

GCSE Geography revision guide

September 2023



How to use your revision guide

- It is important to plan your revision over a period of time (for example, several weeks) rather than leaving it to the last minute and rushing. Studies prove this is more effective than trying to remember everything in one go. Therefore it is a good idea to create a revision timetable.
- Revise a subject for a maximum of 45 minutes at a time.
- A good starting point is to check that you understand the **keywords** that are highlighted in bold in this revision guide.
- Effective revision techniques include creating flashcards and quizzes to test yourself, as well as mind maps and posters to summarise information. These are considered more effective than reading, highlighting, or copying out writing.

Course information

The GCSE Geography course (AQA 8035) is assessed by three exams at the end of Year 11.

Paper 1: Living with the physical environment	Paper 2: Challenges in the human environment	Paper 3: Geographical applications
1 hour 30 minute exam - 35% of GCSE	1 hour 30 minute exam - 35% of GCSE	1 hour 15 minute exam - 30% of GCSE
<ul style="list-style-type: none"> • Section A: The challenge of natural hazards • Section B: The living world • Section C: Physical landscapes in the UK 	<ul style="list-style-type: none"> • Section A: Urban issues and challenges • Section B: The changing economic world • Section C: The challenge of resource management 	<ul style="list-style-type: none"> • Section A: Issue evaluation • Section B: Fieldwork

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GCSE Geography Knowledge Organiser Paper 1 Question 1 – Hazards

Tectonic key terms

Tectonic hazard	Any hazard caused by the movement of the Earth i.e. earthquakes, volcanic eruptions and tsunamis.
Natural hazard	Has the potential to cause damage, destruction and death to humans.
Crust	The surface of the Earth. It is a rock layer split into tectonic plates.
Convection currents	Found in the mantle (the semi-molten layer below the crust). These cause tectonic plates to move.
Distribution of tectonic hazards	Earthquakes and volcanic eruptions are usually found in narrow bands on, or close to, tectonic plate margins.
Plate margin	Where two or more tectonic plates meet. There are three types of plate margin.
Destructive margin	Two plates move towards each other. The oceanic plate is more dense so subducts (is forced below) the continental plate.
Constructive margin	Two oceanic plates move apart, magma rises from the mantle to create new crust.
Conservative margin	Plates move past each other or slide by side at different speeds. Friction occurs and when pressure is released huge amounts of energy causes an earthquake.
Magnitude	The strength of an earthquake. Measured on a scale from 1-10.
Primary effects	Damage caused directly by the hazard e.g. deaths from buildings collapsing.
Secondary effects	Damage caused by the primary effects e.g. disease due to contaminated water.
Immediate response	Actions that take place immediately after a disaster e.g. rescuing survivors.
Long-term response	Actions that are taken a while after a disaster e.g. rebuilding.
Protection	Designing earthquake-proof buildings e.g. reinforced foundations.
Preparation	Educating the community how to behave e.g. earthquake drills.

Weather hazard key terms

Tropical storm structure	<ul style="list-style-type: none"> The centre of a tropical storm is called the eye (an area of light wind speeds and no rain). The eye wall surrounds the eye. This has very heavy rainfall and high winds over 100mph.
Tropical storm formation	Sea surface temperatures must be warm and over 27°C. The storm starts to spin due to the Coriolis effect (the natural rotation of the earth).
Storm surges	A large mass of water forced onto land by tropical storm winds.
Monitoring	Observing storms using satellites.
Prediction	Scientists use monitoring data to predict the path of a tropical storm so people can be evacuated.
Protection	Trying to reduce the damage caused by a tropical storm e.g. people removing trees near buildings.
Planning	Teaching the public what to do e.g. National Hurricane Preparedness Week in the USA.
Extreme weather	Severe weather that is unusual with devastating impacts for people e.g. heatwave, heavy rain.

Climate change key terms

Climate change	Changes to the climate due to an increase in the blanket of greenhouse gases in the atmosphere which traps heat escaping the Earth.
Greenhouse gases	Gases created by human activity causing climate change e.g. carbon dioxide (CO ₂), methane (CH ₄).
Orbital change	Orbit of Earth around the sun changes shape every 100,000 years - if closer to the sun = warmer climate. Natural cause of climate change.
Solar activity	if sun is hotter (more dark spots) then Earth's climate increases. Natural cause of climate change.
Volcanic eruptions	Dust ejected into atmosphere from volcanoes blocks sunlight and cools Earth.
Energy	Heating and power for homes and businesses that uses fossil fuels (oil, coal and gas) and release CO ₂ into the atmosphere. Human cause of climate change.
Transportation	Driving cars releases CO ₂ into the atmosphere. Human cause of climate change.
Deforestation	Cutting down trees which releases CO ₂ into the atmosphere. Human cause of climate change.
Mitigation strategy	Strategies that prevent greenhouse gases being released into the atmosphere.
Alternative energy	Renewable energy e.g. solar and wind which uses fewer fossil fuels. A mitigation strategy.
Planting trees	Trees absorb carbon dioxide and convert it into oxygen. A mitigation strategy.
Carbon capture	Stores carbon dioxide from power stations underground. A mitigation strategy.
Adaptation strategy	Adapting to impacts of climate change e.g. building barriers on the coast to prevent flooding from sea level rise.

Ecosystem key terms	
Climate	The average weather conditions taken over a long period of time (30 years +).
Weather	The day to day state of the atmosphere over a short period of time.
Ecosystem	A community of plants and animals living in a certain environment.
Biome	Very large ecosystems e.g. deserts, rainforests.
Biotic	Living things in an ecosystem.
Abiotic	Non-living things in an ecosystem.
Biodiversity	The variety of plant and animal life in an ecosystem.
Food chain	Shows how energy (food) is transferred between different elements in an ecosystem i.e. what eats what. Arrows show the flow of energy.
Producer	An organism that uses sunlight to produce food e.g. a tree.
Consumer	An organism that eats other living organisms (producers or other consumers).
Decomposer	Bacteria and fungi which break down dead producers or dead consumers.

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GCSE Geography Knowledge Organiser Paper 1 Question 2 – The living world

Tropical rainforest key terms	
Rainforest distribution	Distributed along the Equator in Asia, Africa and South America.
Biodiversity	The Amazon Rainforest is home to millions of species of plants and animals.
Carbon sink	Rainforests absorb CO2 and release oxygen so regulate global climate.
Rainforest climate	Climate is the same all year round. Temperature is above 25°C and rainfall is very high, around 2000mm a year.
Emergents	The tallest trees in a rainforest, up to 30m high to access the sun.
Buttress roots	These lie along the surface of the soil to gather nutrients and are large to anchor trees to the ground.
Lianas	Vines that grow up trees to reach the sunlight at the top.
Sloths	Sloths have large claws to hang in the trees all day and are active at night (nocturnal) to avoid predators.
Deforestation	The removal of a large area of forest.
Logging	Companies remove trees in the rainforest and then sell them for profit. A cause of deforestation.
Commercial farming	Forests are cleared to make way for huge ranches to graze cattle. Makes up 80% of rainforest destruction in Brazil. A cause of deforestation.
Sustainable management	Managing the rainforest to reduce impacts on biodiversity so that it lasts into the future.
Selective logging	Only older trees are removed and younger trees are left which helps to maintain the canopy and conserve natural habitats.
Ecotourism	Small numbers of tourists visit the rainforest to learn about its importance without harming the environment.
International agreements	<ul style="list-style-type: none"> Legal agreement between different governments to reduce illegal logging. The International Tropical Timber Agreement (2006) restricts trade of rainforest wood so it is difficult to sell illegally felled trees.

Hot desert key terms	
Hot desert distribution	<ul style="list-style-type: none"> Distribution is where something is located on a map. Hot deserts are distributed close to the Tropic of Cancer & Tropic of Capricorn.
Desert climate	Temperatures can exceed 40°C and rainfall is less than 250mm a year.
Nocturnal	Active at night e.g. a kangaroo rat in a hot desert.
Succulents	Plants that store water in their stem.
Transpiration	The transfer of water from vegetation (trees/plants) to the atmosphere due to heat.
Tap roots	Some desert plants have roots that can go 20 feet underground to access groundwater.
Desertification	A threat to deserts - land on desert fringes (edges) turns to desert.
Overgrazing	Too many cattle/sheep eat plants or grass faster than it can re-grow.
Over-cultivation	Farming too many crops in the same area throughout the year.
Soil management	Not overusing soil so it does not lose nutrients e.g. leaving land to rest after grazing animals.
Appropriate technology	Using cheap and easily available materials that are easy for local people to use e.g. solar cookers which use the sun's energy to heat food.

GCSE Geography Knowledge Organiser Paper 1 Question 3 – Coasts

Coasts key terms	
Upland landscape	Mountainous areas of high relief (steep land) made of resistant hard rock e.g. granite.
Lowland landscape	Areas of low relief and gently rolling hills made of soft rock.
Fetch	The distance of open water over which the wind blows.
Constructive wave	Have less energy, with a strong swash and weak backwash.
Destructive wave	Powerful, tall waves formed by storms - have a weak swash and a strong backwash.
Sediment	Loose rock that has been eroded.
Erosion	The breaking down and transport of rocks by water, ice or wind.
Transportation	The movement of sediment along a coastline by longshore drift .
Deposition	Sediment transported by longshore drift is dropped when there is low wave energy.
Weathering	Breaking down of rock in situ (staying in the same place) by water, wind or chemicals.
Freeze-thaw	Also known as mechanical weathering – ice breaks rocks apart.
Biological	Weathering of rock by plants and animals.
Chemical	Weathering of rocks by acid in rain.
Abrasion	Sediment thrown at a cliff by waves.
Hydraulic action	Water is forced into cracks in rock which compresses the air. When the wave retreats the compressed air blasts out which forces the rock apart.
Attrition	Sediment collides with other sediment to become smaller and more rounded.
Mass movement	The downward movement of rocks/soil from a cliff top under the influence of gravity
Slumping	A type of mass movement - slumping happens when rain soaks into soil which makes the saturated ground heavy.
Erosional landforms	Landforms created by erosion e.g. (crack), caves, arches, stacks and stumps (CCASS).
Headland	Resistant rock which is eroded slowly so it protrudes (sticks out) into the sea.
Bay	An area of land curved in shape which has been eroded between two headlands.
Discordant coastline	A coast with alternating bands of hard and soft rocks – headlands and bays.
Wave-cut notch	Formed at the bottom of a cliff when waves undercut it through erosion.
Wave-cut platform	A gently sloping rocky area left at the bottom of a retreating cliff.

