Unit 1a
The Challenge of Natural Hazards

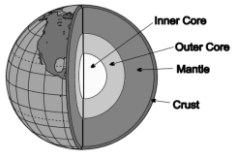
What are Natural Hazards?

Natural hazards are physical events such as earthquakes and volcanoes that have the potential to do damage to humans and property. Hazards include tectonic hazards, tropical storms and forest fires.

What affects hazard risk?

- Population growth
- Global climate change
- Location
- Wealth - LICs are particularly at risk as they do not have the money to protect themselves.

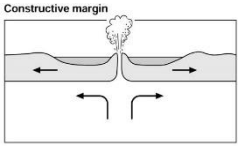
Structure of the Earth

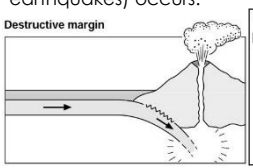


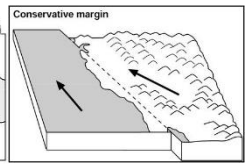
The earth has 4 layers
The core (divided into inner and outer), mantle and crust.

The crust is split into major sections called **tectonic plates**.
There are 2 types of crust: **Oceanic** (thin and younger but dense) and **Continental** (old and thicker but less dense).
These plates move due to convection currents in the mantle and, where they meet, tectonic activity (volcanoes and earthquakes) occurs.

Plates either move towards each other (**destructive** margin) away from each other (**constructive**) or past each other (**conservative**).







Effects of Tectonic Hazards - Primary effects happen immediately. Secondary effects happen as a result of the primary effects and are therefore often later.

Primary - Earthquakes	Secondary - Earthquakes
- Property and buildings destroyed. - People injured or killed. - Ports, roads, railways damaged. - Pipes (water and gas) and electricity cables broken.	- Business reduced as money spent repairing property. - Blocked transport hinders emergency services. - Broken gas pipes cause fire. - Broken water pipes lead to a lack of fresh water.
Primary - Volcanoes	**Secondary - Volcanoes**
- Property and farm land destroyed. - People and animals killed or injured. - Air travel halted due to volcanic ash. - Water supplies contaminated.	- Economy slows down. Emergency services struggle to arrive. - Possible flooding if ice melts Tourism can increase as people come to watch. - Ash breaks down leading to fertile farm land.

Responses to Tectonic Hazards

Immediate (short term)	Long-term
- Issue warnings if possible. - Rescue teams search for survivors. - Treat injured. - Provide food and shelter, food and drink. - Recover bodies. - Extinguish fires.	- Repair and re-build properties and infrastructure. - Improve building regulations - Restore utilities. - Resettle locals elsewhere. - Develop opportunities for recovery of economy. - Install monitoring technology.

Comparing Earthquakes – Nepal and Chile

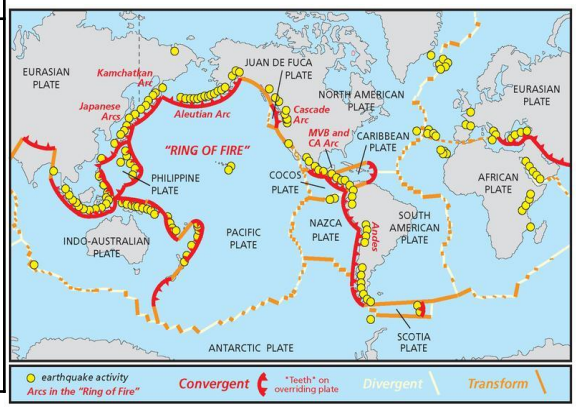
Nepal. April 2015. Magnitude 7.9.	Chile. Feb 2010. Magnitude 8.8.
Primary Effects	
9000 deaths 23000 injured Over 500,000 homes destroyed Historic buildings including Dharahara Tower fell 26 hospitals and 50% of schools destroyed	500 deaths 12, 000 people injured. 220,000 homes destroyed 53 ports and 56 hospitals destroyed Santiago airport badly damaged Most of Chile lost power and water supplies
Secondary Effects	
Avalanche on Mount Everest killing 19 people. Loss of income from tourism (which was 8.9% of Nepal's GDP). Rice seed stored in homes was ruined as homes collapsed. This caused food shortages.	1500km of roads damaged, mainly by landslides Triggered a Tsunami, which devastated several coastal towns Several Pacific countries were struck by Tsunami – warnings prevented loss of life.
Immediate Responses	
Nepal requested international help. UK's DEC raised $126 million. Red Cross- tents for 225,000 people. UN and WHO distributed medical supplies to the worst districts. Facebook launched a safety feature so people could indicate they were safe.	Emergency services reacted quickly. International help needed for field hospitals, satellite phones and floating bridges Temporary repairs made to Route 5 N-S highway within 24 hours. Power and water restored to 90% of homes within 10 days.
Long term responses	
Rebuilding. World Heritage Sites reopen June 2015. Longer climbing season.	Housing reconstruction plan to help rebuild 200, 000 affected homes. Strong economy rebuilt with little foreign aid

LICs suffer more than HICs from natural disasters because they are not as prepared and struggle to react effectively.

