PAPER 1: PHYSICAL GEOGRAPHY

Section A: The Challenge of Natural Hazards (1-5)

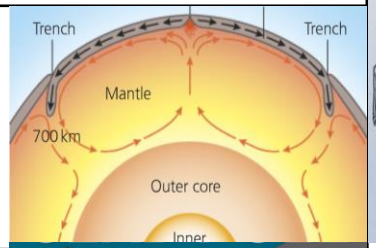
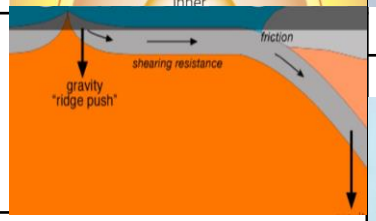
- *Tectonic hazards:* ***Japan*** *and* ***Haiti***
- *Tropical storm:* ***Typhoon Haiyan***
- *Extreme weather event:* ***Somerset Floods***

Section B: The Living World (6-10)

- *Small scale ecosystem:* ***the pond***
- *Tropical rainforest:* ***The Amazon Rainforest***
- *Hot desert:* ***The Sahara Desert***
- *Fringe of a hot desert:* ***The Sahel***

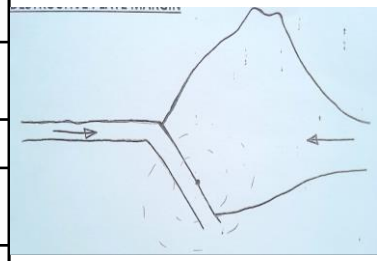
Section C: Physical Landscapes in the UK (11-16)

- *Example of a river to show its landforms:* ***River Tees***
- *Example of a flood management scheme:* ***Somerset Flood***
- *Example of a coastline to show its landforms:* ***Dorset***
- *Example of a coastal management scheme:* ***Dorset*** *and* ***Medmerry***

4 layers of the earth	• Crust: outer layer of the earth (solid, thin layer) • Mantle: layer beneath the crust (semi-liquid, thick) • Outer core: layer beneath the mantle (liquid iron) • Inner core: centre layer (solid iron)
Tectonic Plates	The crust is split into several pieces. These large pieces of rock are called tectonic plates. They float on the mantle.
Oceanic Crust	Crust found under the oceans (thinner (5-10km), younger, more dense)
Continental Crust	Crust found under land (thicker (25-100km), older, less dense)
Continental Drift	Theory that states the earth's continents are very slowly moving and that once all the continents were joined together to form a super-continent called Pangea. The tectonic plates move due to convection currents and slab pull.
Convection Currents	Circular currents within the mantle that cause the overlying tectonic plates to move. *The mantle is made up of semi molten rock. Mantle rock is heated by the core. The warm material rises to earth's surface. As it rises, the material starts to cool and sink. This motion of rising and sinking rock forms circular currents known as* ***convection currents.*** 
Slab Pull	At destructive plate margins dense/heavy plates sink into the mantle, which pulls the rest of the plate with it. 
Natural Hazard	A natural process that poses a threat to people and property. If it poses no threat to humans it is called a natural event.
Meteorological hazard	A hazard that occurs in the atmosphere (e.g. hurricane, thunder and lightening, tornado, drought
Tectonic hazard	A hazard that occurs due to the movement of tectonic plates (e.g. volcanoes and earthquakes)
Hazard risk *It is affected by…*	The probability that a natural hazard occurs. 1. Urban vs rural: urban areas have a higher risk due to high population densities = more people at risk. Hazards that occur in urban areas (e.g. Haiti earthquake) have a higher impact. 2. LIC vs HIC: LICs have a higher risk as they have poor quality buildings and less planning and prediction strategies. 3. Type of hazard: e.g. earthquakes are harder to predict than tropical storms, floods happen more often than volcanic eruptions. 4. An effect of climate change is more extreme weather events. This has resulted in more tropical storms, flooding and droughts.

Tectonic hazards occur along plate boundaries/margins. There are four types of plate margin (see below.)

Destructive Plate Margin

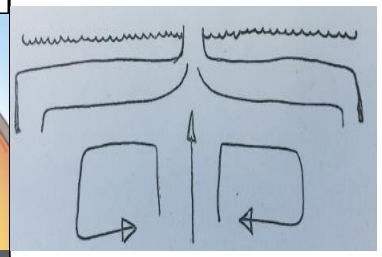


2 plates move towards each other due to convection currents/slab pull. The denser oceanic plate is pushed beneath the lighter continental plate. This process is called SUBDUCTION and occurs at a subduction zone.

- ***Volcanoes*** *– as the oceanic plate sinks into the mantle, it melts = magma. This rises to the earth's surface = explosive volcanic eruptions.*
- ***Earthquakes*** *– as the plates slide past each other, they can get stuck = pressure builds up. The plates suddenly move, releasing the pressure = violent earthquakes*

Example: the Philippine plate is being subducted beneath the continental Eurasian plate along the east coast of Japan.

Constructive Plate Margin

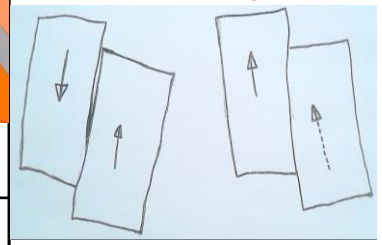


2 plates move away from each other due to convection currents/slab pull, leaving a gap between the two plates. Magma rises up from the mantle to fill the gap, creating NEW CRUST (new land). This usually happens under the oceans. The new creation of land is called SEA-FLOOR SPREADING.

- ***Volcanoes*** *– the magma rises to fill the gap between the two plates – gentle eruptions.*
- ***Earthquakes*** *– as the magma rises it causes small tremors (gentle earthquakes).*

Example: Mid-Atlantic Ridge. The Eurasian and North American plate are moving away from each other.

Conservative Plate Margin

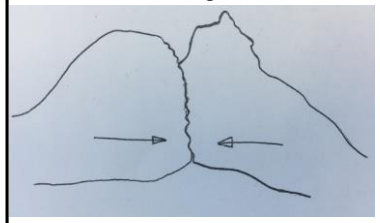


2 plates slide past each other due to convection currents/slab pull. They can be moving in opposite directions or moving in the same direction but at different speeds. The line between the two plates is called the FAULT LINE.

- ***No volcanoes*** *(no subduction and so no melting)*
- ***Earthquakes*** *– as the two plates slide past each other, they can get stuck = pressure builds up. The plates suddenly move, releasing the pressure = violent earthquakes.*

Example: the North American and Caribbean plate are moving past each other near Haiti.

Collision Plate Margin

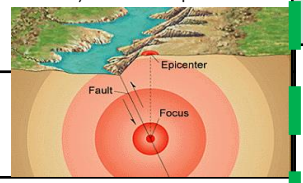


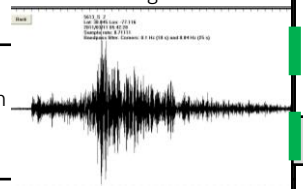
2 plates of the same density move towards each other due to convection currents/slab pull. As they are the same density neither subducts. Instead the plates collide and are forced upwards = mountain ranges. These are known as FOLD MOUNTAINS.

- ***No volcanoes*** *(no subduction and so no melting)*
- ***Earthquakes*** *– the two colliding plates crash together creating a huge amount of pressure which when suddenly releases causes VIOLENT EARTHQUAKES.*

Example: the Himalayas were formed due to the collision of the Eurasian and Indian Plates.

An earthquake is….	A sudden or violent movement within the earth's crust. It is caused by a build up and sudden release of pressure/tension.
Shockwaves	As the tectonic plates suddenly move, they send out SHOCK WAVES (vibrations) from the point of movement in the earth's crust.
Focus	The point of movement in the earth's crust.
Epicentre	The point directly above the focus is called the EPICENTRE. The closer you are to the focus and epicentre, the stronger the earthquake will be.
Magnitude	The amount of energy released during an earthquake.
Seismometer	The instrument that measures the strength /magnitude of an earthquake.
Richter Scale	The scale on which earthquake magnitude is measured. The higher the magnitude on the Richter Scale, the more powerful the earthquake.
LICs are worse affected by earthquakes because…	The quality of infrastructure (buildings, roads, ports) is worse in LICs. As a result they more easily fall down and trap people. Many HICs have earthquake proof buildings. LICs are poorer than HICs. As a result they are unable to meet the costs of immediately responding to earthquakes (search and rescue, clear rubble, build temporary structures) or reconstruct cities. They rely on financial aid from other countries or organisations = less in control. HICs are able to meet many of the costs and immediately respond to the earthquake = less loss of life. LICs do not have as many planning and prediction strategies so are unable to predict when the earthquake will occur or prepare people for when it does occur.





JAPAN EARTHQUAKE (HIC)

Where: Tohuku Japan, east Asia
Plate Margin: underwater destructive plate boundary earthquake: Pacific plate subducting underneath Eurasian plate.
When: 11th March 2011 **Magnitude**: 9 on the Richter Scale.

PRIMARY EFFECTS	SECONDARY EFFECTS
• 65% of deaths were >65 years old, 6,142 injured, 2,668 missing • 50,000 buildings destroyed • US $235 Billion cost of damaged infrastructure, property and businesses.	• 38 metre **tsunami** caused 15,882 deaths, 92% from drowning • 4.4 million homes left without electricity due to damaged power plants. • Fukishima nuclear power plant leaked radiation due to tsunami damage causing 200,000 people to be evacuated. Effects of radiation release are at present unknown. • Soil liquefaction caused 30 homes to be destroyed. • Backlash against nuclear power policy from the public after Fukishima

IMMEDIATE RESPONSE	LONG TERM RESPONSE
•early warning system saved 1 million lives. •NGOs, TNCs, Govts gave $5.5bn aid and workers to help with the recovery effort.	•Japan is debating the future of nuclear power in its country after the Fukushima disaster was caused by the tsunami.

HAITI EARTHQUAKE (LIC)

Where: Haiti, Caribbean Islands.
Plate Margin: conservative plate margin (Caribbean and North American plates)
When: 12th January, 2010 **Magnitude**: 7.0 on the Richter Scale.

PRIMARY EFFECTS	SECONDARY EFFECTS
• 220,000 dead • 300,000 injured • 300,000 homes damaged or destroyed. • 8 hospitals destroyed in Port-au-Prince • 5000 schools destroyed or damaged • Transportation routes (roads, rail, ports, airports) destroyed by fallen buildings • Service lines (water, gas, electricity) destroyed	• Trauma and diseases from dead bodies. • 1.3 million Haitians in temporary camps • Unemployment • High crime rates • Aid supplies could not reach victims. • 2 million Haitians with no food, electricity, water • Cost: $11.5 billion

IMMEDIATE RESPONSE	LONG TERM RESPONSE
• People were evacuated • USA sent ships, helicopters and the army to search and rescue for victims and clear rubble at the port so that companies could start to export goods again. • UN sent police to distribute aid & keep order. • The Red Cross set up temporary hospitals • The UK raised £100 million for emergency aid. • USA gave $100 million for emergency aid.	• Relocation – 1000s left Port-au-Prince permanently • Cash for work programs set up to clear rubble to give locals jobs in the long term. • World Bank gave $100 million to support long term reconstruction in Haiti. • ¾ of the buildings were repaired.

Why do people live in areas of risk?