Coasts key terms	
Depositional landforms	Landforms created by deposition e.g. beaches, spits, bars, sand dunes.
Longshore drift	<ul style="list-style-type: none"> The process of sediment being transported (moved) along a coast. Sediment is transported in a zigzag movement, carried by swash (waves move up the beach in the direction of the prevailing wind) and backwash (waves go back down the beach at right angles due to gravity).
Coastal spit	<ul style="list-style-type: none"> A long stretch of sand that stretches out to sea. Joined to the land at one end, the seaward end has a hook due to the wind.
Coastal bar	When a spit extends across a bay and connects two headlands/areas of coastline.
Sand dune	A small hill of sand found on a coastline created by the wind.
Hard engineering	Using solid, artificial structures to reduce erosion.
Groynes	Wooden or rock barriers built at right angles to the beach to prevent longshore drift.
Sea wall	A concrete wall curved at the top to deflect wave power.
Rip rap	Large boulders that force waves to dissipate (break) around them.
Gabions	Small wire cages filled with rocks stacked on top of each other to absorb the power of waves.
Soft engineering	Using smaller structures from natural resources to stop erosion.
Managed retreat	Naturally protecting coasts by flooding low land to create salt marshes which act as a natural barrier to waves.
Dune regeneration	Sand dunes are natural defences along a coastline. Dunes can be stabilised by planting marram grass.
Beach nourishment	Sand is added to build a larger beach which absorbs wave power.

GCSE Geography Knowledge Organiser Paper 1 Question 4 – Rivers

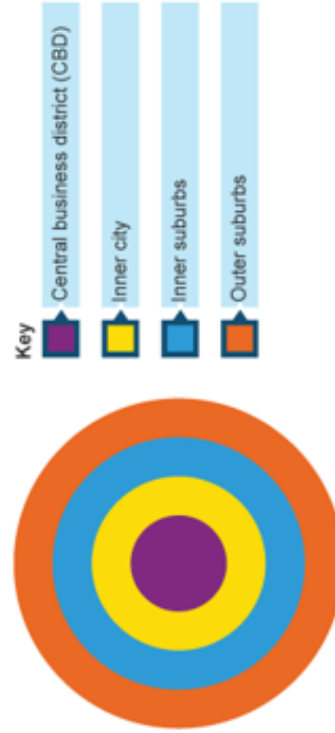
Rivers key terms	
Drainage basin	The land drained by a river and its tributaries (smaller rivers that run into a larger river).
Source	Where a river starts in the mountains.
Mouth	Where a river ends and meets the sea.
Upper course	The first stage of a river where it begins – the river channel is narrow and shallow.
Middle course	The river channel widens and deepens due to lateral (sideways) and vertical erosion.
Lower course	The river channel is very wide and deep.
Long profile	Diagram that shows the gradient (steepness) of a river from upper course to lower course.
Cross profile	Diagram that shows how a river channel becomes wider & deeper downstream.
Hydraulic action	Erosion - the force of water hitting the river bed (bottom) and banks (sides).
Abraision	Erosion - sediment hitting the bed and banks of a river channel.
Attrition	Erosion - sediment hitting each other causing it to become rounder and smaller.
Traction	Type of river transportation – large rocks are rolled along the river bed.
Saltation	Type of river transportation – small rocks are bounced along the river bed.
Suspension	Type of river transportation – light material is carried by the river.
Solution	Type of river transportation - river water is slightly acidic so dissolves some rock in the river.
Interlocking spurs	High land sticking out of steep valley sides in the upper course. An erosional landform.
Waterfalls	Erosional landform - formed along a river when a band of hard rock lies over soft rock.
Meanders	Bends in a river in the middle and lower course. The fastest velocity is on the outside bend.
Oxbow lakes	Old meander bends cut off by faster flowing water when it has flooded.
Levees	Raised riverbanks formed when rivers flood.
Estuary	A complex network of streams formed where a river meets the sea.
Floodplains	Wide, flat areas either side of the river in the lower course.
Precipitation	Rain, sleet or snow.

Rivers key terms	
Interception	Trees intercept (capture) precipitation so less water reaches rivers.
Transpiration	Loss of water vapour through plants.
Infiltration	Water soaking into the ground.
Surface runoff	Water runs off a surface into a river or drains.
Saturated	When the ground cannot hold any more water.
Geology	Geology (rock type) can make areas more likely to flood if there are impermeable rocks in an area (rocks/surfaces that cannot store water).
Relief	The steepness of land. Steep slopes = water will flow quickly downhill.
Urbanisation	More buildings and roads prevent infiltration of rain into the ground because impermeable surfaces increase surface runoff.
Deforestation	Cutting down trees – trees intercept rainfall and reduce surface runoff.
Hydrograph	Shows how a river responds to rainfall i.e. how quickly rainfall reaches a river.
Discharge	Hydrograph - volume of water which flows through a river in a given time measured in cubic meters per second (cumecs).
Lag time	Hydrograph - the difference between the time of heaviest rainfall and the point when the river contains the largest amount of water.
Rising limb	Hydrograph - shows the rising water after rainfall.
Channel straightening	Hard engineering - when a meander is straightened, widened and deepened.
Embankments	Hard engineering - raised (higher) river banks.
Dam	Hard engineering - barrier built across a river to reduce the flow of water.
Flood relief channels	Hard engineering - artificial river channels which divert water away from cities.
Floodplain zoning	Soft engineering - floodplains are divided into zones with areas near the river only used for activities which are less important like fields.
Flood warnings	Soft engineering - the Environment Agency warn the public of heavy rain in advance so they can prepare e.g. by moving valuables upstairs.
Planting trees	Soft engineering – more trees prevent rainwater from reaching rivers.
River restoration	Soft engineering - removing hard engineering e.g. channel straightening to restore the river back to its natural conditions.

GCSE Geography Knowledge Organiser Paper 2 Question 1 – Urban issues & challenges

Urbanisation key terms	
Urbanisation	An increasing number of people living in towns & cities / cities becoming larger.
Rural-urban migration	Migration from the countryside to a city.
Natural increase	When birth rates are higher than death rates.
Push factor	Something that forces a migrant to leave the countryside in search of a better life in an urban area e.g. a natural disaster.
Pull factors	Something that attracts migrants to move to an urban area from a rural area e.g. higher paid work.
Megacity	A city with a population over 10 million.
GDP	Gross Domestic Product - the value of all goods and services produced in a country in a year.
Formal sector	Jobs that are officially recognised by the government – workers are taxed, receive sick pay and holiday pay.
Informal sector	Jobs that are not officially recognised by the government – workers do not pay tax and may have no workers' rights.
Quality of life	The degree to which a person is healthy, comfortable, and able to enjoy life events.
National migration	People that migrate (move) within a country.
International migration	People that migrate (move) between countries.
Urban land use	What land is used for in a city.
CBD (Central Business District)	The most accessible part of a city – shopping centres, banks, and the main train/bus stations are found here.
Inner city	Industry/factories and terraced housing (a row of houses that occupy a street connected by a single wall on either side) is the main land use here.
Suburbs	Houses here are larger than inner city terraced houses and most have a garden. The suburbs are often home to commuters who need access to the CBD along main roads and railways.

Urbanisation key terms	
Commuter	A worker that travels from their home to their place of work in a different town/city.
Urban regeneration	Completely transforming (improving) a place in a city – an economic opportunity e.g. Liverpool ONE shopping centre.
Urban greening	Increasing the amount of green space in towns and cities.
Inequality	When some groups of people in society have more opportunities than others.
Greenfield site	Land that has not been built on before.
Brownfield site	Land that has been built on before.
Urban sprawl	When a city extends into the countryside – an environmental challenge.
Rural-urban fringe	An area of land found at the edge of a town or city where it meets the countryside e.g. Aughton in Liverpool.
Sustainable urban living	Improving the social, economic, and environmental conditions in a city to ensure a good quality of life for current and future residents e.g. East Village in London.



Development key terms

HIC	High Income Country – rich/developed countries
LIC	Low Income Country – poor/developing countries.
NEE	Newly Emerging Economy – a country that has an improving economy.
Development gap	The difference in development between HICs and LICs.
GNI (per capita)	Gross National Income (per person) - the total value of goods and services produced in a country in a year, including overseas investment. An economic measure of development.
Life expectancy	The average number of years a person is expected to live. A social measure of development.
Literacy rate	The percentage of people who can read and write. A social measure of development.
Infant mortality rate	The number of babies who die under one year old per 1,000 births a year.
HDI	Human Development Index – measures life expectancy, average years of schooling & GNI.
Demographic Transition Model	Graph with 5 stages that shows how changing birth rates and death rates affect population growth.
Primary products	Natural materials extracted from the land or ocean e.g. bananas, cocoa, oil, fish.
Landlocked	A country that is only bordered by land, with no access to the sea.
Colonialism	Control by a country over a different country e.g. European countries controlling of the African slave trade.
International migration	The movement of people from one country to another country.
Remittances	Money sent home by a migrant to their family in a different country.
Brain drain	Highly trained or qualified people migrating from a country to a different country.
FDI	Where a country or a TNC invests money in another country.
TNC	Transnational corporation - a company that operates worldwide.
Intermediate technology	Technology that is small-scale, easy to use and can be maintained/repaired by the local community e.g. the Afrikey handpump.
Aid	When a country or organisation donates money/resources to help a country develop.
Microfinance	A small loan given to people in poor communities.
Debt relief	When a LIC's debt is written off (they don't need to pay it back).
Fairtrade	Trade where producers (farmers) receive a guaranteed and fair price for their products.

GCSE Geography Knowledge Organiser

Paper 2 Question 2 – Changing economic world

UK key terms

Primary sector	Jobs that extract raw materials from the land or sea e.g. farming.
Secondary sector	Jobs manufacturing goods in factories.
Tertiary sector	Jobs that provide a service.
Quaternary sector	Jobs based on knowledge which involves technology, information, research, and development.
De-industrialisation	The decline in manufacturing (secondary) industry and the subsequent growth in tertiary and quaternary sectors.
Globalisation	The growth and spread of cultures, people, money, goods and information around the world.
Post-industrial economy	Where manufacturing industry declines and is replaced by growth in the service and quaternary sectors.
Science park	A group of scientific and knowledge-based businesses located usually associated with universities.
Business park	An area of land occupied by businesses.
North-south divide	The economic differences between the south and north of England. The south of England is wealthier than the north of England.
Commonwealth	A group of 53 countries, most of which were once British colonies under the rule of the British Empire between the late 16th and early 18th centuries.

GCSE Geography Knowledge Organiser
Paper 2 Question 3 – Resources
Paper 2 Question 6 - Energy

	Resources key terms
Resources	Anything that humans can use.
Social well-being	Similar to quality of life - the condition in which needs and wants of a given population are satisfied.
Irrigation	The large scale watering of crops.
Carbon footprint	Measures the impact human activities have on the environment in terms of the amount of greenhouse gases (carbon dioxide) they produce.
Food miles	The distance food travels from where it is grown to supermarkets.
Agribusiness	Farming on a large scale using pesticides and fertilizers to produce as many crops as possible.
Organic farming	Farms usually small in size producing food that does not use pesticides.
Water stress	When there is not enough water to meet demands of the population.
Water transfer	Schemes that would move water from reservoirs and rivers in areas of water surplus to areas of water stress.
Eutrophication	Growth of algae on rivers which can harm biodiversity. Caused by fertilizers from farms.
Legislation	Strict laws.