Volcanoes	Earthquakes
Constructive margins – hot magma rises between the plates e.g. Iceland. Forms *shield volcanoes*. **Destructive** margins – an oceanic plate subducts under a continental plate. Friction causes oceanic plate to melt, and pressure forces magma up to form composite volcanoes e.g. the west coast of South America.	**- Constructive** margins – usually small earthquakes as plates pull apart. **- Destructive** margins – violent earthquakes as pressure builds and is then released. **- Conservative** margins – plates slide past each other. They catch and then as pressure builds it is released e.g. San Andreas fault.

Distribution of tectonic activity:

- **Along plate boundaries.**
- **On the edge of continents.**
- **Around the edge of the Pacific.**

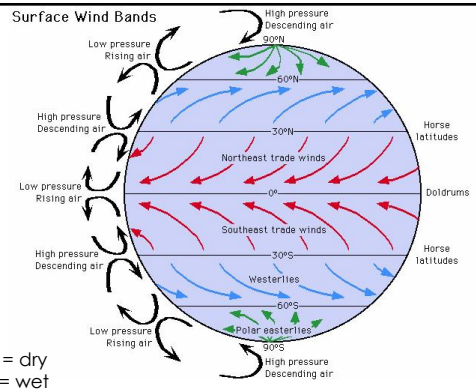


Reducing the impact of tectonic hazards

Monitoring	Prediction
Seismometers measure earth movement. Volcanoes give off gases.	By observing monitoring data, this can allow evacuation before event.
Protection	**Planning**
Reinforced buildings and making building foundations that absorb movement. Automatic shut offs for gas and electricity.	Avoid building in at risk areas. Training for emergency services and planned evacuation routes and drills.

Global atmospheric circulation

At the equator, the sun's rays are most concentrated. This means it is hotter. This one fact causes global atmospheric circulation at different latitudes.

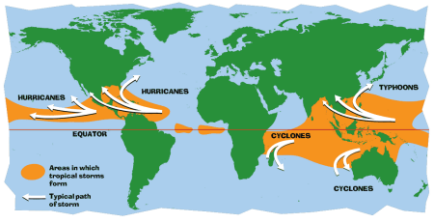


High pressure = dry
Low pressure = wet

As the air heats, it rises, causing *low pressure*. As it cools, it sinks, causing *high pressure*. Winds move from high pressure to low pressure. They curve because of the **Coriolis** effect (the turning of the Earth).

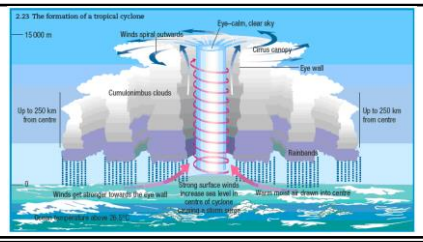
Tropical Storms

Occur in low latitudes between 5° and 30° north and south of the equator (in the tropics). Ocean temperature needs to be above 27° C. Happen between summer and autumn.



Sequence of a Tropical Storm

1. Air is heated above warm tropical oceans.
2. Air rises under low pressure conditions.
3. Strong winds form as rising air draws in more air and moisture causing torrential rain.
4. Air spins due to Coriolis effect around a calm eye of the storm.
5. Cold air sinks in the eye so it is clear and dry.
6. Heat is given off as it cools powering the storm.
7. On meeting land, it loses source of heat and moisture so loses power.



Climate change will affect tropical storms too. Warmer oceans will lead to more intense storms – but not necessarily more frequent ones.

Extreme weather in the UK

Rain – can cause flooding damaging homes and business.
Snow & Ice – causes injuries and disruption to schools and business. Destroys farm crops.
Hail – causes damage to property and crops.
Drought – limited water supply can damage crops.
Wind – damage to property and damage to trees potentially leading to injury.
Thunderstorms – lightening can cause fires or even death.
Heat waves – causes breathing difficulties and can disrupt travel.

UK weather is getting more extreme due to climate change. Temperatures are more extreme and rain is more frequent and intense leading to more flooding events. Since 1980 average temperature has increased 1 degree and winter rainfall has increased.

Typhoon Haiyan, Philippines, November 2013

Primary Effects	Secondary Effects
At least 6340 killed 314 km/hr wind speeds. 5m Storm Surge 90% buildings in Tacloban destroyed Habitats & Crops destroyed	$14 Billion of damage Water supply polluted 130,000 houses destroyed, leaving 4.2 million homeless Public Order – Looting Airports unusable for supplies
Immediate Responses	**Long-term Responses**
1,069 emergency shelters set up in public buildings. Disaster Emergency Committee helped 3,316,500 people outside these centres by providing aid. UK aid charities provided shelter, food and medical supplies.	UN appeal raised $300 million. Typhoon warning systems have been improved. People are now better educated about how to respond.

Prediction	Planning	Protection
Monitoring wind patterns allows path to be predicted. Use of satellites to monitor path to allow evacuation	Avoid building in high risk areas Emergency drills Evacuation routes	Reinforced buildings and stilts to make safe Flood defences e.g. levees and sea walls Replanting Mangroves

Somerset Levels flood, 2014

The Somerset levels consist of extensive low lying farm land surrounded by hills. The area is drained by several rivers including the River Tone and Parrett.