- Friends and family
- Employment
- Confident the government will protect them (planning & prediction)
- The land is very fertile near volcanoes (good for farming).
- They do not know it is unsafe – lack of education.

Monitor earthquake prone areas to PREDICT when it will occur.

Previous Earthquake Data	Historical records can be used to show patterns and trends. These can then be used to predict future earthquakes.
Measure for Small Tremors	Before a larger earthquake often there is an increase in the number of small tremors. Scientists use seismometers to record any ground movement.
Unusual Animal Behaviour	Animals often act strangely before an earthquake. In China, the city of Haicheng was evacuated following strange animal behaviour. Days later a 7.3 magnitude earthquake struck. It is estimated it saved 150,000 lives.

PLAN to prepare for when an earthquake occurs.

Earthquake Proof Buildings	Buildings are designed to withstand the earthquakes ➢ *Using flexible steel frames which sway as the ground moves.* ➢ *Rubber foundations that absorb the shockwaves/shaking.* ➢ *Building with a larger base than top will be less likely to topple over.*
Practice Drills	Educate people about to do should an earthquake occur. ➢ *On 1st September everyone in Japan practices what to do in an earthquake. It is called Disaster Prevention Day.*
Emergency Kit	Residents are encouraged to have an emergency kit ready, including *a torch, canned food, batteries, radio, medical kit, dust mask, water…etc.*
Hazard Mapping	Prevent building on loose/weak ground & reduce the height of buildings in high risk areas. This means that in high-risk areas, stronger and lower buildings can be used.

Tropical storm	A storm with wind speeds of over 74mph and torrential rain.
Tropical storms are also known as…	*Hurricanes (USA, Caribbean)* *Typhoons (Japan, Philippines)* *Cyclones (SE Asia, Australia))*
Two conditions needed for tropical storm formation	• Warm water (>27°C). As a result they are often found in tropical areas and occur in the summer/autumn when seas are at their hottest. • Latitudes between 5 -20°north and south of the equator. A tropical storm is a spinning mass of clouds. The earth's spin between 5-20° north and south of the equator is enough to spin the clouds = tropical storm.
Effects of tropical storms:	• Torrential rain • Strong winds • Storm surges
A storm surge is…	Tropical storms have a very low air pressure due to the rising air. This causes the sea level to rise. These high seas (3-8m higher than normal) flood huge areas of land.
Saffir-Simpson Scale	Tropical storms are measured using the Saffir-Simpson scale. There are 5 categories.
How will Climate Change affect tropical storms?	• Increase in temperature = more of the world's oceans will be >27°C = more places will have tropical storms. • Increase in temperature = tropical storms become stronger. There will be more category 4 and 5 storms.

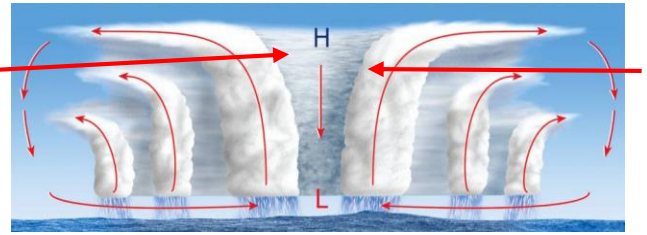
Tropical Storm Formation:

HEAVY	HEAT	The sun HEATS the sea/ocean.
ELEPHANTS	EVAPORATE	Warm, moist air EVAPORATES and rises.
REALLY	REPLACE/ REPEAT	More air rushes in to REPLACE the air that has just evaporated. It is also evaporated.
CAN	CONDENSATION/ CLOUDS	As the air rises it CONDENSES to form thick CLOUDS.
SQUASH	SPIN/SPIRAL	The earth's rotation causes the clouds to SPIN, forming the tropical storm's distinctive spinning shape.
SARAH	SINKING AIR = EYE	Cold air SINKS in the centre of the storm forming the EYE of the storm.
MARTIN	MOVE	It MOVES in the prevailing wind direction (east to west)
LOLS	LAND/LOSE ENERGY	It reaches LAND and LOSES energy as its energy source (warm water) is gone. Friction of the land also reduces its energy.

Tropical storms are circular in shape and usually lasts 7-14 days.

Up to 400 miles across.

The eye – in the centre of the tropical storm cold air sinks. There are no clouds or wind. It is very calm.



On either side of the eye is the eyewall – a tall bank of cloud. Here are very strong winds, heavy rain, thunder & lightening.

Heavy rain & possible thunderstorms

Heavy rain and thunderstorms.

TYPHOON HAIYAN

Where: Philippines, Asia
When: November, 2013
Saffir-Simpson Scale: category 5 with wind speeds of 170mph and waves 15m high

PRIMARY EFFECTS	SECONDARY EFFECTS
• 6,300 dead • 27,000 injured • 40 000 homes destroyed = 90% of Tacloban • 30,000 fishing boats destroyed • Schools, hospitals and shops destroyed. • 400mm of rain flooded agricultural land. • Transportation routes (roads, rail, ports, airports) blocked by trees and debris (e.g. the Tacloban airport was damaged) • Service lines (water, gas, electricity) destroyed	• Trauma and diseases from dead bodies. • 600,000 people in temporary camps • 6 million lost their income/employment (*farmers & fishing companies*) • Crops destroyed = loss of $53million due to rice crops not being exported • Crime rates increased • Aid supplies could not reach victims. • Some areas had no power for 1 month • Shortages of water, food & shelter = disease.

IMMEDIATE RESPONSE	LONG TERM RESPONSE
• People were evacuated to 1200 evacuation centres that were created • USA – search and rescue (aircraft/helicopters) • People cleared rubble • Emergency food from Philippine Red Cross • Emergency hospitals from France, Belgium and Israel (FBI) • Emergency shelter kits from UK	• Reconstruction – 1000s of new homes built in flood safe areas • Reconstruction of roads, bridges & airports • NGOs (e.g. Oxfam) replaced fishing boats. • UN, EU, UK, Australia, Japan and USA provided long-term medical supplies and financial aid to start new lives. • Cash for work programmes were created to help people earn money in the long term

How can we protect ourselves from future tropical storms?

We cannot prevent a tropical storm from occurring, however we can protect ourselves.

- Monitor tropical storms to PREDICT when it will occur.
- PLAN to prepare for when a tropical storm occurs.

Monitor earthquake prone areas to PREDICT when it will occur.

Satellite Imagery	We can watch the hurricane progress using satellites, radar and aircraft
Previous Tropical Storm Data	We can use previous data and computer models to create a predicted path for the storm.

PLAN to prepare for when an earthquake occurs.

Evacuation Routes & Practice Drills	Educate people about what they need to do and where they need to go, should a tropical storm occur.
Emergency Kit	Residents are encouraged to have an emergency kit ready in case of a tropical storm (*e.g. a torch, canned food, batteries, radio, medical kit, dust mask, water…etc)*
Warning Systems	A warning alarm is used to alert people of an approaching tropical storm.
Building regulations	➢New homes built in low risk areas. ➢Buildings designed to withstand tropical storms (reinforced concrete) ➢Flood defences placed around coastlines (sea wall) and rivers (levee)

Weather	The day-to-day conditions of the atmosphere.
Extreme weather	Weather events that are significantly different from the normal.
Evidence that weather is becoming more extreme	➢ International Disaster Database shows the number of floods has increased since 1960s. ➢ 2003 Heatwave affected the whole of Europe between June to August. Tourism increased in the UK due to hot weather, however 2045 people died in the UK due to heat. ➢ It is raining more. 2007 Gloucestershire Floods, 2004 Boscastle Floods (1000 residents affected) and 2014 Somerset Floods due to heavy rain. ➢ 2010 Big Freeze due to heavy snow. In December, 2010, temperatures dropped to -20C in Scotland, schools and businesses closed, motorways/airports/railways closed, crops were destroyed.

An example of a recent extreme weather event in the UK: THE SOMERSET FLOODS

Where	Somerset, south-west England
Physical landscape	Somerset is low lying farmland. There are several rivers, including the Tone and Parrett, which flow into the Severn Estuary.
When	January and February, 2014
Why	350mm of rain in January and February (100mm above average), high tides, storm surges, rivers had not been dredged in 20 years and so were clogged with sediment
Social Effects	• 600 houses flooded. People in temporary accommodation for months. • 16 farms were evacuated • Villages (e.g. Moorland) were cut off by the floodwater. This meant residents could not attend school, work or shop. • Power supplies were cut off. • Local roads and railway lines were flooded.
Economic Effects	• Somerset County Council estimated the cost at £10 million. • 14,000 hectares of farmland under water for weeks = could not sell crops. • Over 1000 livestock had to be evacuated, which was very expensive for farmers and insurance companies. • Local roads and railway lines were flooded. These needed to be repaired.
Environmental Effects	• Floodwater contained sewage and chemicals which contaminated farmland. • Habitats were lost.

To reduce the risk of future floods, a £20 million Flood Action Plan was launched.

Dredging	In March 2014, 8km of the River Tone and the River Parratt were dredged. This is when material/soil/mud is removed from the river bed. As a result the river channel is larger and can hold more water. This prevents the river overflowing its banks.
Elevated roads	Roads have been elevated in places. As a result even if a flood occurs, people can still drive on the elevated roads. This also helps the economy by allowing import/export.
Flood defences	Settlements in areas of flood risk have flood defences. As a result they are able to protect themselves.
Embankments	River banks have been raised. These are called embankments. This means the river channel can hold more water and therefore it is less likely to overflow.

GLOBAL ATMOSPHERIC CIRCULATION

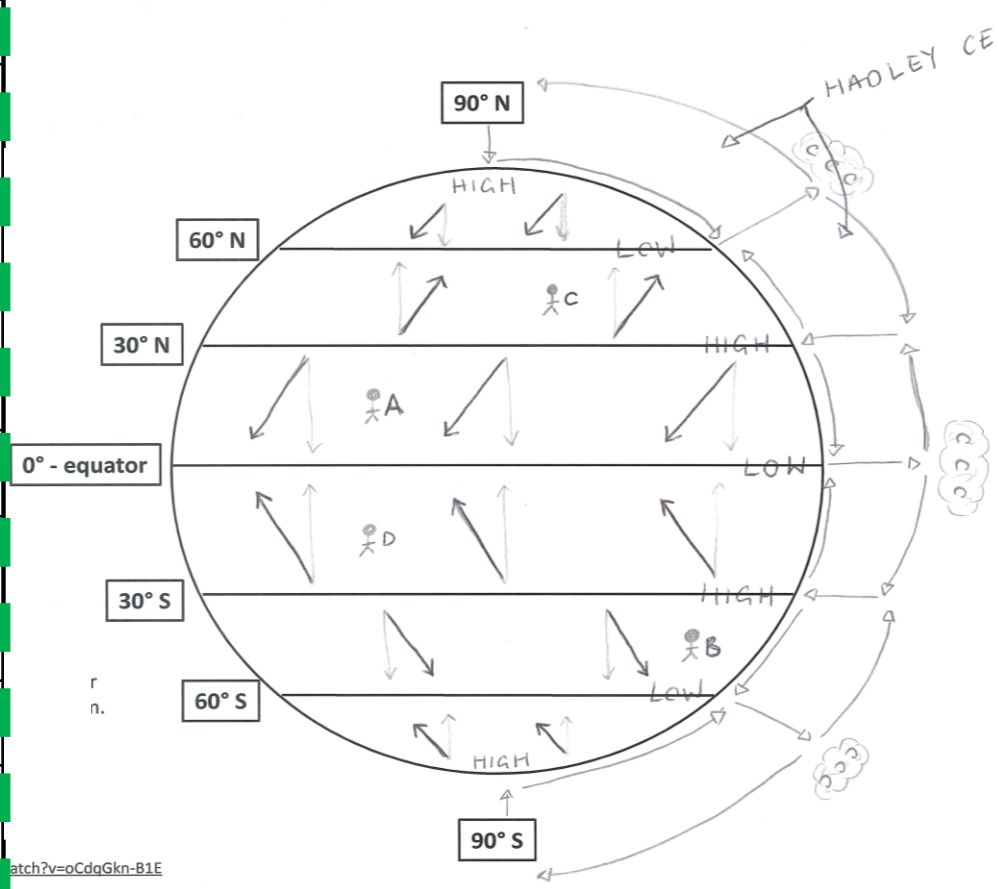
Global atmospheric circulation is the world's system of winds, which transport heat from equator to poles. It is the main factor determining global weather and climate patterns.

