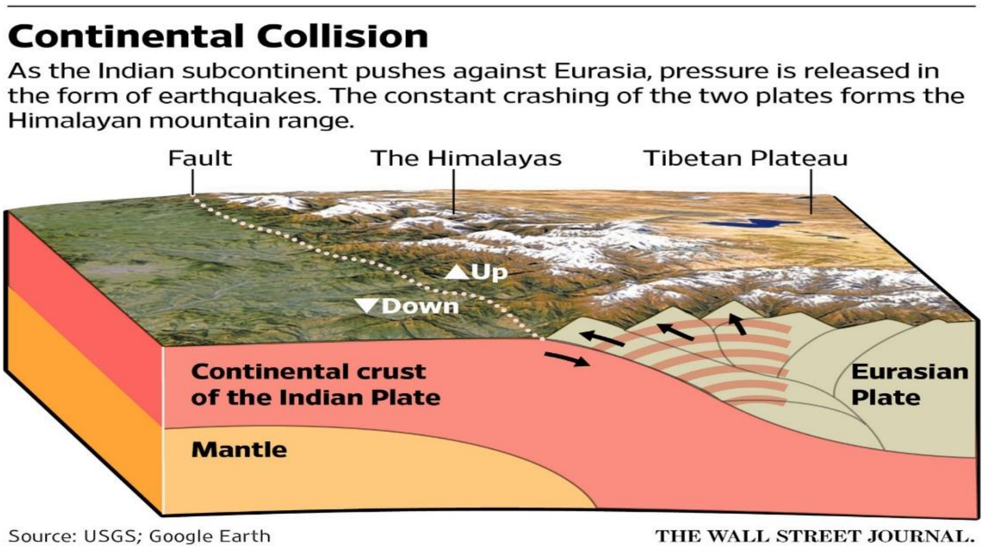
Place: GHORKA district in Nepal

Date: 28th April 2015, 12.50 am

Magnitude: 7.8 on Richter scale

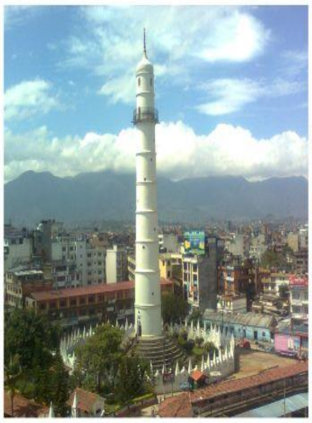
Epicentre: Barpak, 80 Km North West of the capital, Kathmandu

1. ***CAUSES*** of the earthquake



2. PRIMARY EFFECTS

- About **8,800 deaths, over 16,000 injured** and **3 million made homeless**.
- **1.4 million people needed food**, water and shelter in the days and weeks after the earthquake.
- Historic buildings and temples in Kathmandu were destroyed. **DHARAHARA TOWER, a UNESCO World Heritage Site was destroyed** and trapped **200** people. There was no compulsory building standards in Nepal, so many modern buildings collapsed.



- **26 hospitals and 7000 schools** were **destroyed**. As a result hospitals were overwhelmed.
- **50% of shops destroyed**, affecting food supplies and people's livelihoods.

- **352 aftershocks**, including a second earthquake on 12th May 2015 measuring 7.3 magnitude.
- **Cost of damage** estimated at over **US$5 billion.**

3. <u>SECONDARY EFFECTS</u>

   - Ground shaking triggered **landslides and avalanches**. It swept through **Everest Base Camp** which is used by International climbing expeditions.

   - The avalanches blocked roads and hampered relief efforts.
   - Avalanches **killed** at least **19 people**.
   - An avalanche in **Langtang region** left **250** people missing.
   - A landslide blocked the **Kali Gandaki River**. Many were evacuated in case of flooding.
   - The earthquake meant that until Nepal could recover from the quake, tourism, employment and income would shrink. **Tourism** accounted for **1.1 million jobs** so this would have affected a lot of people and the country's income (money they make from tourism).

   - The earthquake happened just before the monsoon season, when rice is planted. **Two thirds** of the population depend on **farming**. Rice seeds stored at homes was ruined in the rubble causing food shortages and income loss.

4. <u>IMMEDIATE RESPONSES</u>

   - Search and rescue teams, water and medical support arrived quickly from countries such as UK, India and China (International aid)
   - The **Disaster Emergency Committee (DEC), a UK group** raised **US $126 dollars** by September 2015 to provide emergency aid and help start rebuilding to worst hit areas.
   - The **RED CROSS** provided **225,000 tents** for people.

- **World Health Organisation (WHO) distributed medical supplies** to the worst affected districts. This was important as monsoon season had arrived early and increased the risk of waterborne diseases.
- Nepal was very mountainous and poor roads made it very difficult for aid to reach remote villages, **315 000 people** were cut off by road and **75 000 were unreachable by air.**
- **Sherpas** were used to hike relief supplies to remote areas.
- Social media was widely used in the search. **Facebook** launched a safety feature so people could indicate they were 'safe'. Several companies did not charge for telephone calls.

5. **LONG TERM RESPONSES**

- Nepal's government (along with the UN, EU, World Bank and other agencies) carried out a '**POST DISASTER NEEDS ASSESSMENT'**. It reported that **23 areas** in Nepal required rebuilding, such as housing, schools, roads, hospitals and monuments.
- **8 months** after the earthquake, it was reported that **US$274 million** of aid (help) had been committed to the recovery efforts.

Thousands of homeless people had to be rehoused and damaged homes were repaired. Over **7000 schools** had to be rebuilt or repaired.

-
- Stricter controls on building codes were brought in.
- In **June 2015** Nepal hosted an International conference to discuss reconstruction and seek technical and financial support from other countries.
- Some heritage sites in **June 2015** was reported. E.g. **The Dunbar Square heritage sites were reopened.** This was important to encourage tourists. Tourism is a big source of **income.**

- Repairs to **Everest Base Camp** and trekking routes – by August 2015 new routes had been established and the mountain reopened for climbers. Climber who had purchased permits to climb in 2015 were able to extend these to 2017 so they could come back and attempt to climb Everest again.
- In late 2015 blockade at the Indian border badly affected supplies of fuels, medicines and construction materials.
- A recovery phase was also started 6 months later to try and help expand crop production. Individuals were trained how to maintain and repair irrigation channels damaged by landslides. (Irrigation is used to help water the crops).

Why do people live in areas at risk of an volcano or earthquake?

- People take a risk as earthquakes happen **relatively infrequently**. (Not often!).
- Many cities have good planning and preparation and so the risk of death is reduced.
- Money from tourism- in Nepal many tourists go trekking and climbing and contribute US$1.8 billion to the country's economy.

Geo thermal energy This is heat generated in volcanically active areas. This energy is used to provide electrical power. Steam is generated by hot magma in the rock. Boreholes are drilled into the rock to harness the super-heated steam to turn turbines at power stations. This is renewable energy and will not run out. **E.G. Hellisheidi Power Plant in Iceland, supplies 30% of Iceland's electricity.**	**Mining** Settlements develop where valuable minerals are found as jobs are created in the mining industry. E.g. **Indonesia has one of the biggest sulphuric lakes** where sulphur is sold. This can be dangerous; miners can afford little protective clothing; sulphur dioxide gases can burn their eyes and throat; 74 miners have died in the past from the fumes;
Tourism Tourists visit for the spectacular views, relax in hot springs, thrill seekers searching for adventure. More than 100 million people visit volcanic sites every year which generate revenue for the locals.	**Farming** Lava and ash kills livestock and destroys crops and vegetation. After thousands of years, minerals are released, leaving behind extremely fertile soils, rich in nutrients, which helps crops to grow.
Family friends and feeling People do not want to leave because their family and friends are there. It is often cheaper and easier to stay especially when the risks may not be perceived as dangerous enough. Residents may be in denial that a disaster could occur.	