Social Effects

Over 600 homes flooded
16 farms evacuated
Residents evacuated to temporary accommodation for several months
Villages such as Moorland and Muchelney cut off (couldn't go to work or school)
Many people had power supplies cut off

Economic Effects

Caused £10 million damage.
Over 14, 000 ha of agricultural land underwater for 3-4 weeks
Over 1000 livestock evacuated
Local roads cut off by floods and the Bristol to Tauton railway line closed.

Environmental impacts

Floodwaters were heavily contaminated with sewage and other pollutants including oil and chemicals. A huge amount of debris has to be cleared. Stagnant water had to be re-oxygenated before being pumped back into rivers.

Management strategies

Met Office issued weather warning
Environment agency issued flood warning
Villagers used boats to go to the shops and to attend school.
£20 million Flood Action Plan launched:
-8km of rivers dredged and river banks raised
-Roads have been raised
Flood defences for vulnerable communities

Climate Change – natural or human?

Evidence for climate change shows changes before humans were on the planet. So some of it must be natural. However, the **rate** of change since the 1970s is unprecedented. Humans are responsible – despite what Mr Trump says!

Causes

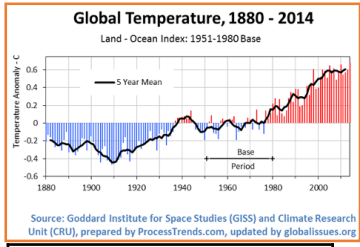
Natural	Human
- Orbital changes – The sun's energy on the Earth's surface changes as the Earth's orbit is elliptical its axis is tilted on an angle. **- Solar Output** – sunspots increase to a maximum every 11 years. **- Volcanic activity** – volcanic aerosols reflect sunlight away reducing global temperatures temporarily.	**- Fossil fuels –** release carbon dioxide with accounts for 50% of greenhouse gases. **- Agriculture –** accounts for around 20% of greenhouse gases due to methane production from cows etc. Larger populations and growing demand for met and rice increase contribution. **- Deforestation –** logging and clearing land for agriculture increases carbon dioxide in the atmosphere and reduces ability to planet to absorb carbon through photosynthesis.

Effects of Climate Change

Social	Environmental
- Increased disease eg. skin cancer and heat stroke. - Winter deaths decrease with milder winters. - Crop yields affected by up to 12% in South America but will increase in Northern Europe but will need more irrigation. - Less ice in Arctic Ocean increases shipping and extraction of oil and gas reserves. - Droughts reduce food and water supply in sub-Saharan Africa. Water scarcity in South and South East UK. - Increased flood risk. 70% of Asia is at risk of increased flooding - Declining fish in some areas affect diet and jobs. - Increased extreme weather - Skiing industry in Alps threatened.	- Increased drought in Mediterranean region. - Lower rainfall causes food shortages for orangutans in Borneo and Indonesia. - Sea level rise leads to flooding and coastal erosion. - Ice melts threaten habitats of polar bears. - Warmer rivers affect marine wildlife. - Forests in North America may experience more pests, disease and forest fires. - Coral bleaching and decline in biodiversity.

Managing Climate Change

Mitigation	Adaption
- Alternative energy production will reduce CO_2 production. **- Planting Trees** – helps to remove carbon dioxide. **- Carbon Capture** – takes carbon dioxide from emission sources is stored underground. **- International Agreements** e.g. the Paris Climate Agreement.	**- Changes in agricultural systems** need to react to changing rainfall and temperature patterns and threat of disease and pests. **-Managing water supplies** – eg. by installing water efficient devices and increasing supply through **desalination** plants. **- Reducing risk** from rising sea levels would involve constructing defences such as the Thames Flood Barrier or restoring mangrove forests, or raising buildings on stilts.



Evidence for Climate Change

The Met Office has reliable climate evidence since 1914 – but we can tell what happened before that using several methods.

Ice and Sediment Cores

- Ice sheets are made up of layers of snow, one per year. Gases trapped in layers of ice can be analysed. Ice cores from Antarctica show changes over the last 400 000 years.
- Remains of organisms found in cores from the ocean floor can by traced back 5 million years.

Pollen Analysis

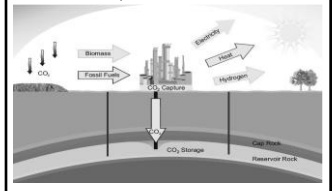
- Pollen is preserved in sediment. Different species need different climatic conditions.

Tree Rings

- A tree grows one new ring each year. Rings are thicker in warm, wet conditions
- This gives us reliable evidence for the last 10 000 years.

Temperature Records

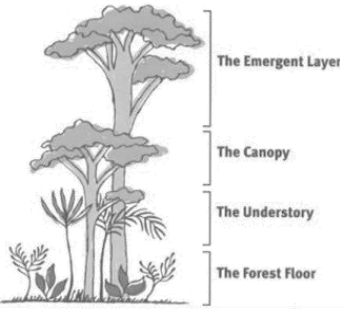
- Historical records date back to the 1850s. Historical records also tell us about harvest and weather reports.