- Warm air rises = low pressure.
- Cold air sinks = high pressure
- Air moves from areas of high pressure to areas of low pressure.

It is hot and rainy (humid) at the equator (0°). It is hot because there is direct sunlight. It is rainy because the hot air rises creating a low pressure system. As it rises, it cools, condenses and forms clouds. Once the clouds reach saturation, they precipitate.

It is hot and dry (arid) at the 30°N and 30°S. It is It is hot because there is direct sunlight. It is dry because the air sinks creating a high pressure system. As the air sinks, no condensation occurs resulting in clear skies.

It is cold and dry at the north pole (90°N) and south pole (90°S). It is cold because there is no direct sunlight. Also many of the sun's rays are deflected off the earth's surface. It is dry because the air sinks creating a high pressure system. As the air sinks, no condensation occurs resulting in clear skies.



Air moves from high pressure to low pressure.

Due to the earth's rotation, the winds move at an angle. This is called the Coriolis Effect.

- Northern hemisphere – winds are deflected to the **right**.
- Southern hemisphere – winds are deflected to the **left**.

These deflections affect the prevailing winds (the most common wind direction)

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CLIMATE CHANGE IS A CHANGE IN THE EARTH'S CLIMATE. There is a lot of evidence that shows climate change has been occurring during the Quaternary Period (covers from 2.6 million years ago to today).

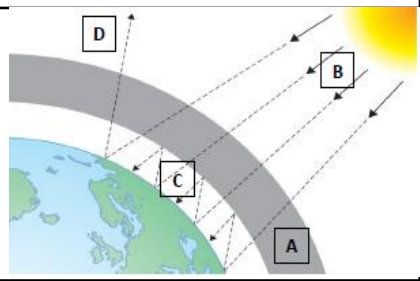
Thermometer recordings	Show that average global temperatures have risen by 0.74°C during the last 100 years and by 0.5°C since 1980.
Photographs	Show many of the world's glaciers have retreated in the last 50-100 years. It is estimated up to 25% of global mountain glacier ice could disappear by 2050
Paintings	Show that the River Thames was frozen over in 1677. People are shown ice skating over the frozen river
Ice cores	Ice sheets are made up of layers of ice (1 layer is formed each year). Scientists drill into ice sheets to get long cores of ice. By analysing the gases trapped in the layers of ice, they can tell what the temperature was each year. One ice core from Antarctica shows the temperature changes over the last 400,000 years.
Tree Rings	As a tree grows it forms a new ring each year. The tree rings are thicker in warm, wet weather. Scientists take tree cores and look at the rings to see what the climate was like in previous years.

Natural causes of climate change

Solar output	A sunspot is dark patch on the sun that appears from time to time. Every 11 years the number of sunspots changes from very few to lots to very few again. *Lots of sunspots = warmer* *Very few sunspots = cooler* *Between 1645 – 1715 there were very few sunspots. During this time, there was a very cold period known as the 'Little Ice Age'. Paintings show that the Thames completely froze over.*
Volcanic Activity	Violent volcanic eruptions blast lots of ash, gases (e.g. sulphur dioxide) and liquids into the atmosphere. Major volcanic eruptions lead to a brief period of global cooling. This is because the ash, gases and liquids can block out the sun's rays, reducing the temperature. • *e.g. Krakatoa 1883 eruption = world temperatures fell by 1.2°C for a year.* • *e.g. Pinatubo 1991 eruption = world temperatures fell by 0.5°C for a year.*
Orbital Change	Orbital change refers to changes in how the earth moves round the sun. It affects how close the earth is to the sun and therefore how much energy we get from the sun. When the earth is very close to the sun, it is warmer. When the earth is further away from the sun, it is cooler. ***a) Eccentricity: how the earth orbits the sun. Every 100,000 years the orbit changes from circular to elliptical (egg-shaped).*** *b) Axial tilt: the angle of the earth changes every 41,000 years between 22.5° to 24.5°.* *c) Precession: the natural wobble of the earth around its axis. Wobble cycles take 26,000 years.*

Human causes of climate change

The Greenhouse Effect	A) Greenhouse gases create a blanket around earth. B) Sunlight travels to earth as shortwave radiation. C) Sunlight bounces off the earth's surface as long-wave radiation. This reflected sunlight is trapped in the earth's atmosphere by the greenhouse gases = earth heats up.
The Enhanced Greenhouse Effect	Due to human actions, there are extra greenhouse gases in the atmosphere which trap more heat = global warming.



Methane	Produced by cattle and sheep. Rising incomes and population = increased demand for meat = more animals farmed = more methane produced. *250% rise since 1850.*
Carbon dioxide	Produced by burning fossil fuels. Rising population = increased demand for electricity = more carbon dioxide produced. *30% rise in carbon dioxide production since 1850.*
Nitrogen dioxide	Produced by car exhausts and airplanes. Rising incomes and population = increased cars and air travel = more nitrogen dioxide produced. *16% rise in nitrous oxide since 1850.*
Deforestation	= less trees = less photosynthesis = less CO2 removed from the atmosphere.

To respond to climate change we can use mitigation. :

- Mitigation: remove greenhouse gases from the atmosphere to slow down climate change.

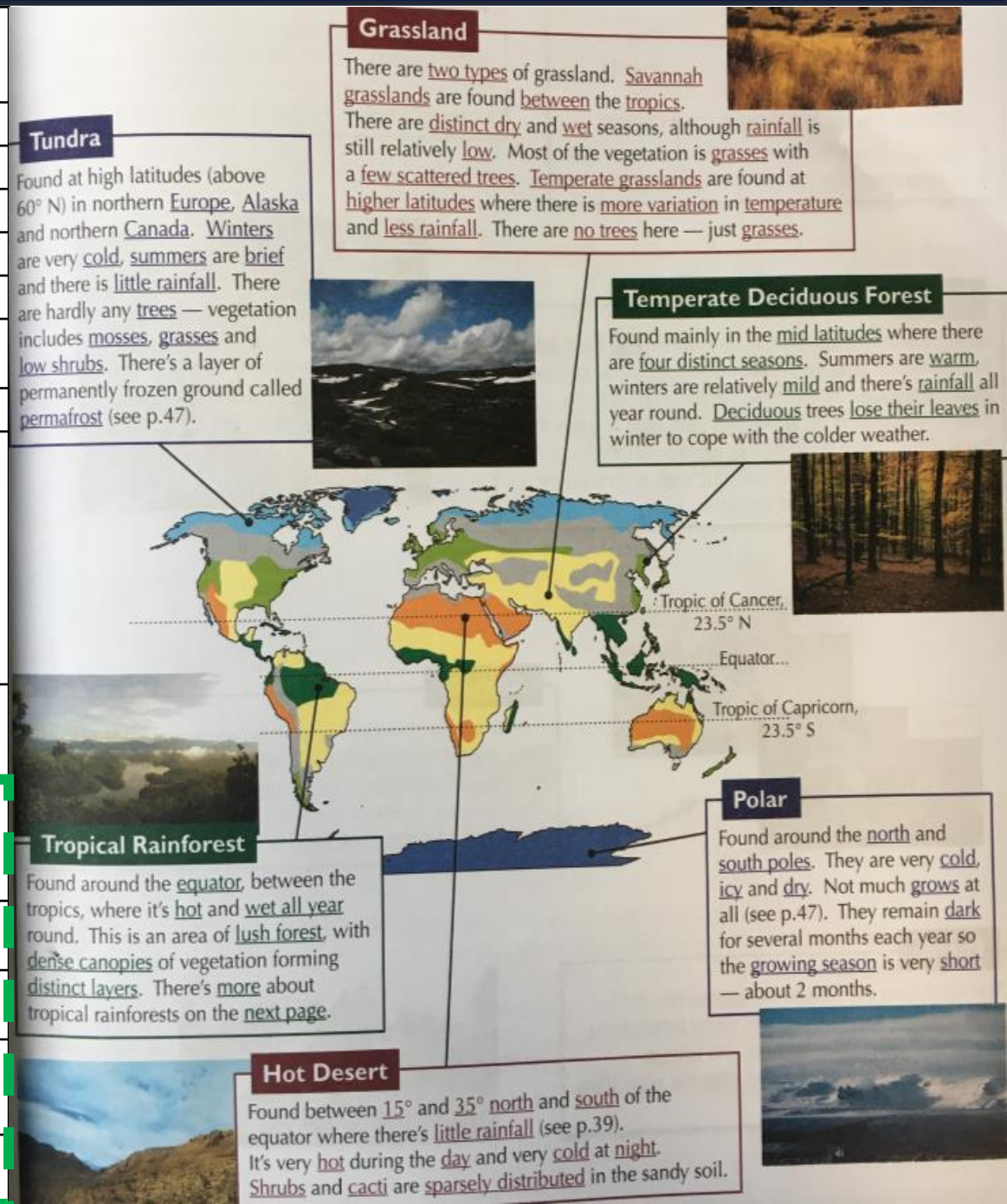
Carbon capture	Carbon dioxide is captured from the power stations, transported in pipes and stored deep underground or in oceans so it doesn't go into the atmosphere.
Afforestation	Planting trees = more trees = more photosynthesis = more carbon dioxide removed from the atmosphere = fewer greenhouse gases = less global warming. Trees remove 3 billion tons of carbon every year! *e.g. China has had afforestation programs since 1970s. Forest cover has increased from 12% to 16%.*
Renewable energies	Generating energy from natural renewable sources (e.g. solar panels, hydro-electric power, wind turbines, tidal energy). They do not produce greenhouse gases.
International agreements	Climate change is a global issue and requires global solutions. International agreements are when countries come together to agree on large scale, international strategies. ➢ **The Kyoto Protocol (1997):** over 170 countries agreed to reduce carbon emissions by 5.2%. ➢ **Copenhagen meeting (2009):** world leaders agreed to reduce carbon emissions, with HICs giving LICs financial support to help them cope with impacts of climate change. ➢ **The EU** agreed to cut carbon emissions by 20% between 1990 and 2020.