Predicting, protecting and preparing for earthquakes

Earthquakes are not as easy to predict as volcanic eruptions. However, there are still some ways of monitoring the chances of an earthquake:

MONITORING and PREDICTION:

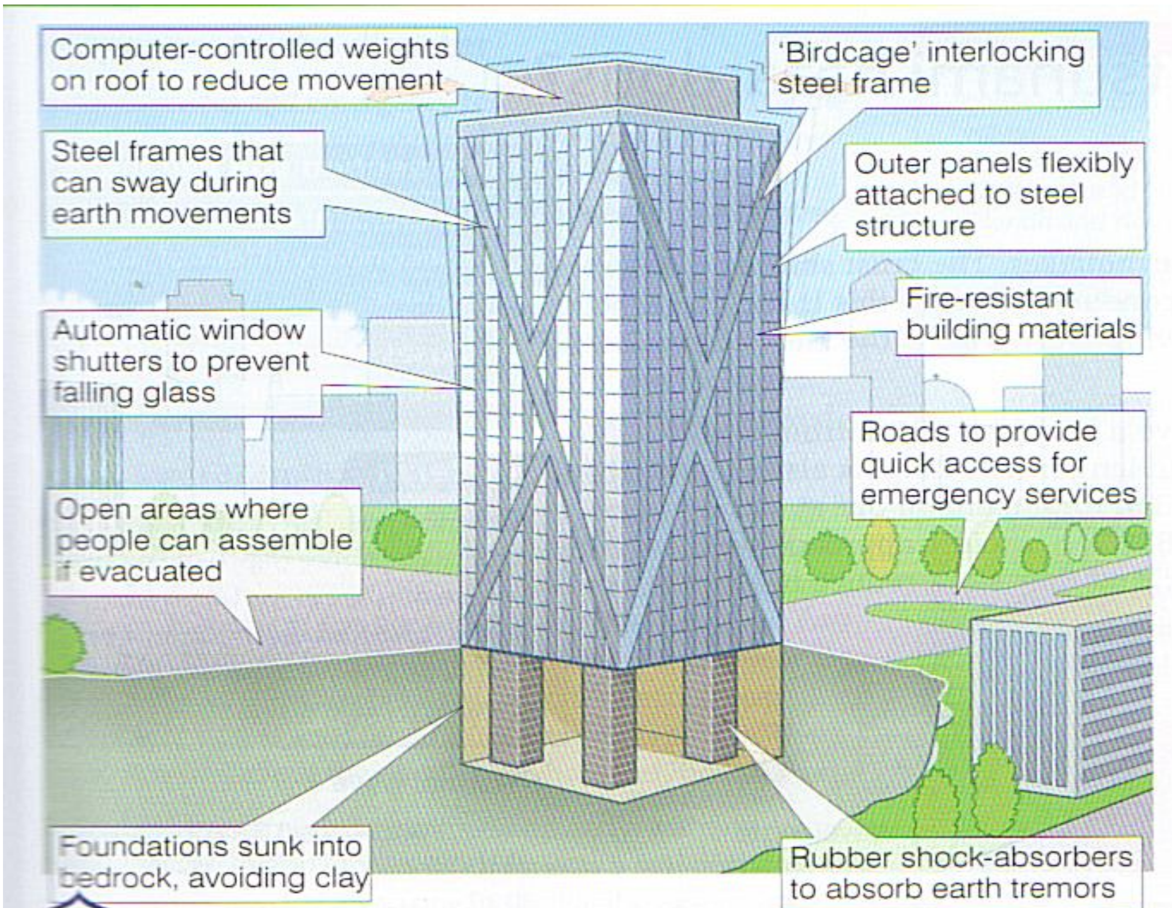
- Unusual animal behaviour
- Laser beams can be used to detect **plate movement**.
- A **seismometer** is used to pick up the **vibrations/ tremors/foreshocks** in the Earth's crust. An increase in vibrations may indicate a possible earthquake.
- **Radon gas** escapes from cracks in the Earth's crust. Levels of radon gas can be monitored in soils and groundwater which escapes from cracks in the earth's surface - a sudden increase may suggest an earthquake.
- **Scientists have turned to earthquake prediction-** scientists map past seismic events.
- **Smart phones have GPS receivers and accelerators built in.** They can detect movement in the ground. , which are analysed to potentially warn others further away.

PROTECTION:

- Designing buildings and strengthening roads and bridges to withstand earthquakes provide protection. This is called **MITIGATION.**
- **Earthquake resistant buildings** and infrastructure are extremely **expensive,** so it is not usually possible to adapt existing buildings.
- These building aims to ensure people are not injured or killed.
- The building may still need to be repaired after an earthquake.

The skyline of San Francisco showing the Transamerica Pyramid

- Old Masonry buildings have been modified and strengthened (retrofitted) to make them more resistant to shockwaves from the earthquake.



Earthquake-proofed building

PLANNING:

- Many of the prediction techniques used to monitor earthquakes are not 100 per cent reliable. Planning and preparing for an earthquake is therefore very important.

- People living in earthquake zones need to know what they should do in the event of a quake. **Training people** may involve holding **earthquake drills** and educating people via **TV** or **radio**.

- Preparation method is often used. 1st September every year JapaneseR practise earthquake drills on a national training day.

- People may put together **emergency kits** and store them in their homes. An emergency kit may include **first-aid items**, **blankets** and **tinned food**.
- Furniture and objects can be **fastened down** so they are secure from toppling over.
- Residents can learn how to turn off the main gas, electricity and water supplies to their properties.
- Red Cross provide an earthquake safety checklist to help plan and prepare for earthquakes in their homes, at work and in schools.

2) <u>Weather Hazards</u>

Weather hazards key words

Atmospheric Pressure: The pressure caused by the weight of air at any point on the Earth's surface; the average air pressure at sea level is 1013 millibars.

Polar front: the boundary between a Polar cell and Ferrel cell.

Coriolis affects: the effect, caused by the rotation of the Earth, which deflects winds to the right in the northern hemisphere or left in southern hemisphere.

Anticyclone: A large scale circulation of winds around a central region of high atmospheric pressure; the circulation is clockwise in the northern hemisphere and anticlockwise in the southern hemisphere.

Depression: areas of low atmospheric pressure which produces windy, cloudy and rainy weather.

Tropical storm: are intense areas of very low atmospheric pressure, which generally develop between the tropics where ocean temperatures are higher.

Meteorologist: a scientist who studies the causes of particular weather conditions.

Eye: The very centre of the storm is often characterised by a column of dry sinking air.

Eye Wall: Huge banks of clouds that carry heavy rain which surround the eye.