	Energy key terms
Energy mix	The different sources of energy used by households, industry and businesses.
Energy consumption	Use of energy.
Renewable energy	Energy that does not create direct air pollution and produces lower carbon emission than fossil fuels e.g. solar, wind, HEP.
Fossil fuels	Coal, oil and gas.
Biomass	Wood and other waste produce burnt to create heat energy.
Geothermal	Uses hot water and steam from deep underground to turn turbines. Often used in tectonic areas to heat water e.g. Iceland.
HEP	Hydro-electric power – uses the power of river water to generate clean electricity.
Fracking	Where water and chemicals are used to extract shale gas from rocks underground.
Energy conservation	The practice of reducing energy use e.g. insulating buildings, upgrading boilers, using solar panels, walking/using public transport instead of travelling by car.

List of all case studies and examples

- The specification sets out **14 examples** and **5 case studies** that you must learn for Paper 1 and Paper 2.
- **Examples** are small scale and will probably be taught within one lesson or less. Sometimes you must learn a **named example** which is usually regarding an event that happens regularly in a place so names are important to avoid confusion (e.g. Typhoon Haiyan 2013). Most of the time you will learn an **example** which is something that is more constant (e.g. a regeneration project in the UK).
- **Case studies** are at a much larger scale. They include a lot of content and will need several lessons to cover the material concerned.

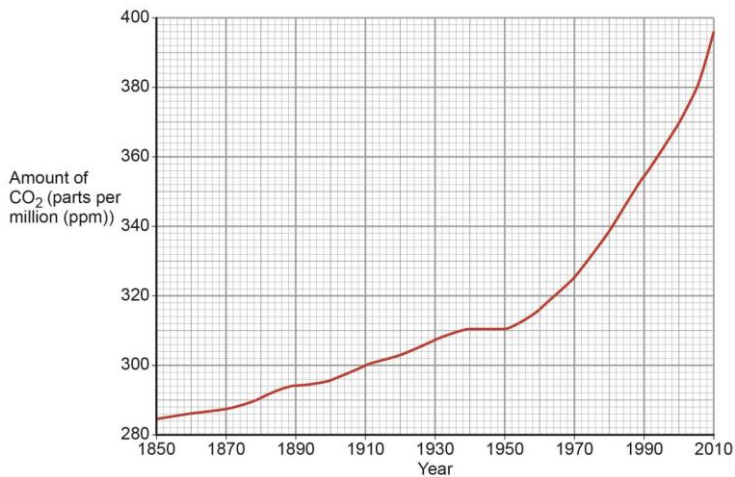
	The specification requires	Our example / case study
Paper 1	1. Named examples of a tectonic hazard (in two areas of contrasting levels of wealth)	L'Aquila (Italy – HIC) Kashmir (Pakistan – LIC)
	2. A named example of a tropical storm	Typhoon Haiyan 2013, Philippines
	3. An example of an extreme weather event in the UK	Cumbria floods, 2009
	4. An example of a small scale UK ecosystem	Epping Forest, Essex
	5. A case study of a tropical rainforest	Amazon Rainforest, Brazil
	6. A case study of a hot desert	Morocco in the Sahara Desert, North Africa
	7. An example of a section of coastline in the UK	Holderness Coast, East Yorkshire
	8. An example of a coastal management scheme in the UK	Mableton groyne scheme
	9. An example of a river valley in the UK to identify its major landforms of erosion and deposition	River Aire (Yorkshire)
	10. An example of a flood management scheme in the UK	Boscastle
Paper 2	11. A case study of a major city in an LIC or NEE	Rio de Janeiro, Brazil
	12. An example of urban planning (LIC or NEE)	The Favela Bairro Project, Rio
	13. A case study of a major city in the UK	Liverpool
	14. An example of an urban regeneration project (UK)	Liverpool ONE shopping centre
	15. An example of tourism reducing the development gap in an LIC or NEE	Tunisia
	16. A case study of an LIC or NEE that experienced rapid economic development	Nigeria
	17. An example of modern industrial development can be more environmentally sustainable	Nissan (in Sunderland)
	18. An example of fossil fuel extraction	Fracking (shale gas)
	19. An example of a local renewable energy scheme in an LIC or NEE	Micro Hydro Scheme, Ghandruk, Nepal

Geographical skills

Describing graphs

- Aim to give the overall trend of the graph first. Is there an overall increase or decrease?
- Always refer to data (numbers) on the graph – but make sure you are accurate. Using a ruler will help to read off correct figures. If the graph has a key, use it.
- If a graph exam question is more than two marks, comment on any anomalies (outlying data).

Study the graph showing changes in the amount of carbon dioxide (CO₂) in the atmosphere. Describe the change in the amount of carbon dioxide in the atmosphere shown in the graph (2 marks).



Model answer

Carbon dioxide levels increased between 1850 and 2010 (1 mark for the overall trend).

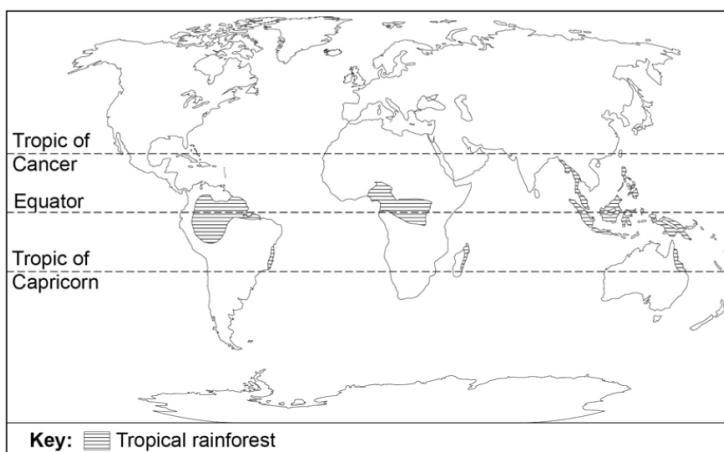
In 1850, the amount of CO₂ was 284 ppm but in 2010 was 396ppm, an increase of 112ppm (1 mark for accurate use of data from the graph).

Describing distribution

Distribution means **where** something can be found on a map. Use the three steps below to help you achieve all the marks available in an exam question:

- **General pattern** – what is the general pattern on the map?
- **Examples** – give at least one example from the map. You may need to show knowledge of compass directions e.g. northern Africa, eastern Europe.
- **Exceptions** (or anomalies) – give an example from the map that does not fit the general pattern.

Describe the distribution of tropical rainforests (2 marks)



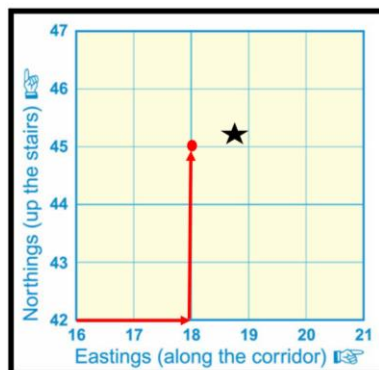
Model answer

Tropical rainforests are found on the Equator and between the Tropic of Cancer and Tropic of Capricorn (1 mark for the general pattern). There are large areas in (the north of) South America, central Africa and south east Asia (examples) (1 mark for correct examples). There are no rainforests in North America or Europe (exceptions).

Map skills - how to use grid references on Ordnance Survey (OS) maps

How to describe a location of the ★ using a 4 figure grid reference

1. Find the square where the is ★ located.
2. Starting from the bottom left corner of the grid, go **along the corridor** until you reach the **lower left** corner of the square the star is in. This number is our first reading (18).
3. Then starting from bottom left corner of the grid, go **up the stairs** until you reach the **lower left** corner of the square the star is in. This number is our second reading (45).

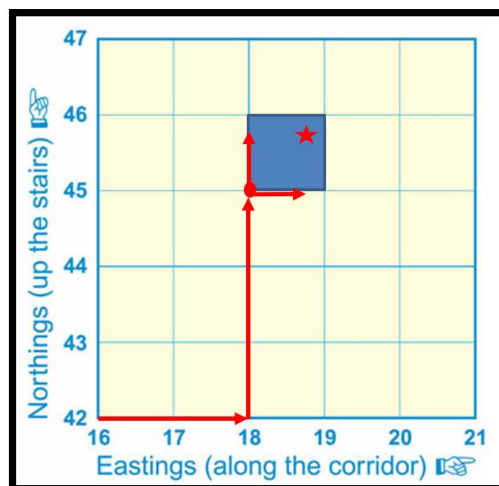


The 4 figure grid reference is **1845**.

A 6 figure grid reference can be used to give a more precise location on an OS map.

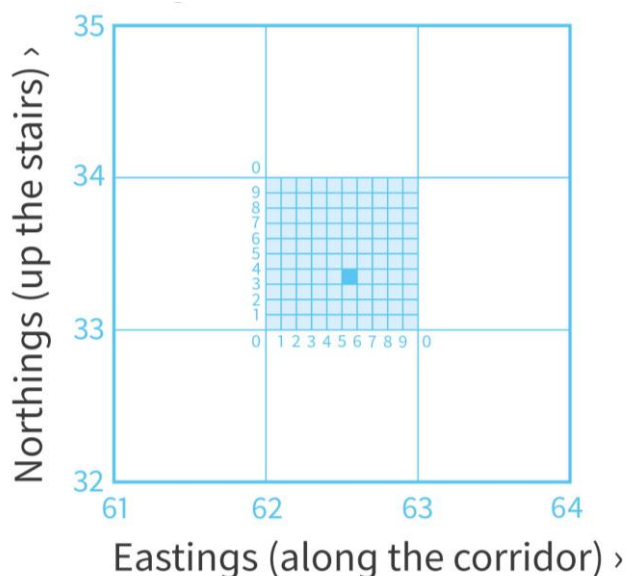
How to describe a location of the star using a 6 figure grid reference

1. Look at the square inside which the star is located.
2. Find the lower left (LL) corner of the square.
3. Starting from the bottom left corner of the grid, go along the corridor until you reach the lower left (LL) corner of the square the star is in. This number is our first reading (18).
4. Divide the **bottom part** of the square into 10 parts and go along the corridor from the lower left corner until you reach the star. Add one digit between 1 and 10 (it can be an estimate). In this example, 8 is the estimate.
5. Then starting from the bottom left corner of the grid, go up the stairs until you reach the lower left (LL) corner of the square the star is in. These are the next two numbers (45).
6. Divide the **left side** of the square into 10 parts and walk up the stairs from the lower left corner until you reach the star. Add one digit between 1 and 10 (it can be an estimate). In this example, 8 is the estimate.