To respond to climate change we can also use adaptation:

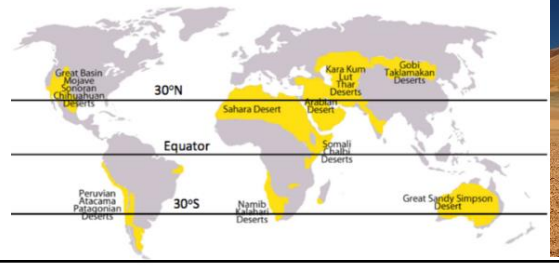
- Adaptation: respond to the likely effects of climate change to reduce their impact.

Changes in agriculture:	**Problem:** changing rainfall patterns and temperatures will affect productivity of farms. **Adaptation**: use drought-resistant crops, grow different types of crops, implement irrigation systems to water crops during droughts, plant trees to shade vulnerable crops from strong sunlight, change crops grown.
Changes to water supply:	**Problem:** dry areas are likely going to get drier = water shortages. **Adaptation – decrease the use of water:** drip irrigation, recycle water, water meters, dual flush system. **Adaptation – increase the supply of water:** build reservoirs, collect rainwater.
Reduce risk of sea level rise:	**Problem:** melting glaciers = sea level rise (rise of 20cm since 1900 and estimated future rise of 82cm by 2100). **Adaptation**: coastal management (sea walls, rock armour, gabions), build houses on stilts in flood prone areas, invest in monitoring and prediction strategies, invest in planning strategies (e.g. hazard mapping, warning alarm, emergency kits).

An ecosystem is…	A natural system made up of plants, animals and the environment. There are many complex interrelationships (links) between the living (plants & animal) and non-living (atmosphere & soils) components. Ecosystems can be as small as a hedgerow or pond. Larger ecosystems, on a global scale, are known as biomes, such as tropical rainforest or the desert.
Producer	Organisms that get their food from the natural environment (*photosynthesis*)
Consumer	Organisms that feed on other organisms (producers and consumers)
Herbivore	Consumer that only eats vegetation.
Omnivore	Consumer that eats vegetation and animals (meat).
Carnivore	Consumer that only eats animals (meat).
Decomposer	Decomposers (fungi, bacteria) feed on dead producers & consumers. This dead material is known as litter. They break down the litter and recycle the nutrients back to the soil.
Food Chain	A food chain is a single line of linkages between producers and consumers. It shows what eats what.
Food Web	A food web shows all the linkages between the producers and consumers in an ecosystem. A food web shows what eats what. A change in one part of an ecosystem has an impact on other parts of the ecosystem. Some parts of an ecosystem depend on the others (e.g. consumers depend on producers for a source of food) and some depend on them for a habitat. So if one part changes it affects all the other parts that depend on it. Two examples can be seen to the right. Hot, dry summer → Reduced plant growth → Fewer berries for birds in the winter → Numbers of sparrows and thrushes fall → Fewer birds for sparrowhawks to hunt, so number of sparrowhawks falls
Nutrient Cycle	The movement of nutrients around an ecosystem. *e.g. when dead material is decomposed, nutrients are released into the soil. The nutrients are then taken up from the soil by plants. The nutrients are then passed to consumers when they eat the plants. When the consumers die, decomposers return the nutrients to the soil. This is the nutrient cycle.*
Example of a small scale ecosystem in the UK:	Freshwater pond. It provides a variety of habitats for plants and animals, due to changes in oxygen, water and light. It is made up of the plants, fish, birds and other organisms that live within it, as well as the water, sunlight, temperature in the area.
Producers in a freshwater pond:	Algae, marsh marigold, waterlily
Consumers in a freshwater pond:	Frog, heron, fish (e.g. perch), duck, waterworms, rat tailed maggot
Humans affect the freshwater pond by:	• Farmers add fertilisers to their fields which leach into ponds. This causes a rapid growth of algae = sunlight and oxygen is depleted = fish and wildlife in ponds die. • Ponds can be drained for irrigating fields.
Climate change affects the pond:	• Extreme weather is a common impact of climate change = more droughts = ponds dry up. • Extreme weather is a common impact of climate change = more flooding = ponds flood.

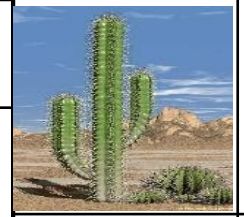


THE DESERT: THE SAHARA DESERT



Location	Deserts are located along the Tropic of Cancer & Tropic Capricorn (23.5° – 30° north and south of the equator latitude), Examples: Sahara Desert: Africa (Algeria, Egypt), Mojave desert (USA)
Climate	Hot and dry: arid. 2 seasons (summer and winter). Temperature range: over 40°C in the day – less than 5°C at night Precipitation: less than 250mm per year. In some areas as low as 70mm per year
Vegetation	Very sparse (cactus, Joshua tree, desert daisy)
Animals	Very few (lizards, scorpion, camel, wolf spider, kangaroo)
Soil	• Shallow, dry and has a coarse, gravelly texture. • Not very fertile as there is hardly any decaying plants to add nutrients to the soil.
People	• Indigenous people in the desert are usually nomadic farmers who travel with their herd (goats and sheep) in search of food, water. • New groups have started to live in the desert to use their natural resources (e.g. oil, farming, tourism, renewable energy)
Biodiversity	The variety of organisms living in a particular area (plants and animals)
Biodiversity in the desert	Deserts have low biodiversity. ➢ Small areas of the desert, that are near water (rivers, ponds) have higher diversity of plants, animals and humans.
Threats to the desert	• Desertification on the fringe of the hot desert. This is causing the desert to get larger and the soils to become drier = erosion. • Climate change = more extreme weather (e.g. droughts) = plants/animals unable to survive the even hotter and drier weather = loss of biodiversity.

VEGETATION ADAPTATIONS

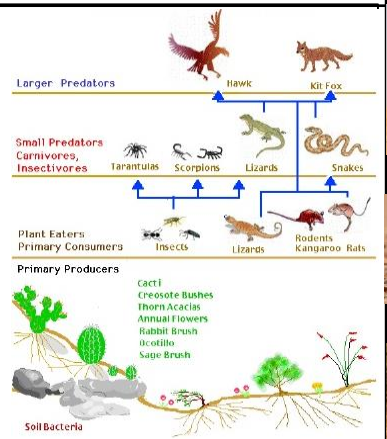
Cactus 	• Some have deep roots to reach water deep under the ground • Some have a very shallow horizontal root system, just below the surface, so that it can soak up water before it evaporates. • Succulent: store water in the stems. • Thick, waxy skin to reduce water loss from transpiration • Spines reduce water loss and protect the cacti from predators who might try and steal the water stored in their stem.
Joshua Tree 	• Deep roots to reach water deep under the ground • Small needle like leaves to reduce water loss. • Leaves are covered in a waxy resin to avoid water loss

ANIMAL ADAPTATIONS

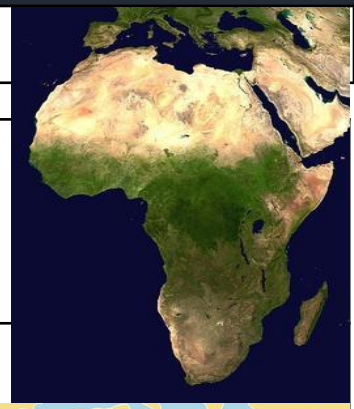
Camel 	• Large, flat feet to spread their weight on the sand. • Triple eye lids and long eyelashes keep sand out of their eyes. • Their colour helps them camouflage (blend in) • Store fat in their hump, which can be used for energy. They can also break this down into water when needed.
Lizard 	• Burrow during the hot days and emerge at night to feed. • Their colour helps them camouflage (blend in) • Nocturnal – only come out at night when cooler.
Other adaptations 	• Some animals sit very still in the shade during the hottest part of the day (e.g. fennec foxes). • Some animals are nocturnal, meaning they burrow and sleep in the hot days and come out during the cooler evenings.

All parts of the desert ecosystem are linked together (climate, soil, water, animals, plants and people). If one of them changes, everything else is affected.

- ➢ Plants get their nutrients from the soils. Animals get their nutrients from the plants.
- ➢ Animals spread seeds in their dung (poo), helping new plants to grow.
- ➢ Hot and dry climate = water is very quickly evaporated = leave salts behind = salinity/salty soils.
- ➢ Very few nutrients are recycled as there is so little vegetation = very litter decay.
- ➢ Sparse vegetation = lack of food = low density of animals
- ➢ Water supplies in the desert are caused due to low rainfall and quick evaporation. As a result humans use irrigation to water their crops using deep wells = less water available for plants and animals.



The Sahara Desert is the world's largest desert. It covers over 9 million square kilometres. It is located in Northern Africa, covering nine countries including Egypt, Algeria and Chad. The Sahara Desert provides a number of opportunities for economic development, however its harsh physical landscape and climate can cause challenges for development.



Economic Opportunities in the Sahara Desert

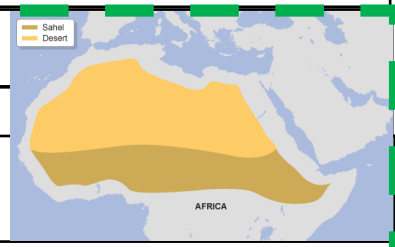
Mining for Oil & Gas	What: digging under the desert for oil and gas. Where: Hassi Messaoud oilfield in Algeria, Sahara Desert, Northern Africa *Good: 50% of Algeria's GDP comes from oil and gas, Hassi Messaoud employs 40,000 people* *Bad: must fly 40,000 workers to the remote oilfield, fly out water and food reserves, difficult to drill hundreds of metres beneath desert and hard to construct pipelines 100s of kilometres across the desert to the coastline.*
Solar Panels	What: solar panels are built to make use of the 12+ hours of bright sunshine in the desert Where: Tunisia, Northern Africa *Good: energy is sold to Western Europe = money for development, it is clean renewable energy.* *Bad: sandstorms destroy solar panels & dusty conditions mean they need cleaning. This requires 10,300 gallons of water/day.*
Agriculture	What: using the River Nile to irrigate land and grow crops (dates, figs and fruit) to feed increasing population (20 to 79 million in last 25 years). Where: Next to the River Nile, Egypt, Northern Africa. *Good: accounts for 13% of Egypt's income, employs 32% of Egypt's labour force.* *Bad: rapid evaporation of irrigation water, leaves salt crystals = salinity.*
Tourism	What: visit world's largest desert, Egyptian culture, pyramids, camel treks. Where: Egypt, Northern Africa *Good: income for development, employment, development of transport and infrastructure.* *Bad: pollution from development, overuse of water, cultures are used as entertainment rather than tourists learning about their tradition,*

Challenge for Development in the Sahara Desert

Extreme Temperatures	• Daily temperatures can reach over 40°C, whereas evening temperatures can go below freezing • Hot temperatures can be too hot for tourists. It can also make farming and mining difficult.
Inaccessibility	• The Sahara is HUGE = people often have to travel long distances, usually by plane which is expensive. • It is difficult to provide services across such a large area • It is difficult to transport products from oil or energy fields, as extensive pipelines have to be built.
Water Supply	There is very low rainfall in the Sahara Desert (less than 70mm in some places). As a result providing water to workers, tourists or for irrigation difficult. Also 10,300 gallons of water is needed to wash the solar panels each day.

The Sahel is located on the southern fringe of the Sahara Desert. It used to be a savannah ecosystem, however human activities are causing environmental harm = desertification.

DESERTIFICATION is the process where land gradually turns into a desert. It becomes drier, less fertile and is vulnerable to erosion.