Ecosystem - Key terms

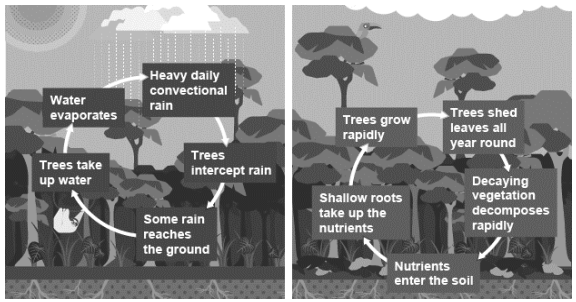
Key term	Definition
Ecosystem	A community of plants and animals that interact with one another and their physical environment.
Abiotic	Relating to non living things.
Biotic	Relating to living things.
Producer	An organism or plant that is able to absorb energy from the sun through photosynthesis.
Primary consumer	Creature that eats plant matter. Also known as a herbivore.
Secondary consumer	Creature that eats other animals. Also known as a carnivore.
Decomposer	An organism that breaks down dead plant and animal matter.
Food chain	The connections between different organisms that rely on one another as their food source.
Food web	A complex hierarchy of plants and animals relying on each other for food.
Biome	A large global ecosystem with flora and fauna adapting to their environment.

Tropical Rainforest - Vegetation

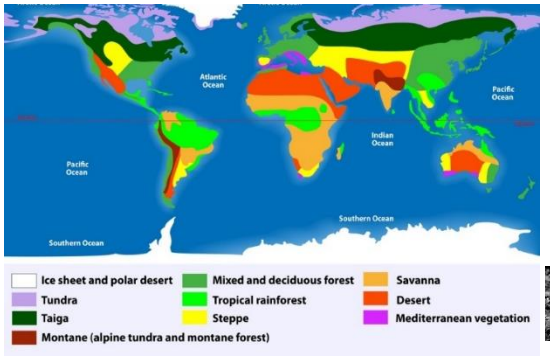


- Competition for light causes trees to grow fast. They are tall and straight. Buttress roots support these tall trees.
- Plants on the forest floor are shade tolerant and able to cope in the darker conditions.
- Epiphytes grow high up on the branches of trees to gain access to the light.
- Lianas wrap themselves around other trees to gain access to light.
- Plants have drip tips.

Water and Nutrient Cycle



Distribution of Biomes



Biome	Key Characteristics
Tropical Rainforests	•Along equator (Asia, Africa / South America). •6% of earth's surface. •25°C – 30°C and over 250mm rain per month.
Tropical Grasslands (Savanna)	•Between equator and tropics. •20 – 30°C and between 500 - 1500 mm of rain per year. •Wet and dry seasons.
Deserts	•Tropics (Sahara and Australia). •Over 30°C and less than 300 mmm per year rain. •20% of land's surface.
Deciduous forests	•Higher latitudes (W Europe, N America, New Zealand). •5 – 20°C and between 500 – 1500 mm rain per year. •4 distinct seasons. •Lose leaves in the winter to cope with the cold.
Coniferous forest (Taiga)	•60°N (Scandinavia / Canada). •Cone bearing evergreen trees. •No sunlight for part of the year.
Tundra	•Above 60°N (Arctic Circle). •Less than 10°C and less than 500mm per year rain. •Cold, icy and dry means 2 month growing season.

Effects of deforestation in the Amazon

Economic development

•Brings in jobs and income. •Destroys resources in the long term. •Livelihoods of locals destroyed. •2008 $6.9 billion from cattle. •Rubber tappers lost jobs. •Mercury from gold mining poisons fish.

Soil erosion

•Land left unprotected from heavy rain leads to landslides and flooding. •Nutrients are washed away decreasing nutrients in the soil. •Rivers silt up.

Contribution to climate change

•Trees cut down change the water cycle and make it drier. •Rainforests are the lungs of the earth and so when deforested there is more carbon dioxide in the air and less oxygen. •Burning also releases carbon dioxide into the air (Greenhouse effect).

Others

•Loss of biodiversity - 137 species a day. •Loss of indigenous tribes (90 since 1990). •Tribal people moving to towns and cities and have drugs and alcohol issues. •Loss of indigenous knowledge. •Conflicts between developers and indigenous people.

Protecting the Amazon

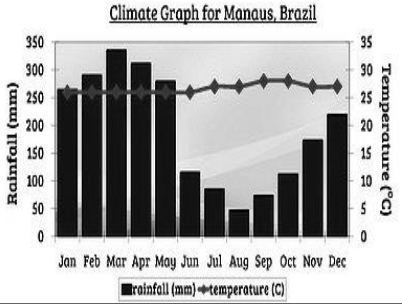
- Selective logging. Only fell fully grown trees. Mark sustainable trees for sale.
- Conservation & education. WWF (NGO) educate and train conservation workers. Buy threatened areas.
- Ecotourism. Minimises damage to the environment and benefits locals. This creates incentive to protect the forest.
- International agreements. International Tropical Trade Agreement restricts trade in hard woods.
- Debt reduction. In 2010 the USA converted $13.5 million from Brazil and used to protect forest.

Tropical Rainforest - Animals

- Jaguars have spotted fur. This camouflages them in the dappled shade of the forest floor.
- Parrots have strong, sharp beaks to help them crack open nuts.
- Spider monkeys have a prehensile tail that allows them to cling to branches. Sharp nails allow them to peel bark.
- Poison dart frogs are a bright colour to warn predators away.