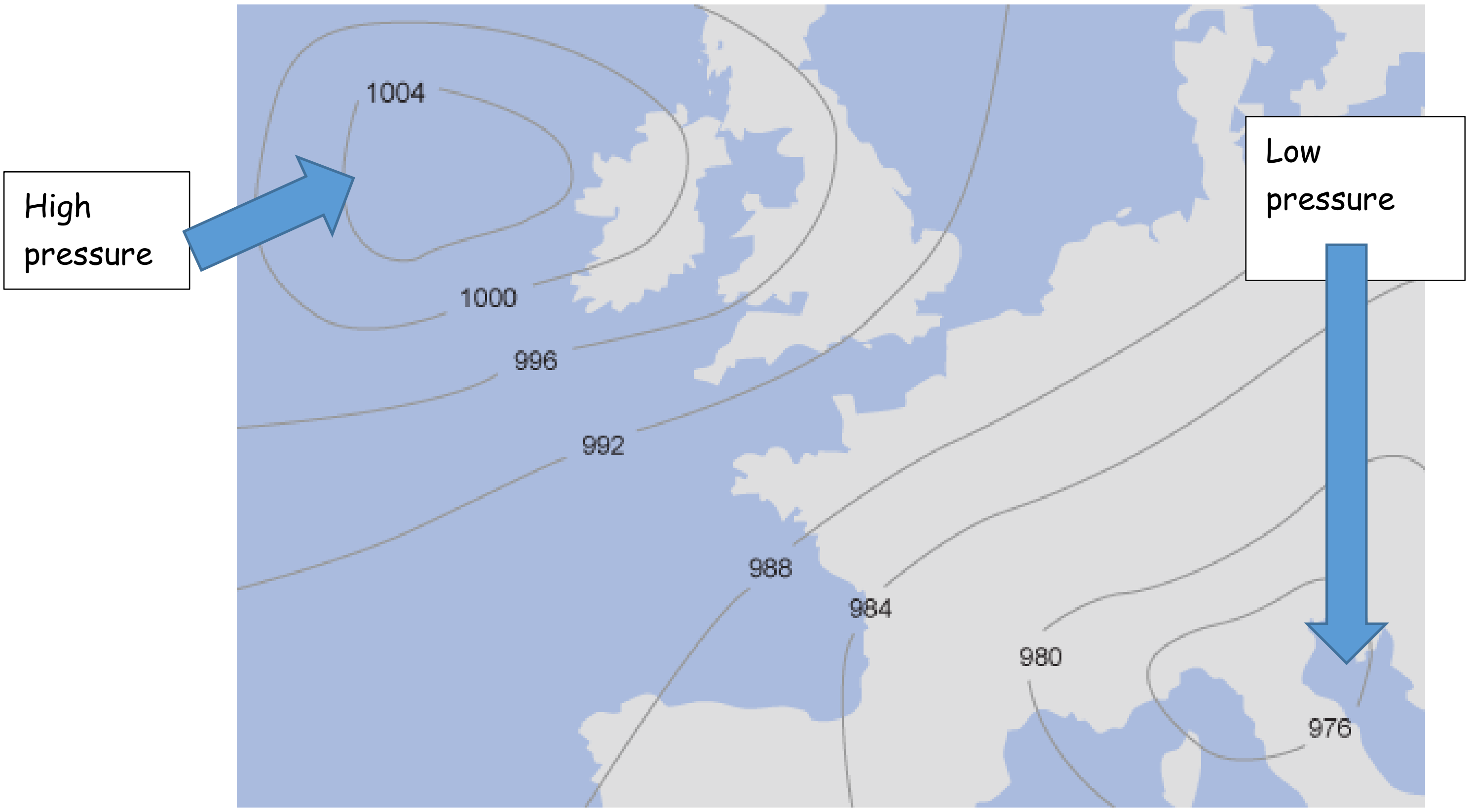
Climate change: the global increase (or decrease) in temperature and it's effect on the world climate.

Storm Surges: When low pressure storm conditions cause the sea to rise.
Landslide: the movement of earth or rock from a slope as a result of it becoming unstable (usually from heavy rainfall)

<u>Saffir-Simpson scale:</u> the five point scale used to classify tropical storms according to their strength

The General Model of global atmospheric circulation

- The general atmospheric circulation model tries to explain how the energy which controls weather and climate is transferred in the atmosphere.
- It also shows how surface and high level winds are influenced by areas of low and high ATMOSPHERIC PRESSURE.
- The weight or mass of the atmosphere pressure down on the Earth's surface is called **PRESSURE.**
- It is measured with an instrument called a **barometer** in units called **MILLIBARS** (mb).
- The average atmospheric pressure at sea level is **1,013mb.**
- On a weather map, areas that have equal pressure are joined together by lines called **isobars**.



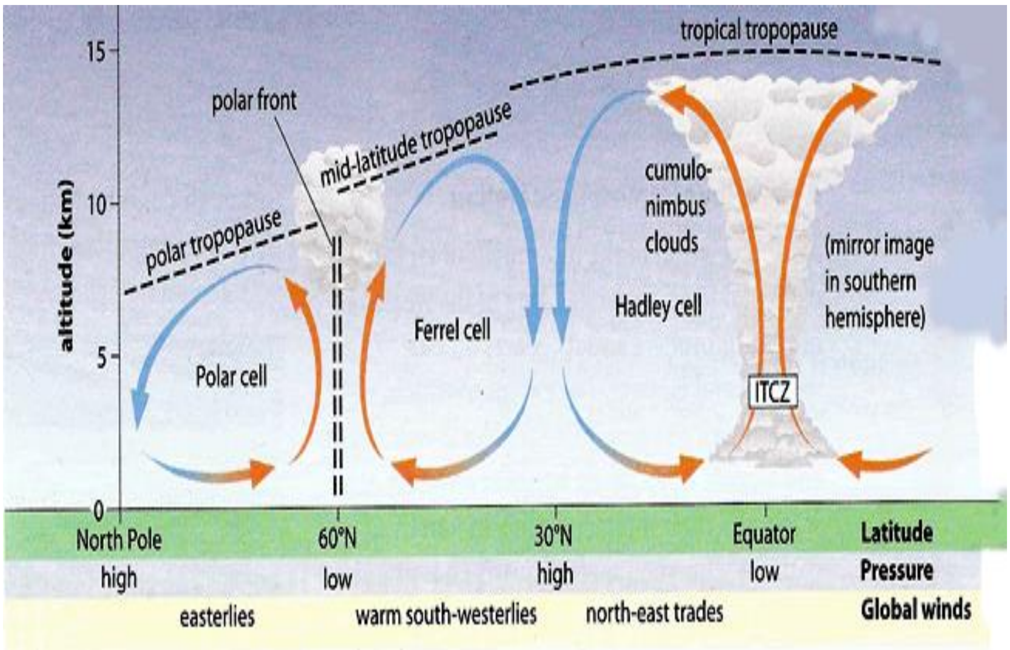
- All air is under pressure but if it is rising then the air pressure is unstable and the pressure is lower.
- In some circumstances air pressure can be extremely low and this might influence and cause tropical storms to form.

Some more air pressure facts

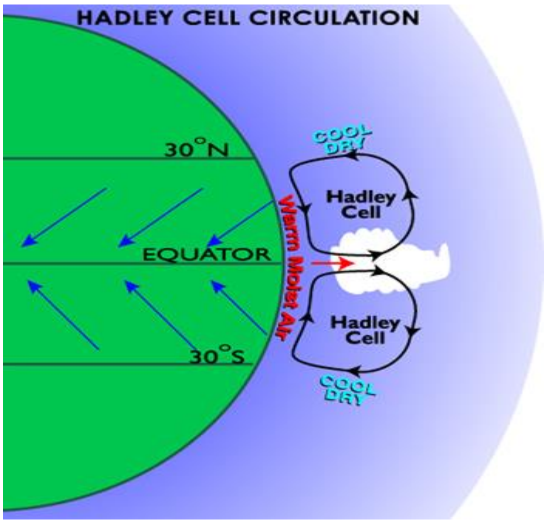
- Air Pressure is greatest closest to the ground
- At the top of the highest mountains it is very low.
- When the temperature rises, air expands and rises by convection, and pressure decreases.
- When temperatures fall, air contracts and becomes denser, causing an increase in pressure.
- High Pressure (anticyclones) usually has dry, sunny weather. This is due to the air warming and becoming drier as it sinks towards the ground.
- Low Pressure (Depressions) is often associated with unsettled weather. This is due to air rising, which makes it cooler and so condensation is more likely to occur, clouds form and rain.

Circulation in the atmosphere involves three different circles or cells that connect with each other.