Causes of desertification in the Sahel

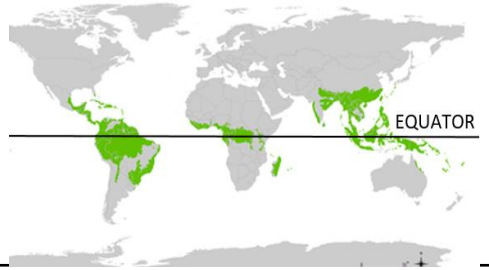
Climate change	Climate change results in extreme weather, such as droughts. Lack of rainfall = not enough rain for the soils to have moisture and stay healthy. Also plants die due to lack of water = roots no longer hold the soil together = vulnerable to erosion. High temperatures = any water is immediately evaporated leaving the soil very dry. Also salts in the water are left on the soil after the water is evaporated = salty, dry soil that is vulnerable to erosion.
Over-grazing	Too many cattle and sheep eat the vegetation = the soil is no longer held together by the plants = vulnerable to soil erosion.
Over-cultivation	Population growth = more demand for food. As a result land is being over-farmed. This uses up all the nutrients in the soil, leaving it dry and exposed to erosion.
Deforestation	Population growth = increased demand for fuel wood = increased deforestation. The roots therefore no longer bind the soil together and the nutrient cycle is stopped = soil becomes dry and exposed to erosion.

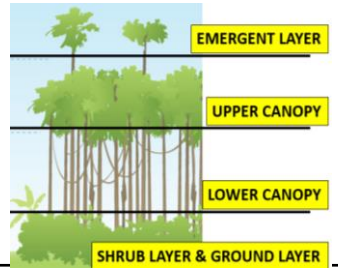
Sustainable strategies to reduce the risk of desertification.

Afforestation (planting trees)	The roots also help to hold the soil together and prevent erosion. When the plants/leaves die, their nutrients are giving back to their soil. They act as windbreakers and therefore reduce wind erosion.
Crop Rotation Grazing Rotation	When farmers allow a field to rest between farming. This allows the soil time to repair and get their nutrients back. This prevents over-cultivation. Move the animals from place to place to reduce the amount of vegetation eaten or reduce the number of farm animals. This prevents over-grazing.
Water Management	Grow crops that don't need a lot of water (e.g. millet or olives) Use irrigation techniques that use very little water (e.g. drip irrigation)
Appropriate Technologies	Use cheap, sustainable and easily available materials Earth Dams: collect and store water in the wet season. The stored water is then used to irrigate crops in the dry season. Using Manure: animal manure is used to fertilise the soil by adding nutrients.

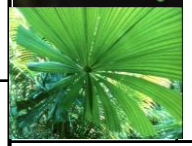
THE TROPICAL RAINFOREST: THE AMAZON RAINFOREST

Location	Rainforests are located along the equator (0° latitude). Examples: South America (Brazil), Asia (Indonesia), Africa (Congo).
Climate	Hot and wet (humid). No seasons Temperature range: 20-30°C (due to direct sunlight from the sun) Precipitation range: 160 – 330mm/month or 2000mm per year
Vegetation	Very dense and varied (e.g. banana and rubber trees).
Animals	Very dense and varied (e.g. apes, parrots, jaguars, insects)
Soil	Not very fertile, as heavy rainfall washes nutrients away. This is known as leaching. Most nutrients are in the top layer of the soil due to nutrient cycling from the decayed leaves. As a result most trees have a shallow root system.
People	Tribes have lived in rainforests for a long time (sustainable). New groups of people and companies have arrived more recently, trying to make money from the rainforests through logging, energy, mining…etc (unsustainable)
Biodiversity	The variety of organisms living in a particular area (plants and animals)
Biodiversity in the rainforest	Deserts have very high biodiversity. Rainforests contain around 50% of the world's plants, animals and insect species.
Threats to the rainforest	Deforestation is causing a loss of biodiversity in the rainforest, as many animals and plants become endangered or extinct.

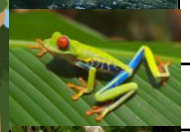
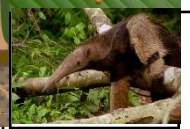




VEGETATION ADAPTATIONS

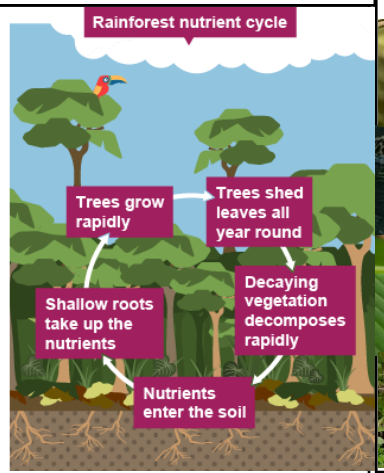
	Layers	The rainforest has four layers (emergent, upper canopy, lower canopy and shrub & ground layer). Vegetation adapts to each layer.
	Trees *(height, buttress roots, bark)*	• The trees can grow to over 40 meters high in order to find sunlight. • To help support their height, they have buttress roots. These are large root systems above the ground that act as an anchor and support the tall trees. • Trees have a smooth, thin bark = helps water to run off easily.
	Lianas	Woody vines that use trees to climb up to the upper canopy where they spread from tree to tree to get as much light as possible.
	Leaves	• On the shrub and ground layer, it is very dark due to the canopy. As a result, their leaves have a large surface area to catch as much sunlight as possible. • Many leaves have drip tips and a waxy coating. This help shed water easily. • Some plants, *e.g. the fan palm*, have large fan-shaped leaves which are segmented so that excess water drains away easily.

ANIMAL ADAPTATIONS

	Spider monkey	Have long, strong arms and tails so they can swing between the trees in the upper canopy. Some animals spend their entire lives in the upper canopy.
	Leaf-tailed gecko & chameleon	Are camouflaged so can blend into their surroundings to hide from predators
	Jaguar	Can swim due to high rainfalls and many rivers.
	Red-eyed tree frog	Have suction cups on their feet and hands to help them climb up trees and leaves.
	Anteater	Some animals have adapted to the low light levels in the shrub and ground layer. Have a sharp sense of smell and hearing so they an detect predators without seeing them. This helps them survive in the low light levels in the shrub & ground layer.

All parts of the rainforest ecosystem are linked together (climate, soil, water, animals, plants and people). If one of them changes, everything else is affected.

- The humid climate = dead plants and animals decompose quickly by decomposers (fungi and bacteria) on the forest floor = the nutrients from the decaying plants/animals makes the top layer of the soil very nutrient rich = lots of plants can grow.
- Plants pass on their nutrients when they are eaten by animals. There is a lot of vegetation = lots of animals.
- People remove trees (deforestation) = less carbon dioxide is removed from the atmosphere = more greenhouse gases = more climate change.
- Trees absorb water = this water travels through the tree to the leaves = transpiration evaporates water from the trees' leaves to the atmosphere = condensation in the atmosphere creates clouds = precipitation. The trees are one of the main reasons there is so much rainfall in the rainforest.



The Amazon Rainforest is the largest rainforest on earth, covering 8 million km_2 of land. It is located in South America. It covers 9 countries, including Brazil, Peru and Colombia. The largest portion of the Amazon Rainforest is located in Brazil. Since 1978, 750 000km_2 of land has been deforested. This is three times the size of the UK!

Uses of the rainforest:

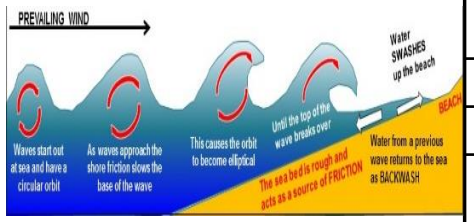
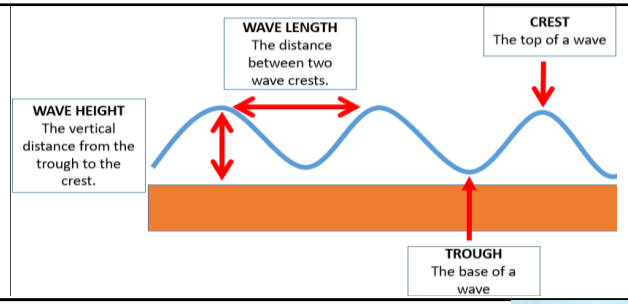
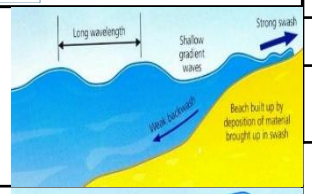
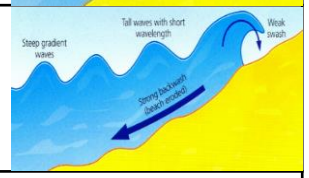
Cattle farming	Clear land for massive, commercial cattle farms. This causes 70% of deforestation in the rainforest.
Logging	Cutting down hardwood trees (mahogany/ebony) to sell. This causes 3% of deforestation in the rainforest.
Hydro-electric energy	Build dam and reservoir to create and sell hydro-electric energy. ➢ e.g. Belo Monte dam in Brazil Monte Dam.
Mining	Digging to extract iron ore, aluminum, copper, tin and gold to sell. ➢ e.g. The Carajas Mine in Brazil is the world's largest iron ore mine.
Building roads	Logging companies, cattle ranches, farms, mines need roads to reach them and transport products to the coast to export = roads built.
Urban growth	Increasing population = increasing urban areas. (e.g. Manaus' pop. grew 22% between 2000 – 2010 reaching 1.7million) due to job opportunities.
Subsistence farming	Local famers clear the land using slash and burn and grow only enough food for their family to eat. This causes 20% of deforestation in the rainforest.

Positive and negative impacts of development in the rainforest.

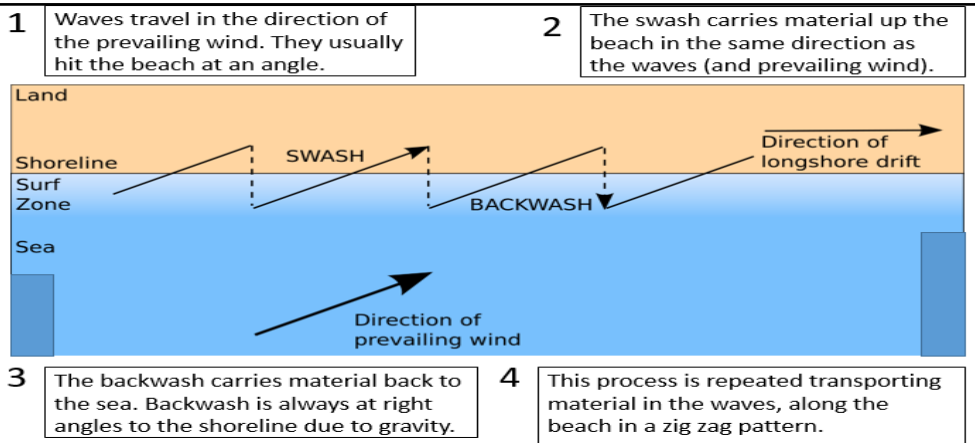
POSITIVE ECONOMIC AND ENVIRONMENTAL IMPACTS	NEGATIVE ECONOMIC AND ENVIRONMENTAL IMPACTS
Economic benefits: • Jobs in mines (Carajas mine), farms, power stations (Belo Monte Dam) and construction. In Peru the Buenaventura mining company employs 3100 people. • Development. Money from companies is used to develop Brazil. In 2008 Brazil made $6.9 billion from selling cattle. • Improved transportation make trading faster and easier = more is exported. **Environmental benefits:** • The Belo Monte Dam will be the world's 3rd largest dam and a source of **clean, renewable energy**.	**Economic negative impacts:** • Some famers (e.g. rubber tappers) have lost their job due to deforestation of rubber trees. **Environmental negative impacts:** • Habitat and settlement loss > Trees cut down = animals living in canopy lose their habitats. > The reservoir behind the Belo Monte Dam will flood 1000s of hectares of rainforest, destroying habitats and the livelihoods of over 2000 families. • Loss of animal biodiversity – plants and animals are endangered or becoming extinct as trees are deforested. • Climate change – trees remove CO_2 from the atmosphere during photosynthesis. If there are less trees, less CO_2 is removed = more greenhouse gases in atmosphere. The Amazon Rainforest stores 100 billion tons of carbon. • Climate change – large cattle ranches contain lots of cattle. These release a lot of methane when they fart and poo). • Soil erosion – deforested trees cannot hold the soil together. As a result heavy rains wash away the soil (erosion).