Rainforest Climate

Temperatures are high all year (around 28°C).
Rainfall is around 250mm per month.



Unit 1b
The Living World

AQA

Causes of deforestation in the Amazon

Commercial farming	Farming to sell produce for a profit. Cattle and crops. Responsible for 80% of Amazon deforestation. Ruins soil and nutrients
Logging	The business of cutting down trees and transporting the logs to sawmills. Selective logging and clear felling. Teak and Mahogany worth the most.
Mineral extraction	The removal of mineral resources from the earth. Gold, Bauxite, Oil and gas. Pollutes rivers and air. Trees above the mines and quarries are removed.
Subsistence farming	A type of agriculture producing food and materials for the benefit only of the farmer and his family or community. Small scale, often slash and burn.
Hydro - electricity	Dams have been built and large areas of rainforest destroyed by flooding.
Resettling	Since 1970 1 million people have been encouraged to move away from shanty towns and into the rainforest. They have been given land which has been cleared to allow farming.
Roads	The 4000km long Trans Amazonia Highway built 1970s. Opened up rainforest, but allowed loggers in.

Trophic levels

Trophic Level	Source of Energy	Examples
Producers	Solar energy	Green plants, photosynthetic protists and bacteria
Herbivores	Producers	Grasshoppers, water fleas, antelope, termites
Primary Carnivores	Herbivores	Wolves, spiders, some snakes, warblers
Secondary Carnivores	Primary carnivores	Killer whales, tuna, falcons
Omnivores	Several trophic levels	Humans, rats, opossums, bears, racoons, crabs
Detritivores and Decomposers	Wastes and dead bodies of other organisms	Fungi, many bacteria, earthworms, vultures

At each (trophic) level of the food chain the number of individuals declines. This is because not all individuals in any trophic level are consumed (eaten). This means not all energy is passed up to the next trophic level.

Changes within ecosystems

If any component within an ecosystem is changed it will have a knock on effect on the rest of the ecosystem.
An example of where this happened was in Yellowstone National Park in the USA when they reintroduced wolves in 1995.

16 packs of grey wolves introduced. Each pack kills one elk a day.

Elk population falls from 20,000 to 10,000 in 8 years.

Competition from wolves results in decrease in coyote population.

More kills by wolves = more food for scavengers.

Increase in populations of grizzly bears, cougars, ravens, magpies and eagles.

Reduction in grazing pressure. Aspen and cottonwood regenerate. There is more tree cover.

Reduction in predation from coyotes leads to increase in mice and voles.

Increase in bank side trees stabilises river banks so there is less erosion. More woody debris in rivers creates pools and trout habitats.

Beavers create ponds and flooded areas, which promote growth of aspen.

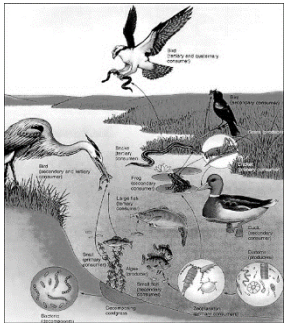
Regeneration of aspen attracts beavers, which begin to recolonise Yellowstone.

Increased tree cover provides habitats for birds.

Populations of predators of small rodents e.g. red foxes and birds of prey, increase.

Ecosystem - A question of scale

Ecosystems can be any size.
- Local e.g a pond or under a dead log. Also called a habitat.
- Regional e.g. the upland moorland of the Pennines in the north of England.
- Global e.g. tropical rainforest. Also called biomes.



A small scale ecosystem – (Pond) Lymm Dam

Producer – Water Lily
Primary Consumer – Water Worm
Secondary Consumer – Stickleback
Top Predator - Heron

Hot deserts NOT hot desserts

To be defined as a Hot Desert, there must be:
-Less than 250mm of rain a year.
- Diurnal temperatures ranging from 50°C during the day to 0°C at night.

Desert - Challenges

Extreme Temperatures
Temperatures are over 40 degrees during the day and drop below freezing at night.

Inaccessibility – The Sahara is huge making travel difficult and expensive.

Water Supply - low rainfall makes water for drinking, washing and agriculture difficult to supply.

Desert - Opportunities	Specific Detail
Mineral resources - mineral resources from the earth can be used by industry or sold for export.	Morocco is the world's largest exporter of phosphate which is used in fertilisers and batteries. The money gained can be used to develop the country.
Oil and gas - oil is trapped in huge aquifers deep underground. It is an extremely valuable resource.	Algeria is a leading exporter of oil and gets 60% of its income from the oil and gas industry. It has many huge oilfields e.g. Hassi Messaoud. The industry provides jobs for 40,000 people.
Solar energy - with 12 hours of cloudless sunshine every day, deserts are ideal locations for this form of electricity generation.	Tunisia is planning a huge development that will supply enough electricity to meet the needs of 2 million homes in Western Europe. Solar power does not contribute to global warming.
Tourism – deserts are remote, romantic and exotic locations for tourists.	You can go camel trekking in Morocco. Cities like Marrakech are popular with many tourists visiting the famous souk (market). Increasing opportunities for sand-boarding and dune buggies exist.
Farming - only possible where there is access to water through irrigation.	Egypt doubled the amount of land where crops were grown by building the Aswan Dam to control the flow of the Nile and irrigate the surrounding desert.