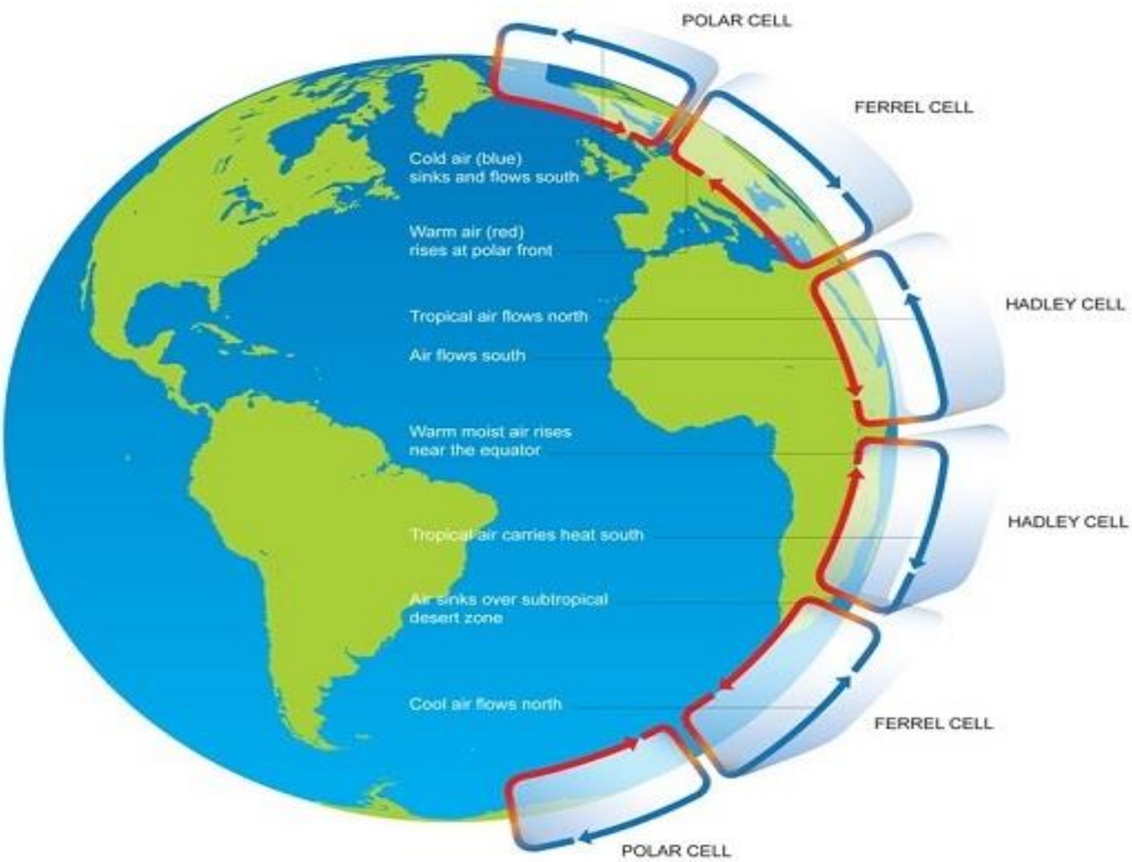
This concept is known as the '**tri-cellular model'** or '**three model cell'** of atmospheric circulation.



The Hadley Cell



- At the Equator the ground is strongly heated by the overhead sun.
- The air **rises** and creates a **low pressure** zone on the ground surface.
- As the air rises, it **cools** and forms thick storm clouds.
- The air continues to rise up and start to move towards the poles. It then sinks towards the ground, forming the subtropical high pressure zone
- As the air sinks, it becomes warmer and drier – this is why there are few clouds and little rain, as well as the existence of deserts, in these latitudes.



- The Hadley cell is then completed as the air flows back towards the Equator – this is known as a trade wind.

The Polar Cell

- The Polar cell is a fairly shallow cell. They are found at the poles between 60º and 70º
- The cold, dense air descends at the higher latitude and move towards lower latitudes.
- AS this happens the warm air begins to rise at an area known as the **POLAR FRONTS.**

Ferrel Cells

- These cells lie between the Hadley Cell and the Polar Cell.
- The cooler air from the poles meet the warmer air from the tropics, causing the air to rise.
- This can often happen where the UK. This partly explains the unsettled weather we can experience.

- The rising air in the Hadley cell at the equator forms an area of low pressure at the surface.

- The intensity of the suns' rays means that the air rises rapidly and huge cumulonimbus rain clouds formed, associated with thundery downpours.

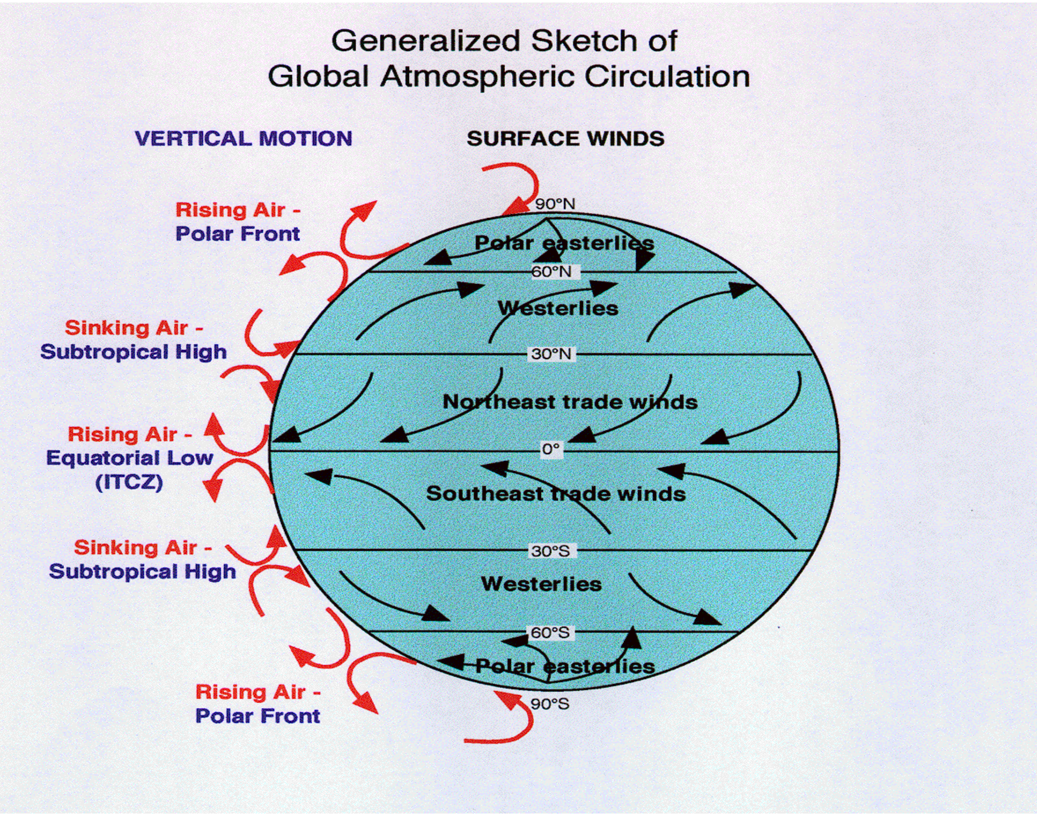
How does global circulation influence surface wind patterns?

- The effects of the three cell model are seen at the surface in the way they affect wind patterns.

- Air should move from high pressure to low pressure just like it does when a tyre is deflated.

- However the rotation of the Earth produces the **Coriolis Effect**. This means wind is defected to the right in the Northern hemisphere and the left in the northern hemisphere.

This leads to prevailing (dominant wind) westerly and south westerly winds experienced in the UK.



- Trade winds blow at surface from the sub-tropical high pressure areas towards the equator. The north- east trade winds are formed in the northern hemisphere and south east trade winds are formed in the southern hemisphere.

- Mid Latitude westerlies blow towards the poles from the sub-tropical high pressure areas. These winds bring series of anticyclones and depressions that influence the weather in the UK.

- Polar easterlies flow from the polar high pressure areas to the mid latitudes

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

What are tropical storms and where to they develop?