SUSTAINABILITY IN THE RAINFOREST: ***Allow people get what they need today, without stopping people in the future getting what they need.***

Selective logging	Only some trees are cut down (usually the older ones), rather than cutting down all the trees in an area. As a result the rainforest canopy is saved where many of the animals live.
Afforestation	Afforestation is when new trees are planted as others are cut down. In some countries it is law to replant trees.
International: debt relief	HICs reduce the amount of debt LICs owe them so that they do not have to use their rainforest resources (trees, mining, cattle farming) to pay back the debt, which all cause deforestation. Unfortunately there is no guarantee the money saved, will be spent on conservation/protection instead. It is therefore better to make a conservation swap that guarantees this. • *e.g. In 2008 the USA reduced the debt that Peru owed them by $25 million. In exchange Peru had to conserve/look after part of their rainforest.*
International: carbon sinks	Trees remove carbon dioxide during photosynthesis and are therefore known as carbon sinks. Rainforests are protected due to their role in reducing global warming. • *e.g. The Gola Forest in Sierra Leone (Africa) is protected for its role in reducing global warming, using money from the European Commission, French Government and NGOs.*
National parks	Areas are protected from development and deforestation. It is difficult to police these areas through. As a result, illegal logging still occurs. • e.g. The Tumucumaque National park in Brazil is the largest in the world. It protects over 38,000 square kilometres of rainforest.
Promoting responsible management	Forest Stewardship Council (FSC) and Rainforest Alliance are organisations that put their logo on hardwood trees that have been deforested in a sustainable way. Therefore consumers can choose products that are not contributing to unsustainable deforestation.
Ecotourism – sustainable tourism	Tourist resorts that use sustainable practices to reduce their impact. In Costa Rica eco-tourism is the largest source of income. It protects 21% of the country from development. • *e.g. reduce negative environmental impacts: renewable energies, water tanks, grey water,* • *e.g. improve social impacts: local employees, use local produce and materials. Money goes into local economy. If locals have a job, they do not need to illegally log.*

Coastline	The outline of the land. Where the land meets the sea
How are waves formed and how do they break?	• Winds push the surface of the water in the direction it is blowing. • The water moves in a circular motion = waves. • As the waves move into shallow water, the rough sea bed = friction = water travels slower at the base of the circular wave = the top of the wave moves faster than the base. • Eventually the top of the wave breaks 
Wave anatomy	
Constructive Waves	• Long wavelength and low wave height • Strong swash and gentle backwash = add material and create big beaches • Very gentle, created in calm conditions and a short fetch. 
Destructive Waves	• Short wavelength and high wave height • Weak swash and strong backwash = remove material and erode beaches • Very powerful, created in storms and 
Wave fetch	The distance of water over which the wind blows (the size of the sea/ocean)
Swash	Breaking waves rush water and sediment up the beach.
Backwash	The water that rushes flows back to the sea.
Infiltration	Water enters the ground
Saturation	Rock that is full of liquid
Impermeable rock (non-porous rock)	Rocks that do not allow liquid to pass through
Permeable rock (porous rock)	Rocks that allow liquid to pass through
Slip plane	A line of weakness along which movement occurs

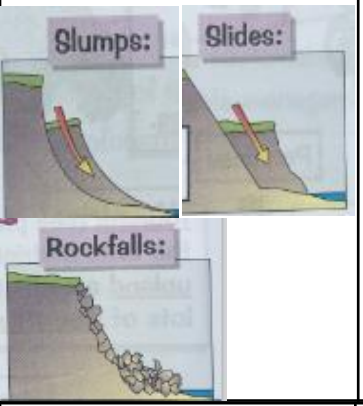
Erosion	The wearing away or removal of rocks. Erosion attacks the base of the cliff.
Hydraulic Action	The force of the waves hitting the cliffs removes material. Air bubbles in the water are pushed into cracks in the cliff and remove material due to an increase in pressure.
Abrasion	Material in the sea hits against the cliffs and removes rocks and soil, *like sandpaper.*
Corrosion	Chemicals in the water dissolve the cliff.
Attrition	Material in the sea crash into each other and break into smaller pieces. Continued attrition = smaller, smoother pebbles and sand particles.
Weathering	The breakdown of rocks caused by the day-to-day changes in the atmosphere. Weathering attacks the top of the cliff.
Freeze-thaw	Water collects in cracks. At night this water freezes and expands. The cracks get larger. In the day the temperature rises and the ice melts (thaws). The repeated freezing and thawing weakens the rock = breaks apart
Biological weathering	Plant roots grow in cracks in the rocks and break them apart. Animals burrow into weak rocks and break it apart.
Carbonation	Carbon dioxide and sulphur dioxide mix with rainwater to produce acid rain. This reacts with rocks. *e.g. rainwater + CO2 = carbonic acid. Carbonic acid + calcium carbonate (in rocks such as limestone) = calcium bicarbonate which is soluble = rock dissolves.*
Transportation	The movement of sediment along the coastline.
Longshore drift	The zig zag movement of transported material along the coastline. It is transported in the direction of the prevailing wind.



Deposition	The dropping of material carried by the water. It takes place in areas where the flow of water slows down. Waves lose energy and can no longer carry sediment and is therefore dropped. This occurs in: • *Sheltered bays when the wave's energy decreases.* • *Areas where there are constructive waves (strong swash/weak backwash)* • *Coastlines with groynes. These are wooden walls that are built out to sea, along the beach. They trap sediment being transported by longshore drift.*

Landforms that have been created by erosion and weathering:

MASS MOVEMENT

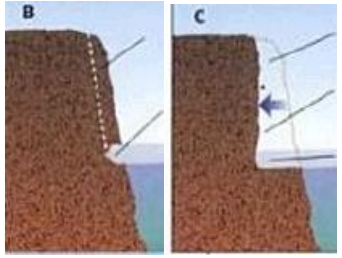


Mass movement is the downhill movement of material caused by gravity.

Rotational slump and Landslide:
- During periods of rain, water infiltrates (goes into) permeable rock. This makes the rock heavier.
- Eventually the rock becomes saturated (full of water) and unstable. A line of weakness forms in the unstable rock. A line of weakness is also known as a slip plane.
- Material moves down along the line of weakness.
  - *Rotational slumps – a CURVED line of weakness forms.*
  - *Landslides – a STRAIGHT line of weakness forms.*

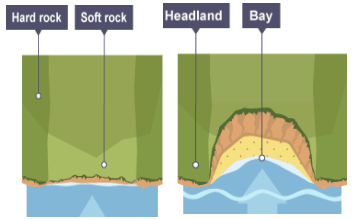
Rock Fall – where rocks fall down a cliff face due to gravity
- Freeze-thaw weakens the rocks at the top of the cliff.
- These weakened rocks fall to the base of the cliff.
- The material that collects at the bottom of the cliff is called a scree slope.

WAVE CUT PLATFORM



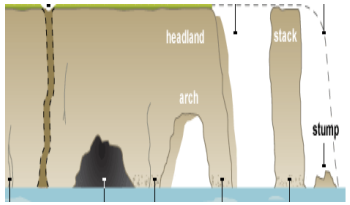
A wave cut platform is a platform of rock found at the base of a cliff, formed due to erosion and weathering.
- Waves attack the base of the cliff between the high and low tide marks.
- Processes of erosion, such as hydraulic action and abrasion erode the base of the cliff creating a ***wave cut notch*** and ***overhanging cliff***.
- Further erosion makes the wave cut notch larger and overhanging cliff unstable.
- Eventually the overhanging cliff collapses leaving a flat area of rock (***wave cut platform***).
- The cliff retreats.

HEADLAND AND BAY



A headland is a cliff that sticks out into the sea.
A bay is an indentation in the coastline between headlands
- Headlands and bays occur along discordant coastlines. These are coastlines with bands of alternating hard and soft rock.
- The two different rock types erode at different speeds.
  - ***Hard rock*** *(granite) will erode more slowly, creating* ***headlands****.*
  - ***Soft rock*** *(clay) will erode more quickly, creating* ***bays****.*
- Bays are sheltered. As a result, deposition occurs and beaches are formed.

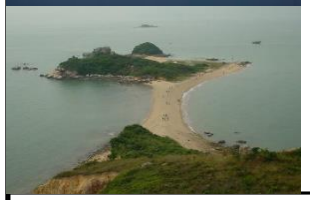
CAVE, ARCH, STACK



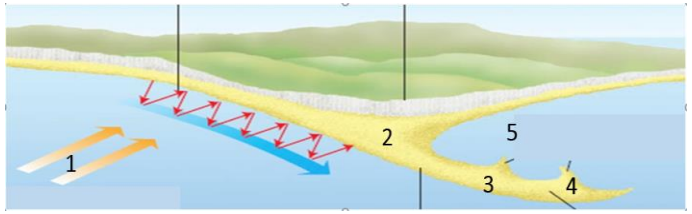
A cave, arch, stack is a coastal landform that is created along headlands.
- Waves attack a line of weakness along a headland. Erosion (hydraulic action, abrasion) widens the line of weakness to create a cave.
- Continued erosion, erodes the back of the cave, creating an arch.
- Weathering (freeze-thaw, animals, salt) weakens the top of the arch making it unstable. It eventually collapses, forming a stack.
- The stack is eroded from the base by the sea and weakened at the top by weathering = stump.

Landforms that have been created by transportation and deposition:

SPIT



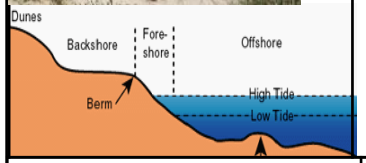
A spit is a long, narrow band of sand/shingle that extends out into the sea from the land.
1. LONGSHORE DRIFT transports material along the coastline in a zigzag pattern.
2. Where there is a sudden BEND in the coastline, the waves lose energy. As a result, material is deposited.
3. REPEAT: continued longshore drift along the coastline and deposition at the bend, deposits material out to sea = spit.
4. Strong winds and waves curve the end of the spit = RECURVED end.
5. The area behind the spit is sheltered from waves = low energy = deposition. SALTMARSHES and mud flats are common here. They attract lots of wildlife.