Desertification - Causes

Desertification is where land is gradually turned into desert, usually on the edge of a desert. It is caused by overgrazing by cattle or trees being cut down for firewood. Population growth is a key factor. Climate change will lead to more droughts that kill vegetation and cause the problem to spread.
In the area to the south of the **Sahara**, known as the **Sahel** heavy rainstorms can wash away the exposed soil in a couple of hours.

Desertification - Solutions

Irrigation - Water from aquifers used to grow crops / vegetation.

National Parks - Conserve areas at risk, protect wildlife.

Afforestation - Green wall being planted across the Sahel.

Crop rotation - Keeps nutrients in the soil by avoiding monoculture.

Appropriate Technology - Use of suitable crops, magic stones, terraces.

The Thar Desert – North West India and Pakistan – 200,000km²

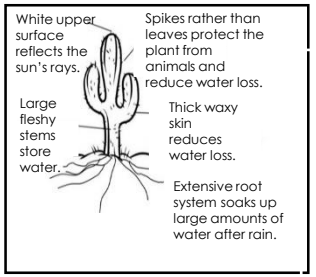
Opportunities
- Farming: Farm crops using irrigated water from the Indira Ghandi Canal; Farm camels and use their milk to sell (and for medicinal purposes)
- Mineral extraction e.g. gypsum, feldspar, phosphorite.
- Energy. Coal, Oil, Jaisalmer Wind Farm, Solar power.
- Tourism: Jaisalmer

Challenges
- Temperatures reach up to 50°C.
- Lack of roads, so many places only accessible by camel.
- Water is limited. Access water from ponds, the River Luni and the Indira Ghandhi canal (which revolutionised farming).

Desert plants

High temperatures should lead to rapid growth but this is not possible due to the lack of moisture. Vegetation is sparse and usually confined to water holes.

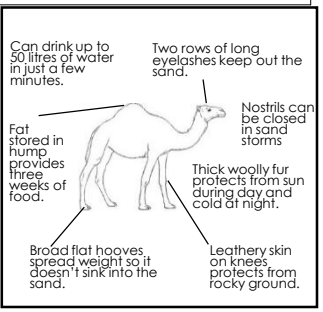
Lack of rainfall is the main limit on plant growth. Plants have thin leaves or spines to reduce water loss and long roots to reach deep underground water. The Cactus is a common desert plant.



Desert Animals

The limited number of producers means the number of consumers is also low.

Animals need to be able to tolerate the range of temperatures in the desert. Many do this by staying underground during the day. They also need to find ways to cope with the limited availability of water. Some gain enough water from their food. Others extract water from air.



Relief of the UK

Relief of the UK can be divided into uplands and lowlands. Each have their own characteristics.

Key

Lowlands	
Uplands	

Areas +600m: Peaks and ridges cold, misty and snow common. i.e. Scotland

Areas -200m: Flat or rolling hills. Warmer weather. i.e. Fens

AQA

Unit 1c Physical Landscapes in the UK

Types of Erosion

The break down and transport of rocks – smooth, round and sorted.

Attrition	Rocks that bash together to become smooth/smaller.
Solution	A chemical reaction that dissolves rocks.
Abrasion	Rocks hurled at the base of a cliff to break pieces apart or scraped against the banks and bed of a river.
Hydraulic Action	Water enters cracks in the cliff, or river bank, air compresses, causing the crack to expand.

Types of Transportation

A natural process by which eroded material is carried/transported.

Solution
Minerals dissolve in water and are carried along.

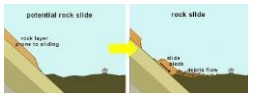
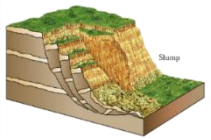
Suspension
Sediment is carried along in the flow of the water.

Saltation
Pebbles that bounce along the sea/river bed.

Traction
Boulders that roll along a river/sea bed by the force of the flowing water.

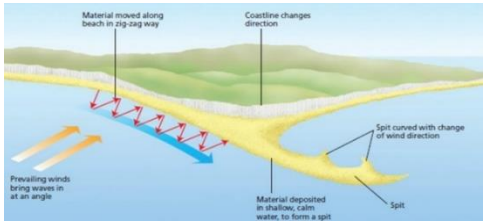
Mass Movement

A large movement of soil and rock debris that moves down slopes in response to the pull of gravity in a vertical direction.

Rock slides occur when there is a failure along the bedding plane.	
Slumping occurs when there is a downward rotation of sections of cliff. Often occur after heavy rain.	
Rockfall is the rapid free fall of rock from a steep cliff face because of gravity.	

Formation of Coastal Spits - Deposition

Example: Spurn Head, Holderness Coast.



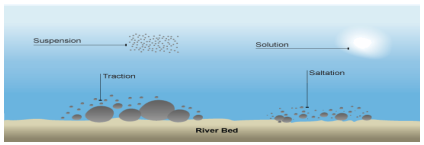
1) Swash moves up the beach at the angle of the prevailing wind.
2) Backwash moves down the beach at 90° to coastline, due to gravity.
3) Zigzag movement (Longshore Drift) transports material along beach.
4) Deposition causes beach to extend, until reaching a river estuary.
5) Change in prevailing wind direction forms a hook.
6) Sheltered area behind spit encourages deposition, salt marsh forms.