4 figure grid reference – 1845

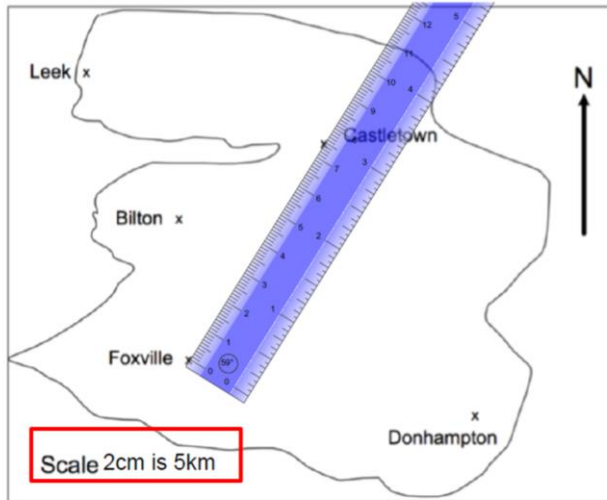
6 figure grid reference - 188458



The example on the left shows how a grid square can be divided into ten parts for a six figure grid reference.

Map skills - measuring distance

For this, **always** use a ruler and the map scale.



a) Work out the actual distance from Foxville to Castletown.

1. Measure the distance in cm

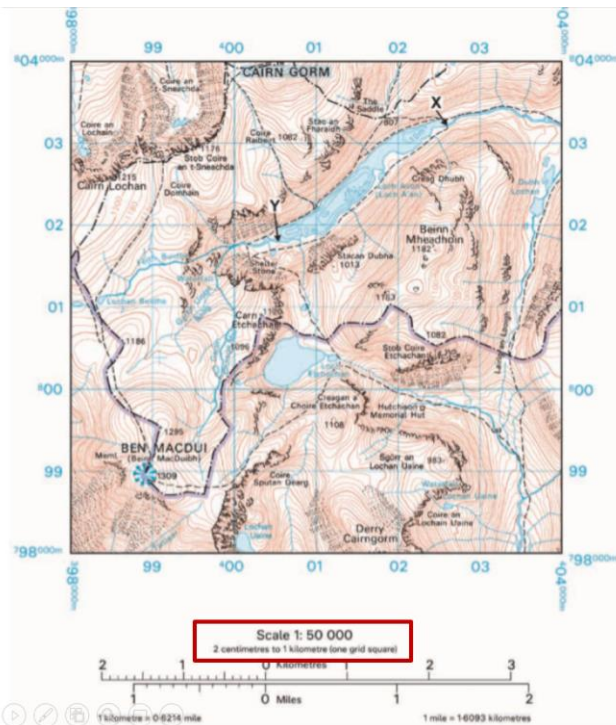
7.4cm

2. Use the scale to convert cm to km

5km / 2cm = 2.5

3. Calculate the distance

2.5 x 7.4 (cm) = 18.5 km



What is the distance between Point X and Point Y? (2 marks)

1. Measure the distance in cm

(in this example it is 4.2cm)

2. Use the scale to convert cm to km

(1km ÷ 2cm = 0.5)

3. Calculate the distance

0.5 x 4.2 = 2.1km

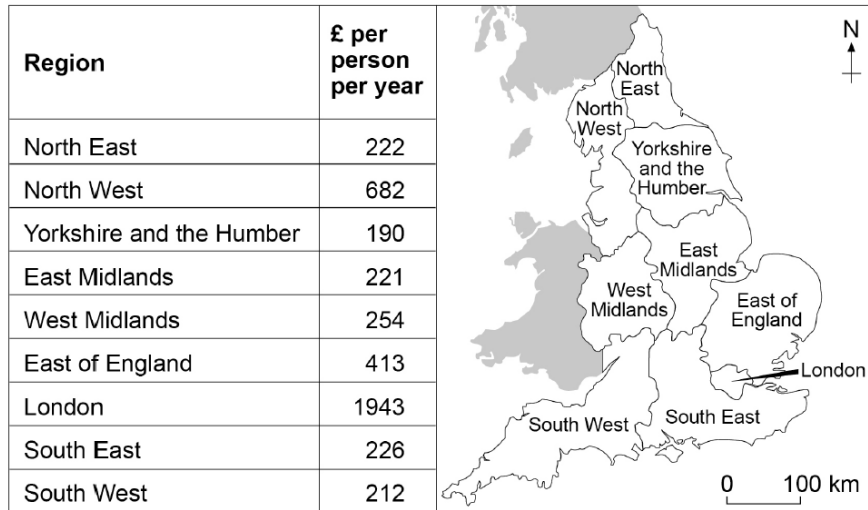
If the question states 'to the nearest kilometre', round the answer to the nearest whole number (in this case, the answer would be rounded down to 2km).

Numeracy (maths) skills

Calculating range

To find the range, subtract the lowest number from the highest number.

Study the figure below, information about the planned spending on transport infrastructure in England's regions 2016-2021.



Calculate the range of spending on transport infrastructure (£ per person per year).
Show your working. (2 marks)

Model answer

Highest number – 1943

Lowest number – 190

£1943 – £190 = £1753

This answer gains 2 marks - 1 mark for the correct answer (must have £ unit), 1 mark for correct working.

Calculating the mean (average) - add all numbers together, then divide by how many numbers there are.

Example - Calculate the mean for the numbers below. Show your working:

3, 3, 5, 2, 9, 8

$$30 \div 6 = 5$$

Calculating the median - the median is the middle number in a sorted list of numbers. The median is sometimes used instead of the mean when there are outliers that might skew the average of the values.

Example - Calculate the median for the numbers below. Show your working:

3, 3, 5, 9, 8, 4

Put the numbers in ascending order, then choose the middle number. If there are two middle numbers, add them together and divide by 2.

Numbers in ascending order... 3, 3, 4, 5, 8, 9

$$4+5 \div 2 = 4.5$$

Calculating mode - the number that is the most frequent.

Example – Calculate the mode from these numbers: 3, 3, 4, 5, 6, 6, 6, 11, 13, 17, 17, 23

The mode is 6 (because 6 is the most frequent number in the list as it appears 3 times).

Percentage change – the formula for this is the difference between the first and last numbers ÷ the original (first) number x 100.

Example - Calculate the percentage increase for car imports between 2012 and 2016. Answer to the nearest whole percentage. Show your working.

Year	Car imports (1000s)
2012	31
2013	33
2014	33
2015	39
2016	48

<p><i>Model answer</i></p> <p><i>Difference/original x 100</i></p> <p><i>48 - 31 = 17 (difference between the first and last numbers)</i></p> <p><i>17 ÷ 31 x 100 = 54.83.</i></p> <p><i>55% to the nearest whole percentage. Answers without working would also not achieve all the marks.</i></p>

Interquartile range

Lower quartile: put numbers in ascending order then find the lower quartile by using the formulae $\frac{n + 1}{4}$

Upper quartile: put numbers in ascending order then find the upper quartile using the formulae $\frac{3(n + 1)}{4}$

Interquartile range is the upper quartile subtract the lower quartile.

Pebble size is measured along the long axis.

Sample	Pebble size in centimetres
1	12
2	5
3	7
4	9
5	4
6	11
7	9
8	11
9	6
10	13
11	21

As part of an enquiry collecting primary physical geography data, a student measured pebble sizes at one location on a beach. The results are shown in the table.

Using the data in the table, calculate the interquartile range of the pebble size data. Show your working. (2 marks).

<p><i>Model answer</i></p> <p><i>4, 5, 6, 7, 9, 9, 11, 11, 12, 13, 21 (all 11 numbers in order)</i></p> <p><i>LQ = $\frac{11+1}{4} = 3$ (3rd value) so LQ is 6. UQ = $\frac{3(11+1)}{4} = 9$ (9th value) so UQ is 12.</i></p> <p><i>Interquartile range: 12 – 6 = 6cm</i></p>

Exam technique

Exam question command words

All exam questions will contain one command word (the word that tells you what to do). When you first read an exam question, underline the command word/s.

Assess/ Evaluate	<ul style="list-style-type: none"> • Use the PEEREEL structure. • Use evidence to determine the relative significance of something. Then, make a judgement about which factor is the most important. • Consider both sides of the statement / question. • You must write a conclusion. • Use connectives like: Firstly, secondly, on the other hand, although, in conclusion. <p>Tip: The higher mark questions on case studies and examples often have an assess/evaluate element, so it's a good idea to go back over your case studies/examples and figure out what your opinions are, and why you have these opinions (evidence).</p>
Define	<p>Say what the term means.</p> <p>Tip: These are usually worth 1 or 2 marks, so don't over-complicate it. Keep it simple, but avoid simply re-stating the term as part of the definition. For example, if you're asked to define 'development gap', don't say 'it's a gap in development'! A bit more detail is needed.</p>
Describe	<p>Describe what you can see from the resource or use evidence or data from the figure (if there is one). Do not explain/say why.</p>
Explain	<p>Say why by giving reasons. Use connectives (such as because, so, which, this means that) that force you to write an extended answer.</p>
Discuss	<p>Give both sides of an argument by presenting key points about strengths and weaknesses of an idea.</p>
Justify	<p>Give evidence for, or defend a decision. Select one of the options from those given and explain your reason for your choice. Use the resources given and your own knowledge / understanding. Consider the short / long term, the environment, economy and impact on people. Use connectives like: However, on the other hand, in the short/long term, overall.</p>
Outline	<p>Give the main points.</p> <p>Tip: Focus on giving the basic/central information. If you are asked to outline one thing be sure to do that (writing about more than one factor when you've been asked to write about only one is a waste of time as you'll only be credited for one idea).</p>
State / Identify	<p>For 1 mark, just give a reason. For 2 marks, extend your point (develop your basic point with some explanation / reasons why).</p>
Suggest	<p>This is similar to 'Explain' but you are not expected to know the exact answer - but you should be able to come up with some sensible reasons after three years studying GCSE Geography.</p>
To what extent	<p>Judge the importance or success of something e.g. a strategy, scheme or project. Has it been successful / unsuccessful to a great extent / to some extent / to a limited extent?</p>
Compare	<p>Identify similarities and differences. Use connectives like: However, in contrast, on the other hand.</p>

How exam answers are marked

1, 2 or 3 mark questions are 'point marked'. This means that each correct point/statement is awarded a mark. 4 mark questions and above are 'level marked' into level 1 (basic), level 2 (clear) or level 3 (detailed). 9 mark answers are assessed against the three Assessment Objectives (AOs) below:

AO1: Knowledge of location and places (includes use of relevant case study information / facts and figures)

AO2: Geographical understanding (answers that use connectives to fully explain ideas)

AO3: Applying understanding and making judgements (includes use of PEEREEL structure when relevant)

How to develop answers using connectives

To make your answers more detailed, use **connectives** to develop your points. Some examples are:

- so
- which
- this means that
- this leads to
- because

Explain how groynes protect a coastline from erosion (4 marks)

Example 1

'Groynes are wooden structures that are built at a 90 degree angle to the coastline. They prevent longshore drift.'