A BAR is formed when a spit joins two headlands together.
A lagoon forms behind the bar.

A TOMBOLO is formed when a spit joins to an island.

BEACH



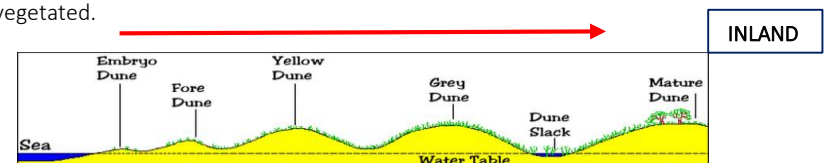
Deposits of sand and shingle (pebbles) at the coast.

Beaches are found on the coast between the high water mark (high tide line) and low water mark (low tide line).
- *Sandy beaches are wide and flat. They are created by constructive waves with a strong swash and weak backwash. They occur in sheltered areas such as bays.*
- *Shingle beaches are steep and narrow. They are created by destructive waves with a weak swash and strong backwash. They occur in exposed coastlines.*

Beaches are made up of the **offshore** (*out to sea*), **foreshore** (*between high and low tide lines*) and **backshore** (*high up the beach, near the sand dunes*).

SAND DUNE

SAND DUNES – mounds of sand at the back of the beach.
- Sand is moved up the beach by the wind.
- It gets trapped by obstacles (e.g. driftwood) and the sand is deposited. Overtime it gets vegetated and larger = embryo dune.
- As you travel inland from the sea, the sand dunes get: taller, larger, darker, more vegetated.



Hard engineering Effective?	Using manmade, artificial structures to prevent erosion and flooding.. More effective, long lasting and need less maintenance than soft engineering, however more expensive and less natural/environmentally friendly.
Sea Wall	A strong concrete wall built in front of the cliff/settlement that absorbs the wave's energy. A curved sea wall reflects the wave back to sea. • Effective, long lifespan, tourists like to walk along it. • Expensive to build and maintain, looks unnatural.
Rock Armour	Large rocks placed in front of the cliff or settlement, that absorb the wave's energy. • Effective, long lifespan, cheaper, more natural and easier to build/maintain than a sea wall. • Expensive (UK rock armour often comes from Norway), access to the beach can be difficult, can become slippery and dangerous.
Gabions	A wire cage filled with rocks that are placed in front of the cliff or seaside settlement. These absorb the wave's energy. • Effective, long lifespan, cheaper and easier to build/maintain than rock armour/sea walls. • Wire cages have short lifespan (5-10 years). Sea water corrodes metal cages creating broken gabions which can be dangerous to tourists. More expensive than soft engineering.
Groynes	Wood or rock fences built out into the sea. They trap sediment transported by longshore drift and make the beach larger. • Groynes make the beach wider. The waves lose energy as they rush up the beach, meaning they have less erosion. Big beaches boosts tourism. • They prevent sediment reaching beaches further along the coastline, making beaches along the coastline smaller. Therefore the problem is moved, not solved. More expensive than soft engineering.
Off-shore Break-water	Stone walls built up in the ocean parallel to the coastline. • They reduce the energy of the waves and help deposition to occur = beach gets larger (e.g. Sea Palling), • They can be very expensive and interfere with boats.
Managed retreat More specifically….	A deliberate decision to allow the sea to floor an area of low-value land. People are evacuated, buildings demolished and any existing sea defences removed. The sea then naturally floods the land and salt marshes develop in the flooded land, which absorb the energy of future waves. New flood defences can be built in high-value land behind the salt marshes
Example of managed retreat	Medmerry Managed Retreat, Chichester, South England. The flat, low-lying land had a low value (used for farming and caravan parks). The sea wall that protected the area needed repairing, but the decision was to not repair it and allow the land to flood as it was cheaper than repairing the sea wall. The managed retreat took place in November 2013.

ADVANTAGES	DISADVANTAGES
• Reduced chance of flooding. • 7km of new cycle routes, 10km of new footpaths for leisure activities. • 300hectares of new habitats created (saltmarshes). This creates a tourist attraction (e.g. birdwatches). • Newly flooded land has created new fishing nursery = new fishing industry in Selsey (economy)	• People were relocated from their homes. • Despite planning, habitats of existing species were affected. • The scheme cost £28 million. • Three farms were flooded = loss of industry and income.

Soft engineering Effective?	Using natural, environmentally friendly methods to prevent flooding. Often cheaper than hard engineering however need more maintaining and have a shorter lifespan
Beach Nourishment	Adds sediment to the beach to make it wider. The widened beach acts as a barrier from the waves and reduces erosion and flooding. • Cheap and easy to maintain, natural looking, bigger beaches = more tourism • Short lifespan, constant maintenance, beach is closed due it is being done.
Beach Reprofiling	Material removed by longshore drift or destructive waves is returned to the beach. This maintains the size of the beach and prevents it getting smaller. • Cheap and easy to maintain, natural appearance, bigger beach = more tourists • Short lifespan, constant maintenance, beach is closed due it is being done.
Dune Regeneration	Sand dunes are repaired and made larger using fences or marram grass. This creates a natural barrier from the waves. • Cheap, very natural, popular with wildlife (creates habitats). • While being repaired, dunes are closed = less tourists. They also require constant maintenance as dunes are constantly changing.
Dune Fencing	Fences are built on sandy beaches to collect sand and create new sand dunes. The new sand dunes act as a natural barrier from the waves. • Cheap, natural, help make dunes larger, minimal impact on wildlife. • Can be dangerous if the fences break, need regular maintenance after storms

The UK's coastline is at risk of erosion. For a section of coastline to be protected, the cost of the scheme must be less than the value of the land, property and infrastructure (e.g. roads) saved, and the scheme must have no negative 'knock-on' environmental effects, for example making erosion worse somewhere else. The British Government creates **shoreline management plans (SMPs)** that outline how our coastline will be protected. There are four strategies.

Advance the line	Build new defence structures (v. high land value)
Hold the line	Maintain/improve existing coastal defences (high land value)
Managed retreat	Allow the sea to flood the land and build new sea defences inland (low land value)
Do nothing	Leave land to erode/flood (v.low land value)

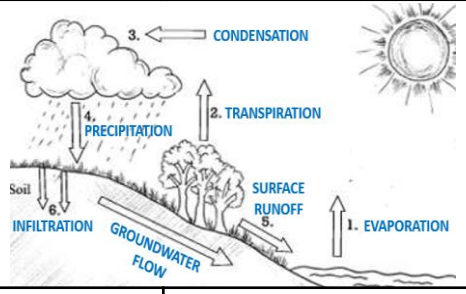
Example: West Dorset is located on the south coast of England. There is evidence of erosion along this coastline, due to:

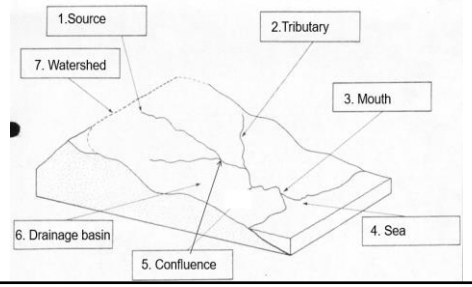
- *The underlying rock is clay, which is soft and erodes very quickly.*
- *The fetch is the distance the waves travel before they reach the coastline. In West Dorset, the waves travel over 4000 miles across the Atlantic = very strong destructive waves are common here.*

To reduce the risk of erosion they use a number of strategies:

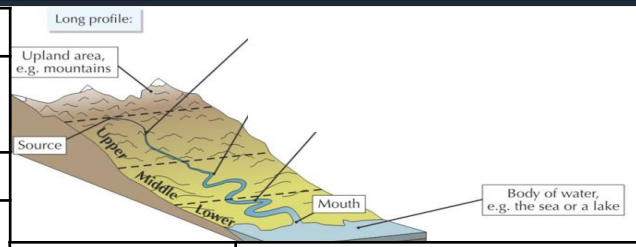
➢ At Lyme Regis in West Dorset a number of hard and soft engineering is used to protect the high value land. These include a sea wall, rock armour, groynes and beach nourishment.
These are very effective at reducing the rate of erosion with little evidence of new erosion at Lyme Regis.
On the other hand, they are very expensive and impact on the natural wildlife. Furthermore, the groynes prevent the transport of sediment along the coastline, which has caused mass movement further along the coastline.

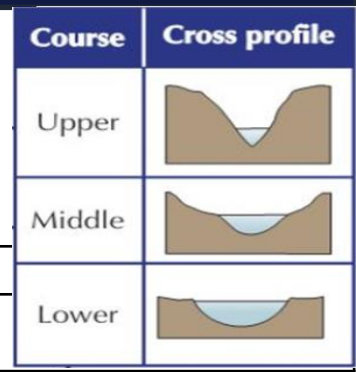
Evaporation	The sun heats up water. The water turns into a gas which rises up into the atmosphere .
Transpiration	The sun heats up water on the leaves of trees. The water turns into a gas which rises up into the atmosphere (air).
Condensation	As the water in the atmosphere rises, it cools and condenses to form clouds.
Precipitation	Water in the cloud falls to the earth's surface as rain, hail, sleet and snow.
Surface run-off	When the water runs off the surface of the ground as a river or stream.
Groundwater flow	When water flows through the rocks and soil underground.
Infiltration	When water enters a rock.





Drainage Basin	The area of land in which water drains into a specific river.
Watershed	The boundary of a drainage basin. It separates one drainage basin from another. It is usually high land.
Source	The point where the river begins.
Tributary	A stream or small river that joins a larger stream or big river.
Confluence	A point where two streams or rivers meet.
Mouth	The point where the river meets the sea or ocean.
Embankments	Raised river banks on either side of a river
Contour Line	Brown lines on an OS map that join up points of equal height. They allow us to determine slope gradient.
Flood	A flood occurs when there is too much water in the river channel. As a result water spills out onto the floodplain.
Flash Flood	Rapidly rising river levels leading to greater
Storm Hydrograph	Shows how a river changes after a storm and is used to predict floods
Lag time	The time (in hours) between the peak rainfall and peak discharge
Discharge	The volume of water in a river channel (measured in cumecs)

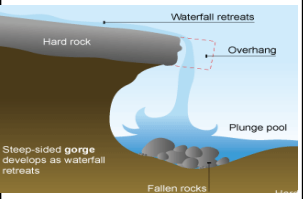




Long profile	Shows the gradient of a river along its course (from its source to its mouth).
Cross profile	Shows the shape of the river channel and valley. It shows a cross section of the river. It is an imaginary 'slice' across a river channel/valley at a specific point.
Upper course:	➢ Long profile: very steep gradient. ➢ Cross profile: Vertical erosion has created steep V shape valleys. The river channel is narrow and shallow. ➢ Landforms: *V shape valleys, waterfalls, gorge.*
Middle course:	➢ Long profile: medium gradient. ➢ Cross profile: Gentle sloping valley sides – formed by lateral erosion. Wider and deeper river channel.
Lower course:	➢ Long profile: flat gradient. ➢ Cross profile: Lateral erosion widens the river valley = very wide, almost flat valley. Widest and deepest river channel ➢ Landforms = *estuaries, floodplain, levees, meanders, ox bow lakes*
Erosion	The removal of rock by the river
Hydraulic Action	The force of water hits against the river channel and removes material. It is common with fast moving, high energy water.
Abrasion	Sediment carried by the river hits the river channel and removes material.
Corrosion	Chemicals in the water dissolve rocks (e.g. limestone)
Attrition	Stones carried by the river hit into each other, gradually making the rocks smaller and smoother. Rocks in the upper course are large and more angular than rocks in the lower course.
Weathering	The breakdown of rocks caused by the day-to-day changes in the atmosphere.
Freeze-thaw	Water collects in cracks. At night this water freezes and expands. The cracks get larger. In the day the temperature rises and the ice melts (thaws). The repeated freezing and thawing weakens the rock = breaks apart.
Transportation	Eroded material is carried by the river downstream.
Traction	Large particles roll along the river bed.
Saltation	Pebble-sized particles bounce along the river bed.
Suspension	Small particles (silt and clay) are carried in the water.
Solution	Soluble materials dissolve in the water and are carried along.
Deposition	Deposition takes place where a river does not have enough energy to carry sediment (its load). As a result it is dropped.