Types of Weathering

Weathering is the breakdown of rocks where they are.

Biological	Breakdown of rock by plants and animals e.g. roots pushing rocks apart.
Mechanical	Breakdown of rock without changing its chemical composition e.g. freeze thaw

What is Deposition?



When the sea or river loses energy, it drops the sand, rock particles and pebbles it has been carrying. This is called deposition. Heaviest material is deposited first.

Formation of Bays and Headlands

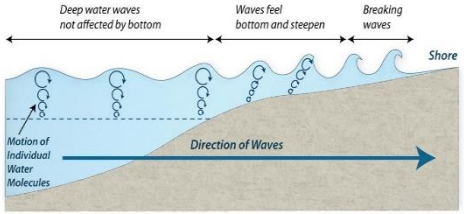
1) Waves attack the coastline.
2) Softer rock is eroded by the sea quicker forming a bay, calm area cases deposition.
3) More resistant rock is left jutting out into the sea. This is a headland and is now more vulnerable to erosion.

How do waves form?

Waves are created by wind blowing over the surface of the sea. As the wind blows over the sea, friction is created - producing a swell in the water.

Why do waves break?

1	Waves start out at sea.
2	As waves approaches the shore, friction slows the base.
3	This causes the orbit to become elliptical.
4	Until the top of the wave breaks over.



Mechanical Weathering Example: Freeze-thaw weathering

Stage One
Water seeps into cracks and fractures in the rock.

Stage Two
When the water freezes, it expands about 9%. This wedges apart the rock.

Stage Three
With repeated freeze-thaw cycles, the rock breaks off.

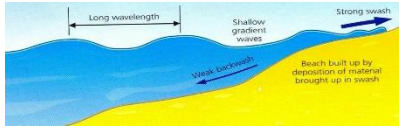
Size of waves

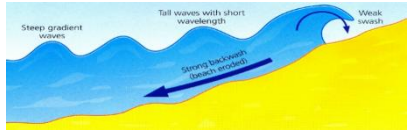
Affected by:

- The fetch (how far the wave has travelled);
- Strength of the wind;
- How long the wind has been blowing for.

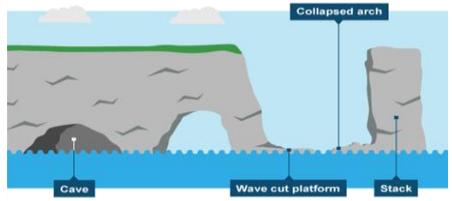
Types of Waves

Constructive Waves	Destructive Waves
This wave has a **swash that is stronger** than the backwash. This therefore builds up the coast.	This wave has a **backwash that is stronger** than the swash. This therefore erodes the coast.





Formation of Coastal Stack



Example: Old Harry Rocks, Dorset

1) Hydraulic action widens cracks in the cliff face over time.
2) Abrasion forms a wave cut notch between high tide and low tide.
3) Further abrasion widens the wave cut notch to from a cave.
4) Caves from both sides of the headland break through to form an arch.
5) Weather above/erosion below –arch collapses leaving stack.
6) Further weathering and erosion eaves a stump.

Coastal Defences

Hard Engineering Defences

Groynes	Wood barriers prevent longshore drift, so the beach can build up.	✓ Beach still accessible. ✗ No deposition further down coast = erodes faster.
Sea Walls	Concrete walls break up the energy of the wave . Has a lip to stop waves going over.	✓ Long life span ✓ Protects from flooding ✗ Curved shape encourages erosion of beach deposits.
Gabions or Rip Rap	Cages of rocks/ boulders absorb the waves energy, protecting the cliff behind.	✓ Cheap ✓ Local material can be used to look less strange. ✗ Will need replacing.

Soft Engineering Defences

Beach Nourishment	Beaches built up with sand, so waves have to travel further before eroding cliffs.	✓ Cheap ✓ Beach for tourists. ✗ Storms = need replacing. ✗ Offshore dredging damages seabed.
Managed Retreat	Low value areas of the coast are left to flood & erode.	✓ Reduce flood risk ✓ Creates wildlife habitats. ✗ Compensation for land.

Case Study: Holderness Coastline

Location and Background
Located on the North East coast of England, it has one of the highest rates of coastal erosion in Europe. The coast is made up of mainly Boulder clay, with a chalk headland to the north.

Geomorphic Processes
- 1.8m of land is lost to the sea every year.
- In Great Cowden, the rate of erosion is 10m per year due to management strategies further north.
- Longshore drift travels from south from Flamborough Head to Spurn Head, where it forms a spit.

Management
Over 11km of the coastline is managed:
- Mappleton – 450m of coastline protected, costing £2million. Two rock groynes create a beach and protect the town. Rock armour along the base of cliff absorbs wave power
- Hornsea – sea wall and groynes
- Withersea – sea wall, groynes and rock armour.

Middle Course of a River

Here the gradient get gentler, so the water has less energy and moves more slowly. The river will begin to erode laterally making the river wider.