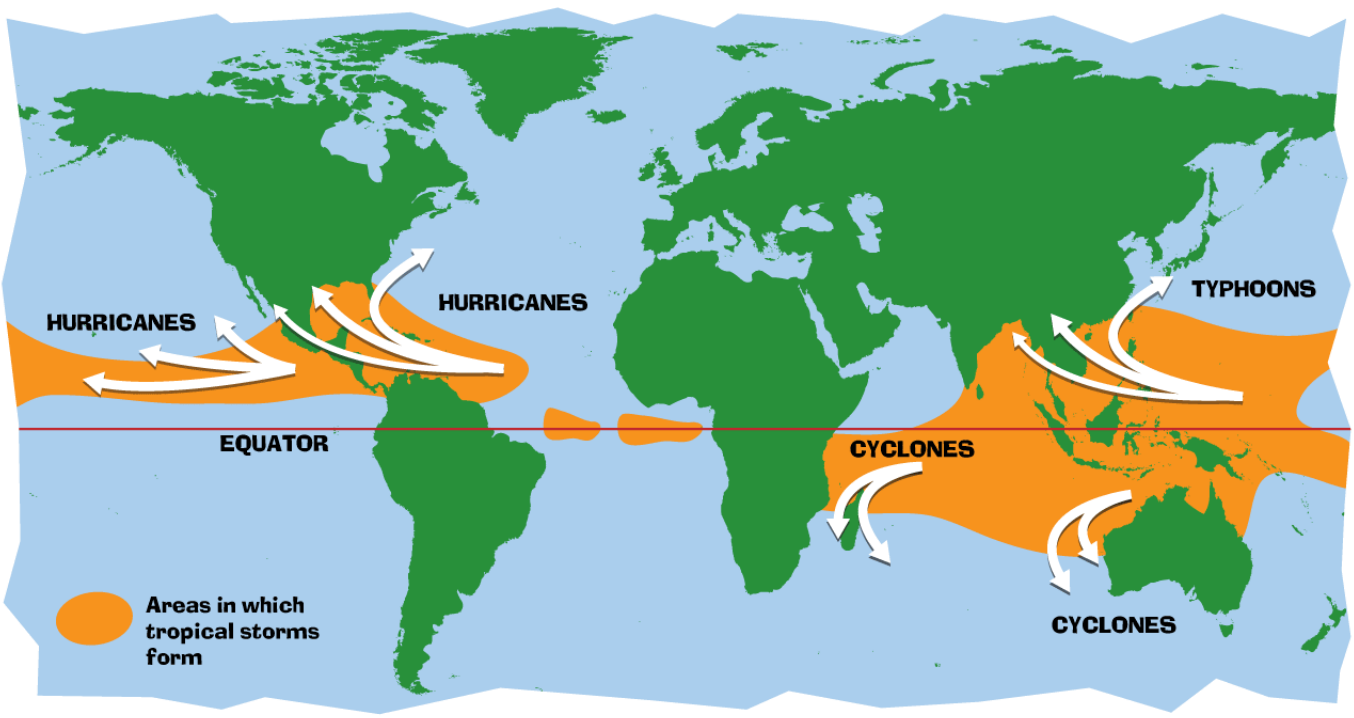
Tropical storms are a natural hazard. They occur when tropical warm air rises to create an area of intense low pressure. As the warm air reaches high altitudes, powerful winds spiral around the calm central point, creating the 'eye of the storm', and the warm air cools and condenses into heavy rainfall and thunderstorms.

They have different names in different parts of the world:

Hurricanes: East Pacific and Atlantic oceans.

Cyclones: Arabian Sea, Bay of Bengal off the coast of India and Bangladesh, and in SW Pacific and Western Australia

Typhoons: Japan, China and other countries in Eastern Asia.



What are tropical storms and where to they develop?

- In the **Tropics**
- **Over Oceans** – The moisture and energy comes from water. **The depth** of the water has to be at least **70 metres**
- **High Temperatures** –sea surface temperature in **excess of 26°C**
- **Atmospheric instability** – They need warm, moist air being is forced to risen upwards
- **Rotation of the Earth** – a certain amount of spin is need to start the rotating motion of the tropical cyclone.
- **Uniform wind directions at all levels** – predominant winds blowing in the same direction.

Why are tropical storms distributed where they are?

- Tropical storms occur in the tropics. (Mainly where the **intertropical convergence zone (ITCZ)** lies, **between the tropic of cancer and Capricorn.**
- They are found in areas of **low latitude between 5^{o} and 30^{o} North and South of the equator**. Here a higher insolation means temperatures are higher than at the poles.
- The sea temperature must be **27^{o}C** to a depth of **60-70 metres**. This provides the heat and moisture that causes the warm air to rise rapidly in this low pressure region.
- Latent heat is then released which powers the tropical storm. The warmest seasons are between summer and autumn when it is most typical for tropical storms to develop,
- Tropical storms do not develop along the equator because the **Coriolis Effect** is not strong enough here for tropical storms.

The Formation of a Tropical Storm

We need to **sequence** how a tropical storm forms from the start, middle and end.

1) **Beginning:**

- Small-scale disturbance (tropical depression).
- Warm air rises in a spiralling motion.
- The tropical disturbance creates a thunderstorm for 24 hours.
- This may develop into a tropical storm and more and more water is drawn upwards
- The clouds grow larger, wind speeds increases (73 MPH)
- 10% of these go on to become hurricanes.

2) Once the tropical storm has formed:

- Warm moist air rises rapidly in its centre
- This is replaced by air drawn in at the surface.
- A central vortex develops as more and more air is drawn in and rises.
- The very centre of the storm is often characterised by a column of dry sinking air. This creates the familiar 'eye' of the storm.

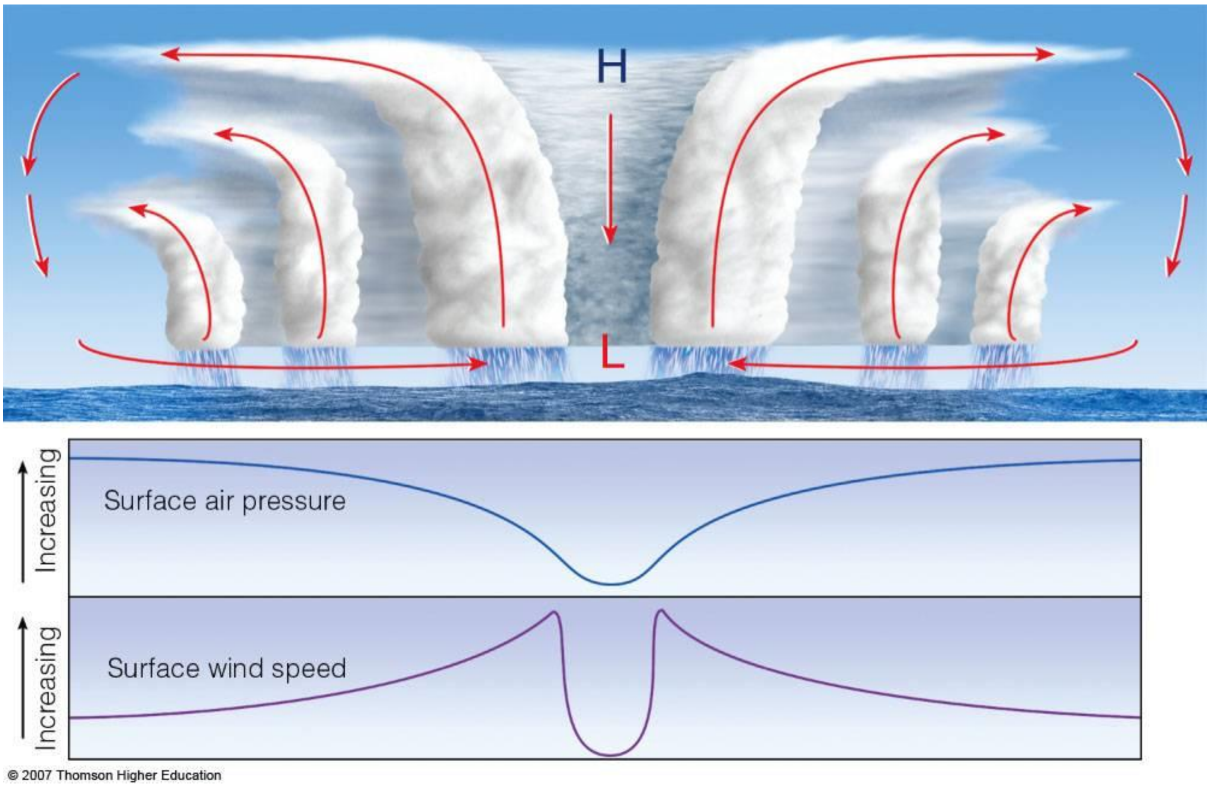
3) The mature tropical storm:

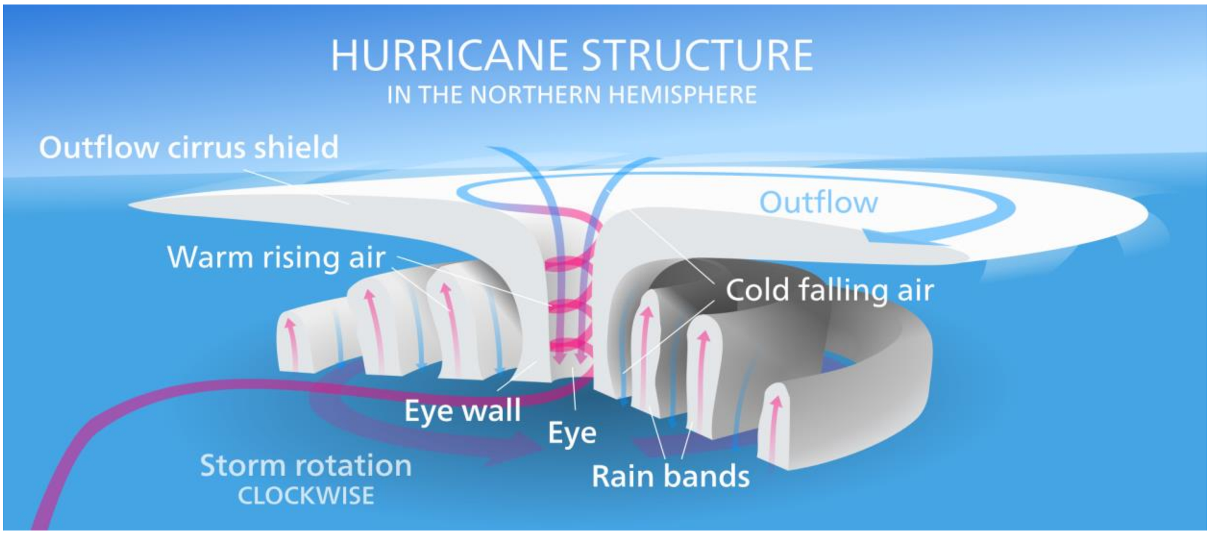
- Pressure falls to 880-970mb.
- This, and the strong contrast in pressure between the eye and outer part of the hurricane, leads to gale force winds.
- It is 200-500km wide.
- Clouds 12km in height.

4) End

- When it reaches land and the supply of energy and moisture is cut off will the storm start to decay.

- Should it move back out over the ocean, it will become invigorated again. This is common in the Caribbean. The average life span is 10-14 days.





How climate change might **affect** the **distribution, frequency and intensity** of tropical storms.

- Scientists have found evidence that tells us ocean temperatures over the last 20 years have increased.

- There may be **more tropical storms** found as more ocean temperatures will be 26°c or above. There may be more of a spread across the equator.

- The **intensity** of storms might increase by up to 11% more. This is because high ocean temperatures generate more energy.

- There may be an increase in rainfall within 100km of the eye of the storm.

- The sea surface temperatures (SST) are set to increase which means this could lead to a higher volume of rising water vapour which **powers** a tropical storm.

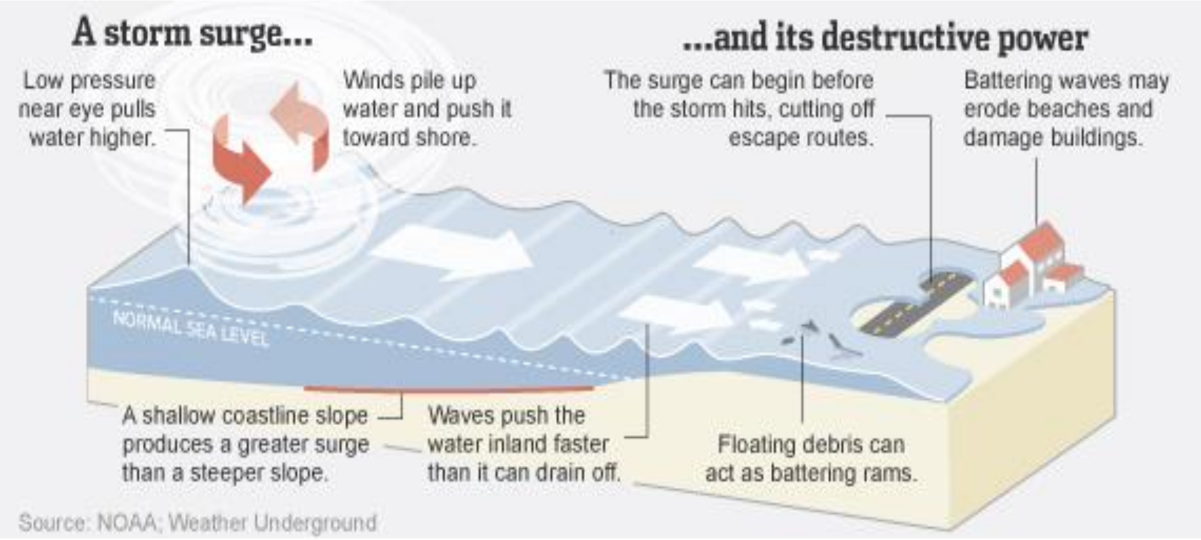
- More evaporation and higher winds speeds would occur because of the higher temperatures which could also increase the **destructive** potential of the storm.

The Saffir-Simpson Scale:

Saffir-Simpson Scale for Hurricane Classification				
Strength	Wind Speed (Kts)	Wind Speed (MPH)	Pressure (Millibars)	Pressure
Category 1	64- 82 kts	74- 95 mph	>980 mb	28.94 "Hg
Category 2	83- 95 kts	96-110 mph	965-979 mb	28.50-28.91 "Hg
Category 3	96-113 kts	111-130 mph	945-964 mb	27.91-28.47 "Hg
Category 4	114-135 kts	131-155 mph	920-944 mb	27.17-27.88 "Hg
Category 5	>135 kts	>155 mph	919 mb	27.16 "Hg
Tropical Cyclone Classification				
Tropical Depression	20-34kts			
Tropical Storm	35-63kts			
Hurricane	64+kts or 74+mph			

What are the effects and hazards associated with tropical storms?

Storm surges



Sea levels are very high and strong on-shore winds create huge waves, which can cause coastal flooding.

Strong Winds

- Wind can reach speeds of 200km/hour which leads to widespread damage to buildings, infrastructure (including power lines, roads, ports and airports), trees and crops.

Torrential rain and flooding

This very heavy rainfall can cause lots of flooding and even some tornadoes.

Responses

- Tropical storms can be generally predicted which allows for vital times to prepare and protect property.
- Putting emergency services on alert
- Evacuating the area, to higher ground or emergency storm shelters.
- Rescuing and treating victims, distributing emergency food and water to survivors.
- Detailed plans ready in place
- Forecasting and efficient communication system (rich countries) mean the loss of life and damage is kept to a minimum.
- Media services will alert people.
- Police and army will carry out street by street reconnaissance trips making sure people comply with the evacuation orders and make sure they have sufficient supplies.
- In poor countries (lower income countries) the lack of infrastructure e.g. descent roads and communication systems make it more difficult to alert people to the dangers of the coming storm.
- People are more reliant on the people that help after the storm has hit.
- Help often arrives from friendly governments and charities who provide medical support and target where most help is needed.
- With government agencies who struggle to cope, these organisations are invaluable in helping to find and treat those in affected areas.

- Rebuilding damaged housing and infrastructure
- Improving protective systems such as Levees.
- In richer countries houses and buildings are often more solidly built and therefore damage is kept to a minimum.
- Governments can respond quickly to make sure infrastructure such as bridges and roads are repaired quickly.
- There may be long term health concerns and, if people have lost their homes and are in temporary housing, this can lead to spread of diseases such as Typhoid, cholera and Malaria.
- With fewer resources available it can take longer for roads to be rebuilt again or for people to move back to their home areas and start their lives again.
- Government, NGO's and charities aim for **sustainable development** after the initial relief has saved lives. These are long term responses. They take longer to implement but have longer lasting impacts.
- Projects range from repairing damage to existing buildings, infrastructure and businesses, to ensuring the country is capable of managing a future hazard by investing in methods of protection and prediction.