Landforms that have been created by erosion and weathering:

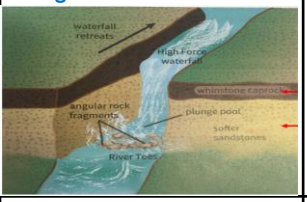
Waterfall



A steep fall of water in the upper course of a river.

- Waterfalls are formed when hard rock overlays softer rock.
- The softer rock is eroded more quickly than the harder rock creating a plunge pool and overhanging rock.
- Continued erosion makes the plunge pool deeper and overhanging rock becomes unstable.
- The overhanging rock collapses and the waterfall retreats upstream.

Gorge



A narrow steep sided valley that is usually found immediately downstream from a waterfall.

It is formed by the gradual retreat of a waterfall over hundreds or thousands of years.

What processes of erosion and weathering result in the formation of a waterfall and gorge.

➢ *You need to be able to identify and define each.*

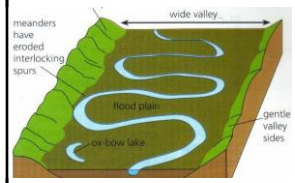
Interlocking Spurs

Interlocking spurs are a landform found in the upper course of the river, formed due to erosion and weathering.

- In the upper course, the river erodes vertically (downwards) creating steep valley sides.
- Weathering of the valley sides creates deep V shape valleys.
- The river in the upper course does not have enough energy to erode laterally and so flows around bands of more resistant rock
- These resistant hard rock creates ridges with jut out, creating spurs. These spurs overlap forming interlocking spurs.

Landforms that have been created by transportation and deposition:

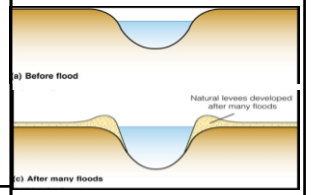
Floodplain



A wide, flat area of marshy land on either side of a river in the lower course of a river.

- Flooding is common in the lower course of a river.
- When a river floods, velocity decreases = energy decreases = deposition occurs.
- Layers of deposited fine sediment (e.g. silt/alluvium) build up on the valley floor, either side of the river creating a floodplain.
- The floodplain is made wider due to large meanders that wind across the floodplain.
- *Common landforms on a floodplain: levee, estuary, meander, oxbow lakes.*

Levee



A raised river bank found alongside a river in the lower course, caused by repeated flooding. They are natural embankments.

Flooding is common in the lower course of a river. When a river floods, velocity decreases = energy decreases = deposition occurs.

- Heavier, larger material is deposited first, next to the river bank.
- Lighter silt/alluvium is deposited further across the floodplain.
- Over time the height of the banks are raised by a build up of coarser sand deposits, creating levees.

Estuary

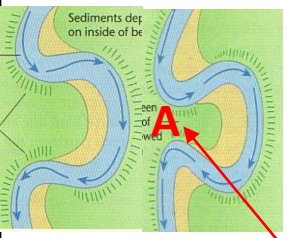
Is the wide part of a river, where the river meets the sea (mouth)

Estuaries are the transitional zone between the river & sea.

- The water flowing down the river meets water flowing up the river from the sea (during high tides). As the water meets, velocity decreases= energy decreases = lots of deposition.
- Due to deposition, salt marshes form creating habitats for wildlife.
- In some estuaries humans have made ports for industry.

Landforms that have been created by erosion and deposition:

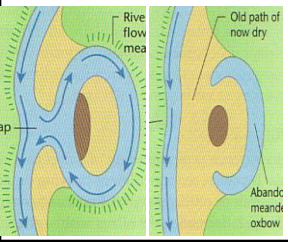
Meander



A meander is a bend in the river on the valley floor.

1. It starts with a slight bend.
2. Water moves faster on the outside of the bend and slower on the inside.
3. The fast water erodes the outside of the bend. The slower water deposits material on the inside of the bend.
4. Continued erosion and deposition makes the bend bigger.

Ox bow lake

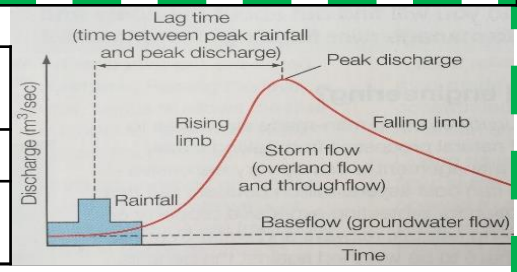


An oxbow lake is a U-shaped lake formed when a meander is no longer connected to a river

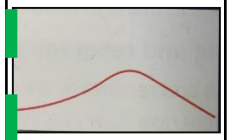
5. Continued erosion and deposition makes the meander bigger and the neck (A) narrows.
6. Eventually the neck breaks through and the water takes the most direct route, avoiding the meander
7. As less water is flowing through the meander, the energy is reduced = deposition. The meander is blocked off and an oxbow lake is created.

STORM HYDROGRAPH

Storm Hydrograph	A graph showing how a river reacts to heavy rainfall. It can be used to predict floods.
Lag time	The time between the peak rainfall and peak discharge
Discharge	The volume of water in a river channel (measured in cumecs).



NO FLOOD



- Trees in drainage basin intercept rainfall meaning there will be a longer lag time.
- Gentle rain will mean more water is infiltrated into the ground. Therefore it takes longer to reach the river channel = longer lag time.
- Permeable rock = more water infiltrated = takes longer to reach river.
- Dry soils = more water can infiltrate = takes longer to reach river channel
- Large drainage basins = water has to travel further to reach river = slower

FLOOD

- Deforestation = no trees to intercept rainfall = rainfall reaches river quickly = shorter lag time.
- Intense rain = too fast to infiltrate = more surface runoff = quicker to river = shorter lag time.
- Impermeable rock = rainwater not infiltrated = more surface runoff = quicker to river = shorter lag time. Impermeable surfaces are created when areas are ***urbanised*** (concrete).
- Steep slopes = quick transfer of water to river channel = short lag time

Hard engineering **Effective?**	**Using manmade, artificial structures to prevent erosion and flooding..** More effective, long lasting and need less maintenance than soft engineering, however more expensive and less natural/environmentally friendly.
Dam & Reservoir	A large wall is built across a river and a reservoir forms behind the dam. It is used to regulate river flow. The flow of water can be 'turned off' during periods of heavy rain. • Effective, long lifespan, used for irrigation, water supply, recreation and HEP. • Expensive, damage habitats, people have to relocate due to flooding.
Channel Straightening	Rivers are straightened by cutting through meanders to create a straight river channel. This speeds up the flow of water along the river. • Effective as water does not have time to build up, long lifespan. • Expensive, unnatural, damage habitats, result in flooding downstream.
Embankment	A raised riverbank (levee) which allows the river to channel to hold more water. • Effective, long lifespan, can look natural if covered in vegetation • Expensive, if concrete is used it is unnatural and unattractive.
Flood Relief Channel	A man-made river channel constructed to divert water in a river channel away from urban areas. • Effective as regulate river discharge (in heavy rain, relief channels are opened) • Expensive, it can destroy habitats while it is being constructed.
Soft engineering **Effective?**	**Using natural, environmentally friendly methods to prevent flooding.** Often cheaper than hard engineering however need more maintaining and have a shorter lifespan
Afforestation	Planting trees to create a woodland/forest • Trees slow down the movement of water into channels (longer lag time) = less likely to flood. Provides habitats. Cheap. • Less effective than hard engineering.
Wetlands	Where land next to rivers is left to flood. • Cheap, easy to maintain, create habitats, stores water so less in river channel. • Short lifespan, constant maintenance, beach is closed due it is being done.
Floodplain Zoning	Land is allocated for different uses according to its flood risk. Land closest to the river is used as parkland and land further from rivers is used for housing and industries. • Doesn't' stop the flood but reduces cost as infrastructure is not destroyed. • Flood is not stopped, is difficult to if the land has already been built on.
River Restoration	Returns a river to its natural state (e.g. remove channel straightening or a dam). • Cheap, easy to maintain, creates habitats, natural. • Flooding still occurs, less effective.
Planning & Preparation	Rivers are monitored to measure flood risk using satellites, instruments and computer models. The Environmental Agency issue alarms if a flood will happen. • People can prepare – sandbags around home, move valuable upstairs, evacuate, create emergency kits, • Flood still occurs, house prices can drop if deemed 'at risk'

An example of a recent extreme weather event in the UK: THE SOMERSET FLOODS

Where	Somerset, south-west England
Physical landscape	Somerset is low lying farmland. There are several rivers, including the Tone and Parrett, which flow into the Severn Estuary.
When	January and February, 2014
Why	350mm of rain in January and February (100mm above average), high tides, storm surges, rivers had not been dredged in 20 years and so were clogged with sediment
Social Effects	• 600 houses flooded. People in temporary accommodation for months. • 16 farms were evacuated • Villages (e.g. Moorland) were cut off by the floodwater. This meant residents could not attend school, work or shop. • Power supplies were cut off. • Local roads and railway lines were flooded.
Economic Effects	• Somerset County Council estimated the cost at £10 million. • 14,000 hectares of farmland under water for weeks = could not sell crops. • Over 1000 livestock had to be evacuated, which was very expensive for farmers and insurance companies. • Local roads and railway lines were flooded. These needed to be repaired.
Environmental Effects	• Floodwater contained sewage and chemicals which contaminated farmland. • Habitats were lost.

To reduce the risk of future floods, a £20 million Flood Action Plan was launched.

Dredging	In March 2014, 8km of the River Tone and the River Parratt were dredged. This is when material/soil/mud is removed from the river bed. As a result the river channel is larger and can hold more water. This prevents the river overflowing its banks.
Elevated roads	Roads have been elevated in places. As a result even if a flood occurs, people can still drive on the elevated roads. This also helps the economy by allowing import/export.
Flood defences	Settlements in areas of flood risk have flood defences. As a result they are able to protect themselves.
Embankments	River banks have been raised. These are called embankments. This means the river channel can hold more water and therefore it is less likely to overflow.

Contour lines tell us about the relief of the land (slope gradient). Contour lines are brown lines on an OS map. They join up points of equal height, shown on the lines.

They often show changes in height of 5 or 10 metres.

- Contours very close together = steep gradient (upper course – gorge)
- Contours far apart = flat land (lower course – floodplain)

http://www.bbc.co.uk/education/clips/zpxwq6f