Water Cycle Key Terms

Precipitation	Moisture falling from clouds as rain, snow or hail.
Interception	Vegetation prevents water reaching the ground.
Surface Runoff	Water flowing over the surface of the land into rivers
Infiltration	Water absorbed into the soil from the ground.
Transpiration	Water lost through leaves of plants.

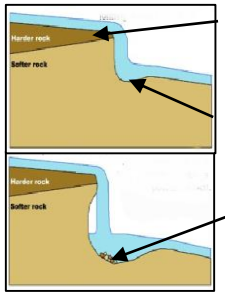
Physical and Human Causes of Flooding.

***Physical:* Prolong & heavy rainfall** Long periods of rain causes soil to become saturated leading runoff.	***Physical:* Geology** Impermeable rocks causes surface runoff to increase river discharge.
***Physical:* Relief** Steep-sided valleys channels water to flow quickly into rivers causing greater discharge.	***Human:* Land Use** Tarmac and concrete are impermeable. This prevents infiltration & causes surface runoff.

Upper Course of a River

Near the source, the river flows over steep gradient from the hill/mountains. This gives the river a lot of energy, so it will erode the riverbed vertically to form narrow valleys.

Formation of a Waterfall



1) River flows over alternative types of rocks.

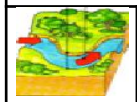
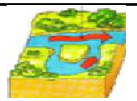
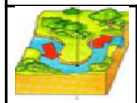
2) River erodes soft rock faster creating a step.

3) Further hydraulic action and abrasion form a plunge pool beneath.

4) Hard rock above is undercut leaving cap rock which collapses providing more material for erosion.

5) Waterfall retreats leaving steep sided gorge.

Formation of Ox-bow Lakes

Step 1	Step 2
 Erosion of outer bank forms river cliff. Deposition inner bank forms slip off slope.	 Further hydraulic action and abrasion of outer banks, neck gets smaller.
Step 3	**Step 4**
 Erosion breaks through neck, so river takes the fastest route, redirecting flow	 Evaporation and deposition cuts off main channel leaving an oxbow lake.

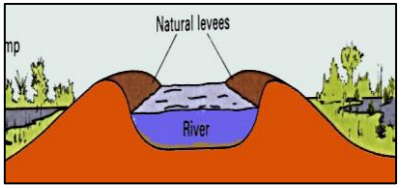
Formation of Floodplains and levees

When a river floods, fine silt/alluvium is deposited on the valley floor. Closer to the river's banks, the heavier materials build up to form natural levees.

✓ Nutrient rich soil makes it ideal for farming.
✓ Flat land for building houses.

Lower Course of a River

Near the river's mouth, the river widens further and becomes flatter. Material transported is deposited.



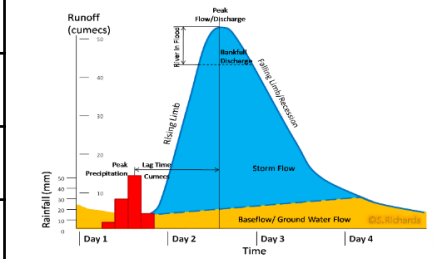
River Management Schemes

Soft Engineering	Hard Engineering
Afforestation – plant trees to soak up rainwater, reduces flood risk. **Demountable Flood Barriers** put in place when warning raised. **Managed Flooding** – naturally let areas flood, protect settlements.	**Straightening Channel** – increases velocity to remove flood water. **Artificial Levees** – heightens river so flood water is contained. **Deepening or widening river** to increase capacity for a flood.

Hydrographs and River Discharge

River discharge is the volume of water that flows in a river. Hydrographs who discharge at a certain point in a river changes over time in relation to rainfall

1. **Peak discharge** is the discharge in a period of time.
2. **Lag time** is the delay between peak rainfall and peak discharge.
3. **Rising limb** is the increase in river discharge.
4. **Falling limb** is the decrease in river discharge to normal level.



Case Study: The River Clyde

Location and Background
Flows 160km from the Southern Uplands in a North-west direction to the sea on the west coast of Scotland.

Geomorphic Processes
Upper – Features include V-Shaped valley, interlocking spurs at Crawford between 300-500m high. Waterfalls- The Falls of Clyde are 4 waterfalls near Lanark, the highest is Corra Linn at 27m high. A gorge has been formed here too.
Middle – Features include meanders between Motherwell and Glasgow and an ox-bow lake is forming in the New Lanark area.
Lower – Greater lateral erosion creates features such as floodplains & levees. Here the land is 5m above sea level. Mudflats at the river's estuary are exposed at low tide. The estuary is 3km wide.

Case Study - Boscastle flood August 16th 2004

Boscastle is a small village in Cornwall. It has a permanent population of under 1000. 90% of jobs in the village are linked to tourism.

Causes of flood - 5 hours of heavy rain (3 inches in 1 hour), Impermeable rock, steep valley sides, thin soils limit vegetation. Buildings narrowing river channel. Narrow bridges trapped debris.

Management Strategy - Scheme cost £4.6 million. River bed lowered by 6ft. Bridges widened. Car park raised by 5m. Trees removed from near river and planted up in the valley. River straightened.