A named example of a tropical storm to show its effects and responses

Typhoon Haiyan

Page 32 and 33 (GEOGRAPHY AQA 9-1)

Page 28 and 29 (GCSE GEOGRAPHY AQA)

How monitoring, prediction, protection and planning can reduce the effects of tropical storms

Monitoring trpical storms

Satellites

The global Precipitation Measurement satellite was launched to monitor precipitation every three hours in latitudes 65^{o} north and south of the equator. This helps identify high altitude rainclouds.

Aircrafts

A plane first flew purposefully into a hurricane in 1943. Now specifically equipped aircraft often fly through tropical storms to collect air pressure, rainfall and wind speed data.

The release sensors which send measurements every second by radio back to the aircraft.

NASA monitors weather patterns across the Atlantic using 2 aircrafts called Global Hawk Drones. The radar and microwaves on board help scientist s to understand more about how the storms form which can help them predict and improve their forecasting models.

Can storms be predicted?

Supercomputers can now give 5 days warning and an accurate location of within 400 km of where the storm is.

In Florida **track cones** are used to predict the path and intensity for up to a week.

Successfully predicting means people can be evacuated and lives can be saved.

National Hurricane Centres around the world issue early warnings so people have time to prepare to evacuate – but some may not bother. Also evacuation can be expensive and time consuming, especially if the path of the tropical storm does not actually pass the area in which they live.

<u>Is protection possible?</u>

Building can be reinforced to reduce the damage (MITIGATION)

Homeowners are advised to:

- Install hurricane straps
- Install storm shutters on windows
- Install an emergency generator
- Tie down wind-borne objects such as garden furniture
- Reinforce garage doors
- Remove trees close to buildings

Salt marshes, mangroves and wetlands can protect against storm surges by reducing the wave energy.

Trees reduce wind energy and trap debris, which can cause damage. However trees can cause devastation too.

Another way to protect land is to ensure that low lying areas are not built on.

Coastal flood defences such as levees and flood walls reduce the impact of storm surges as the hold back the sea water.

<u>How can planning reduce the risks?</u>

'American National Hurricane Preparedness Week in May aims to encourage people to plan what they need to have in the event of a storm.

Advice includes:

Preparing disaster supply kits

Having fuel in vehicles

Knowing where official evacuation shelters are

Storing loose objects

Planning with family what to do.

4 The UK is affected by a number of weather hazards

Overview of types of weather hazards experienced in the UK

Storm events

The UK is regularly hit by depressions which can bring very heavy raingfall and trigger river floods.

West coast of UK receive storm damage.

2013- During the St Jude storm 160 km/h winds killed 5 people, felled trees and toppled lorries. Subsequent storms brought more deaths and thousands were stranded at Gatwick airport.

Flooding

There are four different types of flooding hazards which may affect people. These are:

- Coastal flooding
- River Flash floods
- Slow onset river flooding
- Surface water flooding

It is often caused by heavy rainfall or strong waves brought by depressions.

Landslides can be triggered as a result.

2013- in Southern England a major railway embankment collapsed after heavy rainfall disrupting London Commuters and financial costs for their employees.

Drought Events

DEFINITION- an extended period of low or absent rainfall relative to expected average for a region

For the UK this means 15 consecutive days (in a row) with less than 0.2 millimetres of rain on any one day.

Longest drought on record in the UK is 18 month period in 1975.

Recently drought conditions struck in 2003, 2006 and 2012. The highest temperature was recorded in the UK at 38°C in Faversham, Kent

Extreme cold weather

Cold conditions take over if depressions are not passing over the UK as usual. Some of the weather risks include:

- Frost- crops and cattle may not survive extremes of around -10^{o}C.
- Freezing conditions- over 17,000trains were cancelled in January 2014 due to freezing conditions.
- Blizzard conditions- transport grinds to a halt, creating costly airline delays.

5 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.

Record Rainfall and Flooding in Cumbria

Page 38 and 39 (text book- AQA Geography 9-1)

How management strategies in Cumbria can reduce risk of extreme weather.

- New flood defences have been built costing £4.5 million.
- The new defences were essential to reduce the extreme weather risk, but it also important that the town's tourist economy was not damaged.
- A mobile wall was built. It rises when needed, and disappears from view at other times, protecting the river view for cafes and restaurants.
- The environmental agency (EA) improved flood warning information. This gave more people time to evacuate and to protect their own properties.

- Some people living in Cockermouth have asked for warning messages to be sent to smart phones.

- Helping local business get back on their foot and earning money is another important element of risk management.

- After 2009 floods, the west Cumbria Development Agency paid for adverts to be placed in National newspapers announcing that Cumbria was 'open for business as usual'.

What more can be done to manage the risk of extreme weather in the UK?

- 'Top down' actions are sometimes taken to protect communities. (**See fig 3.27 on page 41)**

- 'Bottom up' actions- these are actions people take to increase their **human resilience** to hazards.

- During winter storms railway companies tweet information and pictures of fallen trees (eg.) to customers, who in turn, retweet to others. Then people have time to change their travel plans.

- Some homeowners in flood prone areas 'future proof' their homes by very sensibly having stone tiles rather than carpets in their ground floor or basement rooms.

Is weather becoming more extreme in the UK?

- No single extreme weather event can be blamed on climate change. There needs to be a pattern or a trend over many years.

- More energy in the atmosphere could lead to more intense storms.

- The atmospheric circulation may be affected, bring 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.

- Lots of data is telling us that the Earth's climate is currently warming and changing.

- A warmer world will be one where evaporation takes place over oceans- and what goes up must come down (meaning there will be more rainfall)

- Climate change scientists believe rainfall patterns will change in the UK, as the world's oceans heat up. This might be happening already.

- There has been an increase in extreme winter rainfall since the 1980's. A reason for this might be increased warming of the Atlantic Ocean during this period. As a result, rain bearing depressions will grow in energy and moisture, which leads to more rainfall coming to the UK.

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

- UK temperatures have increased by $1^{o}C$ since 1980. The patterns shows a rise (upward trend).

- High temperatures alone do not lead to drought, there must also be a lack of rainfall (deficiency).

- Scientists say that it is hard to predict rainfall trends and patterns for a world that is warming as there is lots of different factors to consider.

Extreme predictions for the future

- Some scientists suggest the global average temperature will rise by 2-3^{o}C in the 21st Century.

- The Met office and Environmental Agency believe if this happens the UK will be faced with warmer and wetter winters, more flooding and high wind speeds.

- Another scenario looks at the global temperature rising by 4-5^{o}C. This could cause melting of land and sea ice in the Arctic. Colder water would pour into the North Atlantic Ocean, which could affect the movement of air masses and ocean currents.

- These air masses and ocean currents affect the UK's climate. In a warmer world, the UK could be left facing more extremes of cold weather!

Climate Change

Climate Change Key Words

Quaternary period- 2.6 million years ago to present day.

Glacial periods- when ice covered parts of Europe and North America.

Inter glacial periods- the warmer periods in between the glacial periods.