This is a basic level 1 answer (1 mark).

Example 2

*'Groynes are wooden structures that are built at a 90 degree angle to the coastline. They prevent longshore drift. **This means that** a bigger beach builds up on one side of the groyne'.*

This is a better answer which uses a connective but is still only level 1 (2 marks). The examiner does not know if the student fully understands how groynes work - what is longshore drift? Why is it important that a bigger beach builds up?

Example 3

*'Groynes are wooden structures that are built at a 90 degree angle to the coastline. They prevent longshore drift which is where material is transported along the coast by waves. **This means that** a bigger beach builds up on one side of the groyne **so** the power of the waves is reduced when they hit the beach, **leading to** slower rates of erosion'.*

This answer is clear and detailed and would be awarded level 2 (4 marks). The examiner can see that the student understands the idea of longshore drift, as well as the importance of a bigger beach.

How to answer an exam question using PEE

Example question: Explain how climate changes naturally (4 marks)

The information in the box below is taken from the revision guide. Your answer should be based on this but not copied directly as that does not show understanding. Two PEEs can be used to answer this question.

Solar output (sunspot theory) – the amount of radiation produced by the sun varies over time. Black areas on the sun can send more solar energy towards Earth which increases temperatures. Fewer sunspots were observed during the ‘Little Ice Age’ between 1645-1715. Crops failed and there were famines so many people died of hunger. The Black Death (bubonic plague) also killed many people and was probably made worse by the cold climate. Many farmers stopped growing wheat because it needs warm summers and replaced it with potatoes which thrive in cold and wet conditions.

Volcanic activity – large-scale volcanic eruptions eject huge amounts of ash into the atmosphere. This material can partially block out solar radiation, reducing global temperatures. For example, 1816 became known as the “Year Without a Summer” because of the effect on North American and European weather. Agricultural crops failed and livestock died in much of the Northern Hemisphere, resulting in the worst famine of the 19th century.

Model answer – 4/4 marks

P: One way climate changes naturally is solar output.

E: These are black areas on the sun that send more energy towards Earth.

E: This means that if there are more black areas on the sun, the temperature of the earth increases.

P: Another way climate changes naturally is volcanic activity.

E: Large volcanic eruptions eject ash into the atmosphere.

E: This means that ash can block out some of the sun which reduced temperatures on Earth.

Paper 1: Living with the physical environment

Question 1: The Challenge of Natural Hazards

Natural hazards and hazard risk

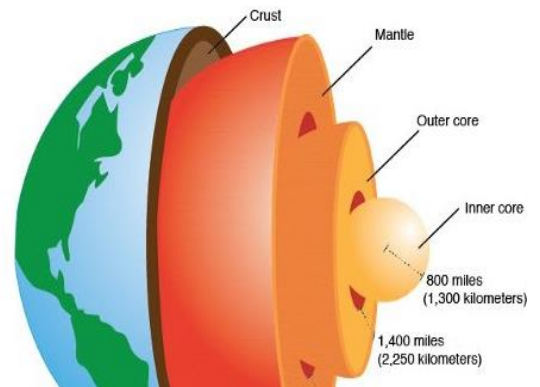
A **natural hazard** is a natural event which has the potential to cause damage, destruction and death to humans. **Hazard risk** is the probability that a hazard may take place. Risk is increased if:

- there is a high population density near the hazard (e.g. a highly populated city)
- there is an increase in the frequency (how often) and magnitude (strength) of the hazard
- a population is unable to cope with the hazard e.g. buildings are weak or the public and emergency services do not know how to deal with a hazard. This is more likely in LICs than in HICs.

Tectonic hazards – earthquakes and volcanoes

The Earth's structure

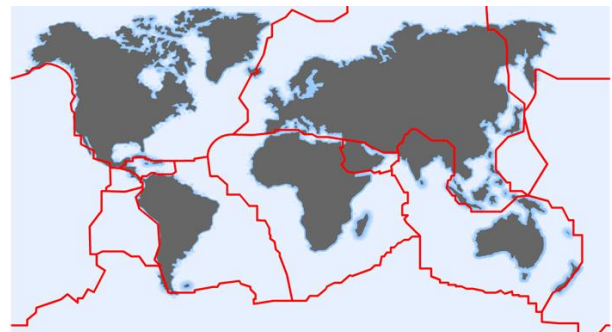
1. The **inner core** is in the centre and is the hottest part of the Earth. It is solid and made up of iron and nickel with temperatures of up to 5,500°C.
2. The **outer core** is the layer surrounding the inner core. It is a liquid layer, also made up of iron and nickel.
3. The **mantle** is the thickest section of the Earth at approximately 2,900 kilometres. The upper part of the mantle is called the asthenosphere. It is made up of semi-molten rock called magma.
4. The **crust** is the surface of the Earth. It is a rock layer forming the upper part of the **lithosphere**. The lithosphere is split into **tectonic plates**.



Tectonic plates move because of **convection currents** in the mantle. These are generated in the core through **radioactive decay** (where natural radioactive materials in the Earth's rocks break down, giving out heat and energy) and **residual heat** (left over when the Earth formed 4.6 billion years ago).

Distribution of tectonic hazards

- Earthquakes and volcanic eruptions are usually found in narrow bands on, or close to, **tectonic plate margins**. They are often found in the middle of oceans e.g. Atlantic, and along edges of continents e.g. west coast of South America. There is a strong pattern around the edges of the Pacific Ocean (the Pacific Ring of Fire).
- An anomaly/exception is that a few volcanoes can be found in more isolated clusters away from plate margins e.g. the Hawaiian Islands in the Pacific Ocean.
- Volcanoes occur at destructive and constructive plate margins. Earthquakes occur at all plate margins.



How earthquakes are measured

The strength of an earthquake is measured by its **magnitude** using a seismometer. The magnitude scale is between 1-10. The higher the number, the more severe the earthquake. The scales are logarithmic meaning each number on the scale is 10 times more powerful than the level below.

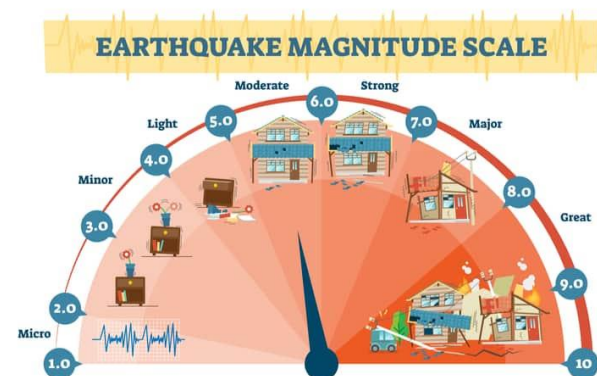
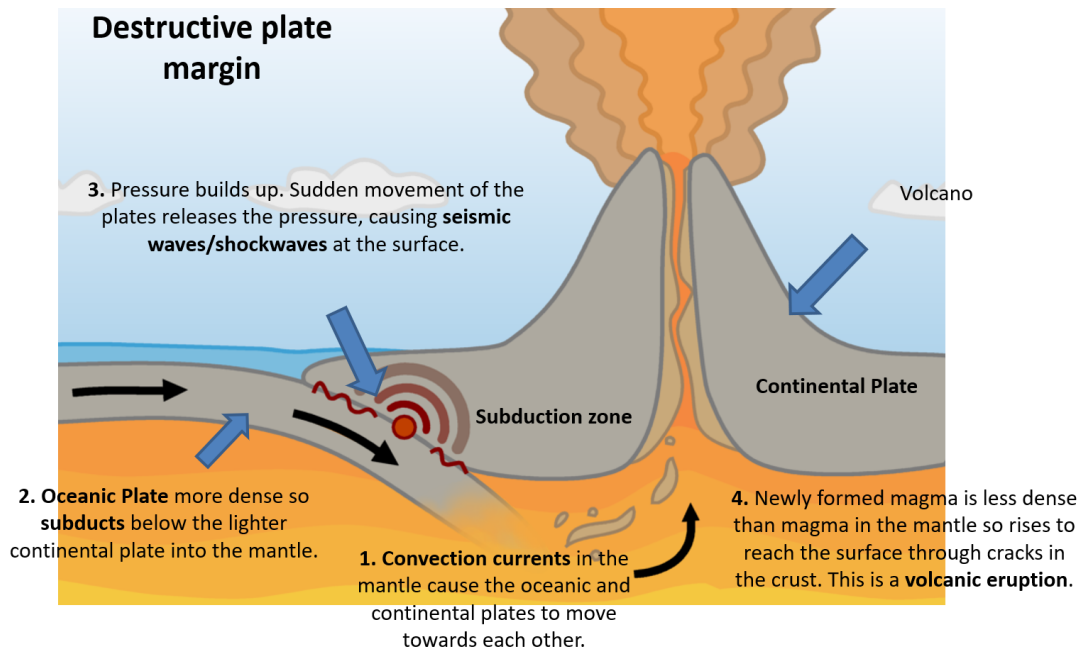
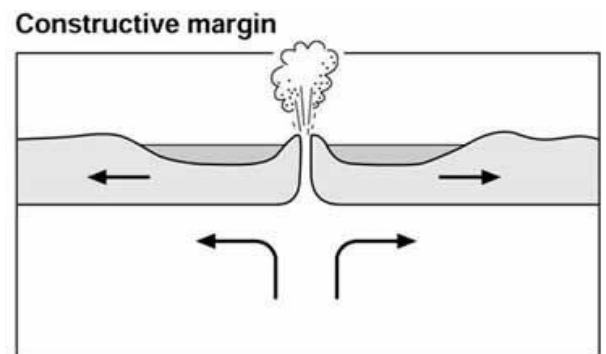


Plate margins

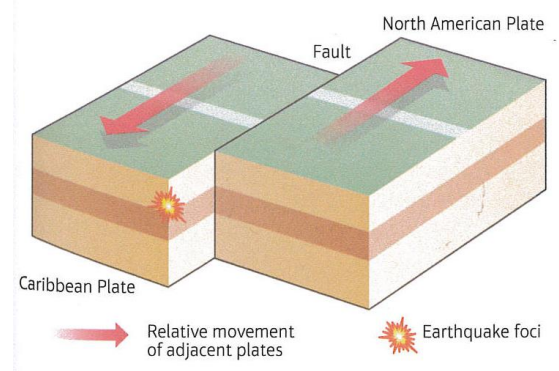
Plate margins are where two or more tectonic plates meet. There are three types of plate margin: destructive, constructive and conservative.



At a **constructive margin**, two oceanic plates move apart from each other and new oceanic crust forms in the gap created. Magma rises from the mantle between the two plates. As the magma cools it forms new oceanic crust. A well-known example of a constructive plate boundary is Iceland which is on the Mid Atlantic Ridge. Earthquakes at constructive plate margins are low magnitude.



At a **conservative plate margin**, the plates move past each other or side by side at different speeds. Friction occurs as plates try to move and become stuck. Pressure builds up because the plates are still trying to move. When the pressure is released, it sends out huge amounts of energy, causing an earthquake. There are no volcanoes at a conservative plate margin.



Earthquake effects and responses – how they vary depending on contrasting levels of wealth

- **Primary effects:** Physical damage caused by the hazard itself e.g. deaths from buildings and other structures collapsing.
- **Secondary effects:** damage caused by the primary effects e.g. fires caused by exploding gas pipes, disease that spreads due to contaminated water.
- **Immediate responses:** actions that take place immediately after a disaster.
- **Long-term responses:** actions that are taken a while after a disaster.

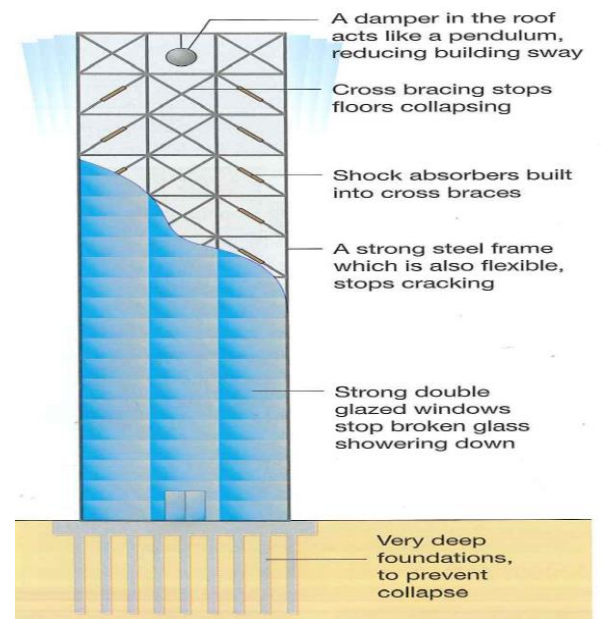
	L'Aquila (Italy) 2009 HIC 6.3 magnitude	Kashmir (Pakistan) 2005 LIC 7.6 magnitude
Primary effects	<ul style="list-style-type: none"> • 300 dead, mostly from collapsed buildings. • 1500 injured. • 10 000 buildings collapsed. 	<ul style="list-style-type: none"> • Entire villages destroyed and thousands of buildings collapsed killing 80,000 people. • 3 million made homeless. • Hundreds of thousands of people were injured. • Water pipes and electricity lines destroyed.
Secondary effects	<ul style="list-style-type: none"> • Aftershocks stopped the rescue efforts and caused more deaths. • A broken water pipe and aftershocks caused a landslide. • Businesses closed and workers were unemployed. 	<ul style="list-style-type: none"> • Landslides buried buildings and people, roads were blocked, electricity and phone lines were destroyed, and water supplies cut off. • Disease spreads due to lack of clean water and sanitation. • Freezing conditions in the winter caused even more deaths as people were still homeless. The cold winter also slowed rebuilding operations.
Immediate responses	<ul style="list-style-type: none"> • Rescue teams, the army and medical teams were sent to rescue people. • Camps set up for homeless people with water, food and medical care. • Money was provided by the government to pay rent and utility bills were suspended. 	<ul style="list-style-type: none"> • Rescue was difficult because of the freezing winter conditions. Help didn't reach some areas for days or weeks so survivors were rescued by hand without any help from the emergency services • Tents, blankets and medical supplies were issued by the USA / UK and the Red Cross, but not to all areas. • International aid was brought in as well as rescue teams from other countries.
Long term responses	<ul style="list-style-type: none"> • Residents not expected to pay tax in 2010. • Government gave discounts on educational equipment and transport. 	<ul style="list-style-type: none"> • Around 40,000 people have been relocated to a new town. Government money was given to people to rebuild their own homes. • New health centres have been built. • Training has been provided to build buildings, so they are earthquake resistant.

- More people died in Kashmir because the buildings were weaker, so more people were crushed by collapsed buildings. More people were homeless in Kashmir for the same reason.
- Kashmir earthquake was 7.6 magnitude (strength) whereas L'Aquila was 6.3 – so the Kashmir earthquake was significantly larger (by around 30 times).
- The responses were very slow in Kashmir because of the lack of emergency services and winter conditions.
- The government in L'Aquila had money to help people whereas the government in Kashmir were less able to help, this meant that the secondary effects were far more severe.
- More than 13 years on and many people in Kashmir are still living in tents. Only small numbers of houses are still incomplete in L'Aquila.

Reducing the effects of earthquakes

Protection – designing buildings or structures that will survive tectonic hazards. HICs can afford to build earthquake proof buildings that can withstand shaking. Features of these buildings include reinforced foundations and shock absorbers to prevent building collapse and automatic window shutters to prevent broken glass from causing injuries. Older buildings can be retrofitted – this is adding new technology to older buildings, such as strengthening the corners to reduce swaying.

Preparation – making plans and educating the community how to behave, for example earthquake drills in Japan. School children practice ‘duck, cover and hold’ – going under tables to protect their heads from falling objects. Emergency services practice rescuing people and the public may be advised by the government to keep emergency kits at home, including water, a torch, radio and food.



Why people live in areas of tectonic activity

Tourism: More than 100 million people visit volcanic sites every year. Residents who live near a volcano can take advantage of the job opportunities the tourist industry provides, for example working in hotels and shops, tour guides and taxi drivers. The revenue generated improves the economy of the country. Jobs are taxed by the government, and the tax money invested in improving the local area. For example, in LICs more funding could go towards improving schools and hospitals.

Farming: After volcanic eruptions, lava releases minerals after thousands of years which leaves behind fertile soil. This improves lives because the land can be farmed to provide a source of food and income which will improve the local economy.

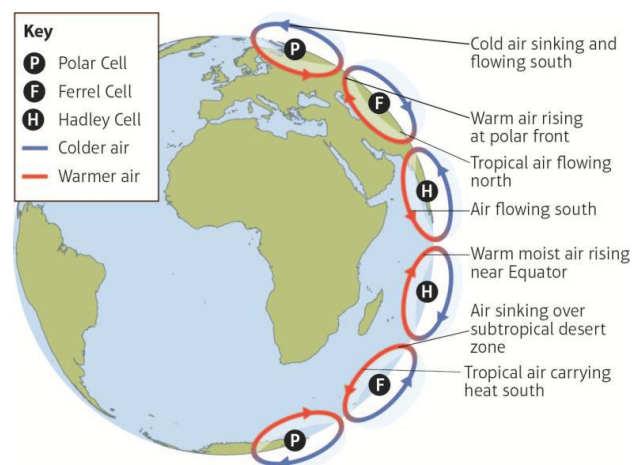
Geothermal energy: In volcanically active areas, geothermal energy is a major source of electrical power: steam is heated by hot magma in permeable rock, then boreholes are drilled into the rock to harness the superheated steam to turn turbines at power stations. It is renewable energy – it will not run out, and it will reduce greenhouse gases and the likely effects of climate change. Hellisheidarvirkjun (or Hellisheidi) power plant in Iceland is the second largest geothermal power station in the world and provides electricity and hot water for the capital city, Reykjavik as well as approximately 30 per cent of Iceland’s total electricity.

Weather hazards

Global atmospheric circulation

Pressure belts – between the two Hadley cells, air at the Equator is heated so it rises in low pressure conditions (warm air is lighter so can easily rise, low pressure refers to low weight of the air). The air flows towards the North and South Poles. As warm air rises it cools and condenses to form clouds. **Low pressure** therefore causes rain. When the air reaches 30 degrees north and south of the Equator (between the Ferrel Cell at the Hadley Cell), it has cooled so sinks back towards the Earth under **high pressure** (the air is colder so is heavier therefore high pressure). High pressure weather brings dry and clear skies because clouds cannot form here.

Surface winds – wind is formed as air moves from high to low pressure areas. Because the Earth rotates, the air does not flow in a straight line. As the air moves above the surface of the Earth, underneath the planet continues to rotate so winds follow a curved path. This is called the Coriolis Effect. Surface winds bend to the right in the northern hemisphere and to the left in the southern hemisphere.



Tropical storm distribution

Tropical storms are large areas of **low pressure** that form over warm tropical oceans, and usually occur within a band between 23.5 degrees north to 23.5 degrees south of the equator (between the Tropics of Cancer and Capricorn) in the Atlantic, Indian and Pacific oceans. Tropical storms are also known as hurricanes, cyclones and typhoons in different parts of the world. Tropical cyclone wind speed is measured by the **Saffir-Simpson scale** (categories 1-5).



Tropical storm structure

- The centre of a tropical storm is called the **eye**. The eye is usually 25-40 miles across. It is an area of light wind speeds and no rain.
- Huge cumulonimbus clouds surround the eye known as the **eye wall**. These are caused by warm moist air condensing as it rises and leads to very heavy rainfall and high wind speeds over 100mph.

Tropical storm formation

1. Sea surface temperatures must be warm and over 27°C.
2. Heating causes evaporation on the surface of the water. Warm air rises and condenses quickly to create a thunderstorm.
3. Several thunderstorms move and cluster together. A low wind shear is needed, otherwise the storm will be ripped apart by the wind.
4. The storm starts to spin due to the **Coriolis effect** (the natural rotation of the earth).
5. The warm water acts as fuel for the tropical storm which will start to **dissipate** (lose energy) when it reaches land, or if it moves into areas of colder water under 27°C.

Physical hazards created by tropical storms

- **High winds** uproot trees and damage or destroy poorly built structures.
- **Intense rainfall** – tropical storms pick up large amounts of water as they move over the ocean which results in a large release of rain, causing **coastal flooding**.
- **Storm surges** – the large area of low pressure causes sea levels to rise. Combined with high winds, a large mass of water can be forced towards land by the power of wind. Storm surges destroy habitats, coastal defences and can contaminate farmland and freshwater lakes.
- **Landslides** – high levels of rain **saturates** soil quickly which make it heavy and, in areas with steep slopes, can cause landslides causing devastation to settlements at the base of the slope.

Typhoon Haiyan (Philippines, 2013)

In November 2013, Typhoon Haiyan hit the Philippines. This was a category 5 storm (the largest type on the Saffir-Simpson scale). 400mm of rain fell in 1 day and winds were up to 314km/hr.