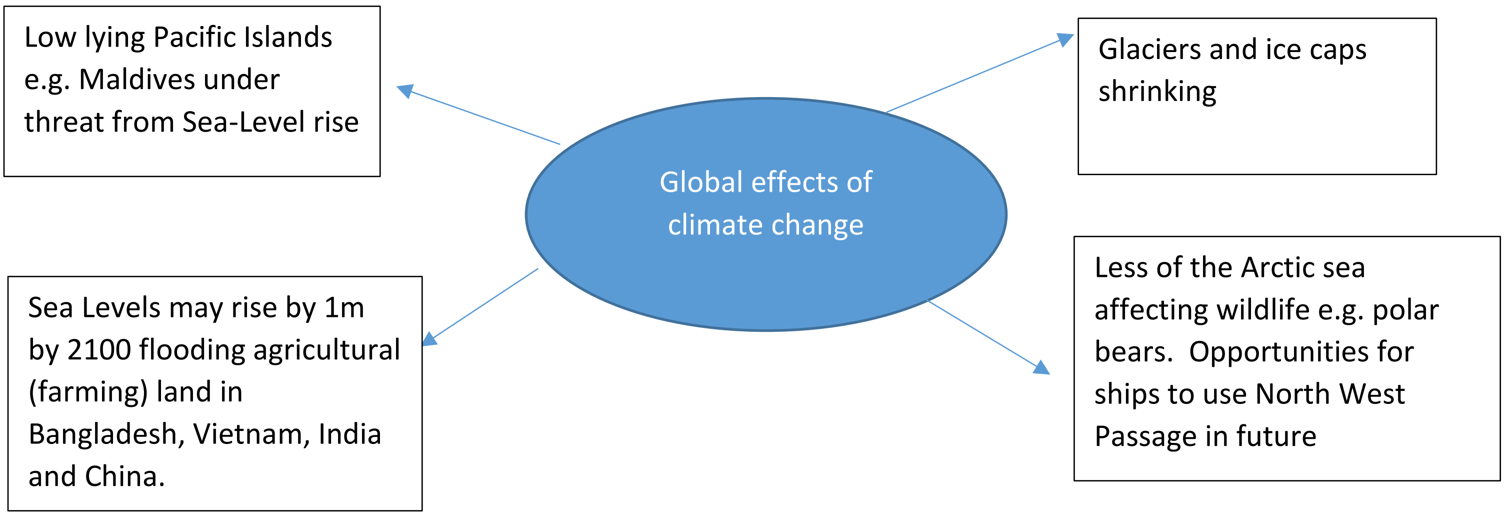
Global Warming- The average global temperature in the last few decades has increased relative to 1901-2000 average. It is an indication of climate change.

Key idea 1:

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

It's not as cold as it used to be!

- The Quaternary period is the last 2.6 million years ago to present day. During this geological period temperatures have fluctuated quite a lot.
- Despite this there has still been a gradual cooling during this period.
- The cold 'spikes' during the Quaternary period are 'glacial periods', when ice covered parts of Europe and North America.
- The warmer periods in between are called inter-glacial periods.
- Today's average temperature is higher than during almost all of the Quaternary period.
- In the last few decades the average global temperatures has increased relative to the 1901-2000 average. This is known as 'global warming'; the most recent indication of climate change.
- Since 1880 the average global temperature has risen by 0.85°C. Most of the increase has occurred since the mid 1970's.



Evidence for Climate Change?

- Thermometers are instruments used to measure temperature. Reliable measurements only go back about 100 years.
- Before this scientists use indirect data stored as fossil record. These are found deep in the ocean sediments and frozen ice cores.

- When layers of sediment or fresh falls of snow become buried they are found preserve evidence of global temperatures at that time.
- Scientists can study oxygen in ocean sediments or water molecules in ice to work out temperature.
- This information is then plotted on a graph.
- Ice cores have been used to reconstruct temperature patterns from as long as 400,000 years ago!

What is the recent evidence for climate change?

<u>Seasonal changes</u>

Studies have suggested that the timing of natural seasonal activities. E.g. trees flowering and bird migration is happening earlier. E.g. in Mid 1990's 65 species nested average 9 days earlier than in 1970s.

<u>Shrinking glaciers and melting ice</u>

Glaciers are shrinking and retreating and it is estimated some may disappear completely by 2035. Arctic sea ice has thinned by 65% since 1975.

<u>Rising sea level</u>

According to the IPCC (Intergovernmental Panel on Climate Change) the average global sea level has risen between 10 and 20 cm in the past 100 years. This is because:

1) When temperatures rise and freshwater melts, more water flows to the seas from glaciers and ice caps.
2) When ocean water warms it expands in volume – this is called thermal expansion.

Possible causes of climate change:

Natural factors;

A) Orbital changes-Changes in the Earth's orbit

The Earth's orbit has 3 distinct cycles. These were believed to affect the world's climate. These are known as the Milankovitch cycles. Scientist believe that these cycles affect the timings and seasons of the Earth's climate.

Eccentricity

This describes the path of the Earth as it orbits the Sun. The Earth's orbit is not fixed – it changes from being circular to a little elliptical. A complete cycle – from circular to elliptical and back to circular happens every 100,000 years.

Axial tilt

The Earth spins on its axis, causing night and day. It is tilted at 23.5°. Over a period of 41000 years, the tilt of the Earth moves back and forth between

The Milankovitch Cycles

Precession

This describes the natural 'wobble', like a spinning top. A complete wobble cycle takes about 26 000 years. The Earth's wobble accounts for certain regions of the world- such as Northern Norway experiencing very long days and long nights at certain times of year.

Solar Activity/output

- Scientists have identified cyclical changes in solar energy output linked to SUNSPOTS.
- A sunspot is a dark patch that appears from time to time on the surface of the sun.
- These sunspots increase and decrease in number over a period of 11 years. This is called a sunspot cycle.
- When sunspot activity is at it's maximum the Sun gives off more heat, with large explosions on the surface of the sun resulting in solar flares.
- When sunspot is at its minimum solar output is reduced, leading to lower temperatures at earth.

Volcanic Activity

- Violent volcanic eruptions blast huge quantities of ash and liquids into the atmosphere.
- Volcanic ash can block out the Sun, reducing temperatures on the Earth. This tends to be a short term impact.
- Sulphur dioxide is converted to sulphuric acid creating droplets. These act like tiny mirrors reflecting radiation from the Sun.
- This can last a lot longer and can affect the climate for many years.
- The cooling of the lower atmosphere and reduction of surface temperatures is called a **volcanic winter**.

Human factors/causes of climate change

Many scientists believe that humans are partly to blame to for the rise in temperatures, known as global warming.

What is the greenhouse effect?

A greenhouse is a small building made out of glass used by gardeners to create warm conditions to grow plants. So how does it work?

Glass allows radiation (heat) from the Sun to enter the greenhouse. However the heat cannot escape through the glass. As a result the greenhouse becomes warmer and so ideal for growing tomatoes, vegetables which need constant warmth.

The atmosphere allows most of the heat from the Sun. (short wave radiation) to pass straight through to warm up the Earth's surface.

However when the Earth gives off heat in the form of (long wave radiation), some gases such as carbon dioxide 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.

How do humans cause climate change?

Fossil Fuels

- These account for the majority of global greenhouse gas emissions- over 50%. Burning these releases CARBON DIOXIDE into the atmosphere.
- Fossil fuels are used in transportation, building, heating homes, manufacturing industry (factories) and burnt in powers stations to make electricity.
- As the world's population grows and wealth increases there is more demand for more energy, which increases the level of fossil fuels and carbon dioxide.

Agriculture

- Agriculture produces large amounts of METHANE. Accounts for 20% of greenhouse emissions.

- Farm livestock or Cattle produce Methane during digestion, microbes produce it as they decay organic matter under the water of flooded rice paddy fields and burning biomass for energy all lead to methane being produced. Decaying organic matter in landfill sites and compost tips also lead to Methane being produced.

- As the world's population increases more food is required, especially in areas such as Asia where rice is the staple diet.

- When countries increase their standard of life, there will be an increasing demand for meat.

Deforestation

This is clearing of forests on a huge scale. Trees are cut down for many different reason;

- Clearing of land for agriculture (farming).
- Logging for wood and paper products.
- Building roads to access remote areas.
- Making room for the expansion of urban areas.

Trees are needed in absorbing carbon dioxide. Deforestation means there are less trees to absorb carbon dioxide.

So leads to extra greenhouses gasses in the atmosphere which contribute to climate change.

When trees are cleared and burnt (SLASH AND BURN) the carbon dioxide that has been stored id released , which contributes to climate change.

Nitrous Oxides

Very small concentrations in the atmosphere are up to 300 times more effective in capturing heat than carbon dioxide.

These comes from:

- Agricultural fertilisers
- Car exhausts
- Power stations producing electricity
- Sewage treatments

Key Idea 2:

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.

What is Mitigation?

This is dealing with the cause of the problem (managing it)

Alternative Energy Sources

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 don't emit large amounts of $CO2$. Sime are also renewable and will last into the future. Nuclear power stations uses uranium to generate electricity but does not emit $CO2$ as a by product.

The Uk aim to produce 15% of it's energy from renewable sources by 2020.

Adaptation- changes in agricultural systems managing water supply, reducing risk from rising sea levels.