Primary effects	<ul style="list-style-type: none"> • 6190 people were killed by the floods or collapsing buildings. Strong winds destroyed 1.1 million homes. • The airport was damaged, and roads were blocked by fallen trees. • The storm destroyed 1.1 million tonnes of rice crops worth \$53 million.
Secondary effects	<ul style="list-style-type: none"> • Because so many homes were destroyed, 4.1 million people were made homeless. • Diseases spread as waste and rubbish were dumped everywhere by the floodwaters. • An oil barge crashed into the coastline and destroyed large areas of animal habitats. The oil spill polluted the water so fishing could not take place.
Immediate responses	<ul style="list-style-type: none"> • A TV warning before the typhoon arrived allowed 800 000 people to be evacuated. • \$1.5 billion in aid was received from other countries. • Survivors were sheltered in an indoor stadium and medical supplies were distributed.

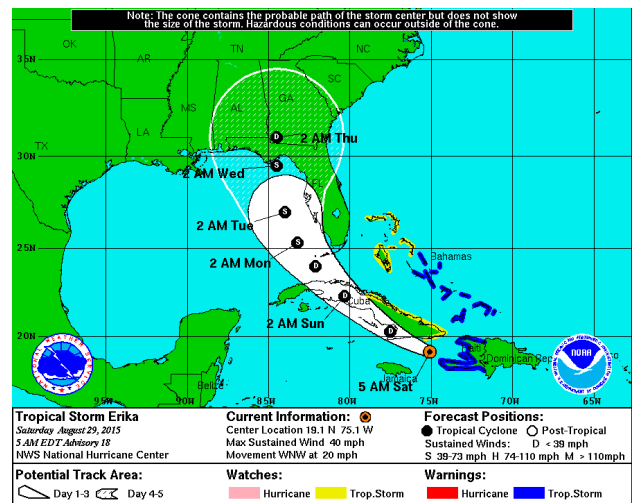
Long term responses	<ul style="list-style-type: none"> • \$88 million was raised from public donations after Coca-Cola and X Factor raised awareness. • A new storm warning system was built to protect against future storms. • A large ditch was built next to the highways so water could be channelled away from roads in future storms. • 'Build back better' scheme by the government – a plan to rebuild Tacloban (the affected city) better than it was before.
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Reducing the effects of tropical storms

Monitoring: Observing storms so we can learn about them and make predictions about where they will go. Satellites are used to measure the height of a storm and follow it across the ocean. This means that warnings can be given and people who live in the path of a tropical storm can evacuate which will save lives.



Prediction: Knowing when and where a tropical storm will be. Scientists use data collected from monitoring to generate computer models. These models predict the most likely path of a tropical storm so that the people who live in the area can be warned. In 2013, Cyclone Phailin hit India but it was predicted in time for 1.2 million people to be evacuated. This saved many lives. In the end, only 21 died. For comparison, a similar size storm hit the same area in 1999 and 10 000 people died.



Protection: Building something to reduce the damage caused by a tropical storm. For example, FEMA in the USA advise people to remove trees near buildings. This means that fewer houses will be damaged or destroyed by falling trees caused by the high wind speeds. Sea defences can be built on the coast to protect from floods caused by storm surges, and many home-owners board up their windows and place sandbags outside external doors to prevent flooding.

Planning: Teaching the public what to do in the event of a tropical storm. In the USA, there is a National Hurricane Preparedness Week every year. If people make disaster supply kits then they are more likely to survive if they are made homeless by a tropical storm.

Climate change and tropical storms

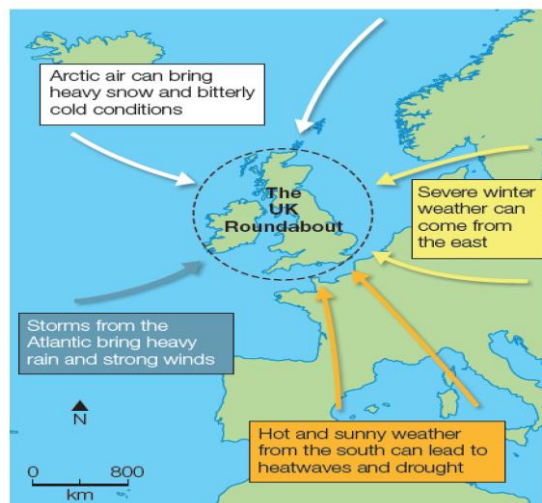
Climate change is expected to increase sea surface temperatures and sea level will rise due to thermal expansion (water expanding). This may affect tropical storms in the following ways:

- **Distribution:** there may be more tropical storms forming in areas like the South Atlantic as sea surface temperatures increase.
- **Frequency:** the overall number of storms is expected to stay the same or decrease but the frequency of severe storms (categories 4 and 5) are expected to increase.
- **Intensity:** warmer oceans will create more intense storms. Every 1 degree Celsius of warming will increase wind speed by 5%.

Extreme weather in the UK

The UK experiences a range of weather types.

- When air travels over water it picks up moisture bringing wet weather to the UK - this often happens when the air is travelling to the UK over the Atlantic Ocean.
- When air comes from the north, it travels from the Arctic bringing cooler air. Wind from continental Europe to the east can also bring cold winter weather.
- When air travels from the south over Africa and France it can bring warmer weather which can lead to heatwaves and droughts.



Extreme weather means severe weather that is unusual with devastating impacts for people. In the UK, this includes

- thunderstorms, heavy rainfall (over a long period that leads to flooding), drought (long spells of dry, hot weather), heavy snow, extreme cold and strong winds.
- 2009-10 – The winter big freeze, average temperatures were 1.2°C, the lowest since 1978-79. Huge amounts of snowfall paralysed the country and brought roads to a standstill, closed schools and put enormous strain on the NHS.
- 2019 – The Met Office declared 29 July 2019 as the hottest day of all time in the UK after confirming a reading of 38.7°C at Cambridge University Botanic Garden. The hot weather caused major travel disruption across England and Wales with damage to overhead cables by the heat causing several train services to be cancelled. The 2019 summer heatwave resulted in almost 900 extra deaths, almost all of who were aged 65 or over. The frail elderly with heart or kidney problems are most at risk in a heatwave and dehydration can also lead to dizziness and falls.
- 2020 - Between November 2019 and February 2020, severe winter flooding occurred across the UK. The first wave of flooding occurred in November 2019, then Storms Ciara and Dennis in February 2020 led to the wettest February since records began in England and Wales in 1766, with 169.6mm.
- 2022 – The hottest day of all time in the UK with a reading of **40.3°C** was reported at **Coningsby, Lincolnshire on 19 July 2022**. At least 13 people died in Britain while swimming, firefighters battled a wildfire at Lickey Hills country park in the West Midlands, and the heat damaged train tracks which resulted in cancelled or reduced services across the country. The dry weather throughout the summer with record-breaking temperatures depleted rivers and reservoirs. On 12 August 2022, a drought was officially declared in eight of the 14 Environment Agency areas and Yorkshire Water became the fifth water company to announce a hosepipe ban, their first in 27 years.

The 2009 Cumbria floods (Cumbria is a county in north-west England)

<p>Causes</p>	<ul style="list-style-type: none"> • In November 2009, there was extremely heavy rainfall across Cumbria with over 253mm of rain in some places. Because so much rain fell in a short space of time, the soil became saturated and could not contain any more water leading to an increase in surface runoff and water quickly flowed into the rivers. • The relief (shape of the land) is very steep as there are many hills and mountains in Cumbria. This means that water cannot infiltrate (soak) into the soil so it quickly flowed downhill and into rivers.
<p>Effects</p>	<p>Social effects - Police officer Bill Barker was killed on Workington’s North Side bridge when it collapsed. He was trying to evacuate people when he was swept into the river. 1500 homes were flooded. When the streets were flooded, sewers flooded and contaminated water which led to large numbers of people becoming ill.</p> <p>Economic effects - it took over 6 months to rebuild the North Side bridge in Workington. The bridge was the main route for many businesses to make deliveries and employees to get to work. Many shops did not reopen for a long time and some businesses never reopened (such as Mill’s Newsagents) and some people lost their jobs. The total cost of the floods was £100 million in an area with only a few thousand.</p>

	Environmental effects - hundreds of trees and large areas of vegetation were lost due to an increase in riverbank erosion caused by the flood. This led to landslides and the loss of hundreds of habitats for animals.
How the floods were managed	<ul style="list-style-type: none"> • Due to climate change, future floods will be very likely and potentially more severe. £4.5 million was spent on new flood defences including a flood wall/embankment which disappears when not in use. The wall adds 1m to the existing wall. Some of the windows of peoples' homes look straight out onto the river. These windows have been flood-proofed, so if the water reaches the window, it will not leak through into the houses. • A soft engineering strategy used has been flood warnings. Everyone who lives near the river has the Environment Agency app on their phone which alerts people if there is any risk of flooding and gives time to evacuate. • Very quickly following the 2009 flood, adverts were placed in all national newspapers that Cumbria was back open for business meaning that customers returned to the area to shop. This improved the local economy. • The North Side bridge was rebuilt but it took over a year. Thousands had to sign petitions for it to be rebuilt. The Army built a temporary bridge which was used for over a year before the North Side Bridge was ready.

Climate change

Evidence of climate change

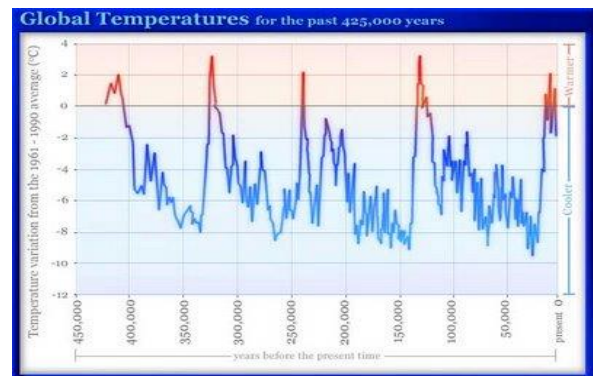
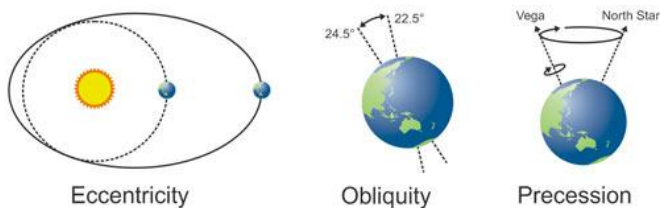
Climate change is the major change in temperature or precipitation that occurs over several decades or longer. The Earth's average surface air temperature has increased by 1 degree Celsius since 1914. Sea levels have risen by 19 cm since 1900 as 287 billion tonnes of ice is per year melts from Greenland. The Earth is 4.5 billion years old. However, we only have temperature records from 1850. To prove that climate change is really happening, we need to look further back in history by using **proxy records** (data gathered from natural recorders of climate).

Evidence	What is it?
Ice cores	<ul style="list-style-type: none"> • Carbon dioxide is sampled from bubbles trapped in ice cores in Greenland (Arctic) and Antarctica. This record goes back 800,000 years and shows CO2 levels have varied naturally between 180ppm (parts per million) and 280ppm over the last 800,000 years. In 2016 the CO2 level was 407ppm. • Ice samples can go back tens of thousands of years so can give long-term climatic data.
Tree rings	<ul style="list-style-type: none"> • The thickness of annual growth rings in trees records climatic conditions. Wide rings = warm/wet climates and narrow rings = colder/drier climates. Some trees can be 5000 years old e.g. Bristlecone Pines in western USA. • Accuracy of tree rings are good but it is localised. Trees can only record temperatures up to around 5000 years ago so can only date temperatures in the medium-term.
Ocean sediments	<ul style="list-style-type: none"> • Ocean sediments work in a similar way to ice cores. The bottom of the oceans are millions of years old. Scientists can dig deep into the sediment at the bottom of the ocean. The deeper they dig, the older the sediment is. They can then measure gases and tell what the sea temperature was up to 2.5 million years ago.

Natural causes of climate change

The Earth's climate has changed naturally many times in the last 500,000 years (see graph).

Milankovitch Cycles



1. Milankovitch cycles are natural changes to the Earth's orbit and position that affect how much radiation we receive from the Sun. If Earth receives less radiation than normal, this leads to cooler periods. If the Earth receives more radiation, this leads to warmer periods or global warming.

- **Eccentricity** – the orbit of the Earth changes shape approximately every 100,000 years. This means that sometimes the Earth's orbit around the Sun is more circular making the planet slightly warmer (interglacial) and sometimes the orbit becomes more elliptical making the Earth slightly cooler (glacial).
- **Axial tilt (obliquity)** – the Earth does not sit with the North and South Poles exactly at the top and bottom of the planet – the Earth is tilted so the poles are around 23° from a vertical position. But over around 40,000 years the angle of tilt changes so sometimes when the Earth is tilted further away from the Sun summers are warmer and winters are colder. When it is tilted closer to the Sun, the difference in the seasons is less.
- **Precession** – as the Earth rotates on its axis it wobbles, similar to a spinning top when it slows down, which affects our seasons. This occurs every 24,000 years.

2. Solar output (sunspot theory) – the amount of radiation produced by the sun varies over time. Black areas on the sun can send more solar energy towards Earth which increases temperatures. Fewer sunspots were observed during the 'Little Ice Age' between 1645-1715. Crops failed and there were famines so many people died of hunger. The Black Death (bubonic plague) also killed many people and was probably made worse by the cold climate. Many farmers stopped growing wheat because it needs warm summers and replaced it with potatoes which thrive in cold and wet conditions.

3. Volcanic activity - large-scale volcanic eruptions eject huge amounts of ash into the atmosphere. This material can partially block out solar radiation, reducing global temperatures. For example, 1816 became known as the "Year Without a Summer" because of the effect on North American and European weather. Agricultural crops failed and livestock died in much of the Northern Hemisphere, resulting in the worst famine of the 19th century.

Human causes of climate change

Human activities since the beginning of the Industrial Revolution (taken as the year 1750) have produced a 40% increase in the atmospheric concentration of carbon dioxide, from 280 parts per million (ppm) in 1750 to 406 ppm in early 2017. This is due to human activity:

- **Energy** – demand for energy is growing due to increasing population (7.8 billion people on the planet in 2020). Most energy in LICs and NEEs is produced by burning **fossil fuels** e.g. coal in power stations which produces **greenhouse gases** such as **carbon dioxide**. This was also the case in the UK and other European countries until recent years.
- **Industry** – as levels of disposable income increase around the world, there is an increased demand for the production of consumer goods. This leads to industrial growth and the need for more energy resulting in more fossil fuels being burnt.
- **Transport** – with cars becoming more affordable and more people taking long-haul flights, huge amounts of fuel is needed. Almost all transport requires burning fuel, again increasing greenhouse gases.



- **Farming** – population growth has led to a higher demand for food production. Intensive farming of cattle results in increased production of **methane** which is a greenhouse gas.
- **Deforestation** – logging trees in rainforests releases huge amounts of carbon into the atmosphere.

Social effects of climate change (on people)

- If climate continues to increase, this will lead to sea level rise caused by melting glaciers and ice in the Arctic and Antarctica. However, oceans will also increase in size due to **thermal expansion** (when water expands when it gets warmer). This could cause flooding of low-lying coastal areas around the world, such as Bangladesh, as well as major cities such as New York, Mumbai and Shanghai.
- The Maldives are an archipelago (island chain) in the Indian Ocean. It is the smallest Asian country in both population and land area, and with an average ground level of 1.5 metres above sea level, it is also our planet's lowest country. The Maldives is famous for its natural beauty which includes blue ocean and white beaches, accompanied by clean air and warm temperatures. The low elevation of the Maldives makes the archipelago extremely vulnerable to sea level rise. Many of the islands are less than one metre above sea-level. As the world's oceans heat up, they expand (thermal expansion) which causes sea levels to rise. A rise in sea level could cause coastal erosion in the Maldives, as well as many of the islands becoming submerged over the next 30 years.
- Flood risk from rain is a UK threat with flood damage expected to rise from £1.2 billion in 2016 to £12 billion by 2080.
- Water shortages are expected to occur in the South of England.
- Heat waves will increase deaths in Europe.
- Drought is likely to put pressure on crop yields in Africa.



Environmental effects of climate change

- One of the major impacts of climate change could be on the **Arctic**. Global warming leads to warmer water which results in fewer marine plants on which small fish feed. In turn, there is a reduction of smaller fish species which then affects larger fish higher up the food chain such as cod and halibut. This in turn affects larger marine species such as seals, as there are fewer fish for them to eat. Consequently, there are fewer seals for polar bears.
- The destruction of coral reefs, home to a great biological diversity of plants and animals and a very important tourist attraction for countries such as Australia. Warmer oceans can cause **coral bleaching**, where the bright coral colours become faded and die due to the loss of algae.
- Forests in North America may be affected more by pests and diseases.
- Wildlife such as the Adélie penguins on the Antarctic Peninsula may continue to decline as ice retreats.
- Less rainfall may affect wildlife, causing food shortages for orangutans in Borneo and Indonesia.
- Around 70% of Asia may experience an increased risk of flooding.
- The Mediterranean region may see increased drought and loss of species.

Managing climate change

Mitigation strategies - reduce or prevent the effects of climate change	Adaptation strategies - respond to climate change by limiting its negative effects
<ul style="list-style-type: none"> • Alternative energy: solar energy is used to reduce the amount of fossil fuels/coal burnt to create electricity. This means that less carbon dioxide is produced which reduces climate change. • Carbon capture: this captures large amounts of carbon dioxide before it can reach the atmosphere and is stored underground. 	<ul style="list-style-type: none"> • Flood adaptations – the Thames Barrier in London is built at the edge of the River Thames. It stops large amounts of water from the coast flooding the city which should reduce flooding to 1 event every 100 years. • Changing agricultural systems: The types of crops can be changed to suit the climate. In Potato Park in Peru because of the increase in

- **Planting trees:** Trees prevent climate change by storing huge amounts of carbon dioxide.
- **International agreements:** at the 2015 Paris climate conference EU countries agreed to reduce emissions of carbon dioxide to below 2010 levels by 2050.

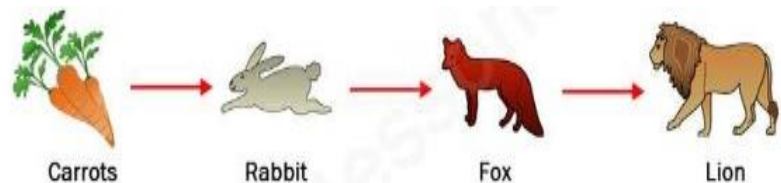
- temperature, farmers can farm many more varieties of potato. This means that they make a lot more money.
- **Managing water supplies** – demand for water can be reduced by using an inflatable bag to reduce the amount of water used in a toilet. This means that more water is saved.

Question 2: The Living World

Ecosystems

An ecosystem is a natural system made up of plants, animals and the environment in which they live. Ecosystems include both living (biotic) and non-living (abiotic) elements. **Biotic** means the living parts of the ecosystem e.g. plants/animals.

Abiotic means the non-living parts of the ecosystem e.g. soil/rock/water.

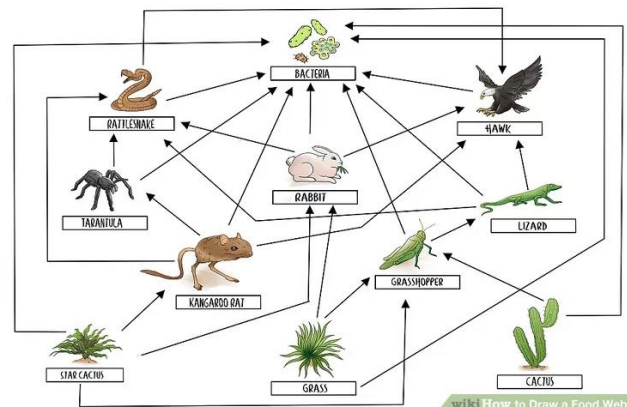


Ecosystems consist of producers, consumers and decomposers:

- **Producers** - an organism that uses sunlight to produce food, for example a plant.
- **Consumers** - an organism that gets its energy by eating other organisms – it eats producers or other consumers. For example a frog.
- **Decomposers** - an organism that gets its energy by breaking down dead material (dead producers / dead consumers). Bacteria and fungi are decomposers.

Food chains and food webs

A **food chain** shows the direct links between different organisms that rely on each other as a source of food (who eats who). The arrows show the flow of energy. A **food web** shows the **complex** interrelationship between producers and consumers. Food webs show several food chains. The removal of one species, or an increase in another, can have huge impacts on ecosystems.



Example of a small-scale ecosystem – Epping Forest in Essex (UK)

Interdependence within Epping Forest: Trees are deciduous (they lose their leaves in winter). This is an adaptation to the UK's seasonal climate. Winters are darker and cooler. They shed their leaves in the autumn, and so conserve their energy during winter. By mid-autumn, the forest floor is covered with a thick layer of leaves. Leaves decompose and the nutrients stored in the soil to support the new season's plant growth. This will ultimately include the fruits and berries that, in turn, support many primary consumers.

The nutrient cycle

In an ecosystem nutrients are stored in the soil and are used by plants and vegetation to grow. The three main nutrients are nitrogen (N), phosphorus (P) and potassium (K).

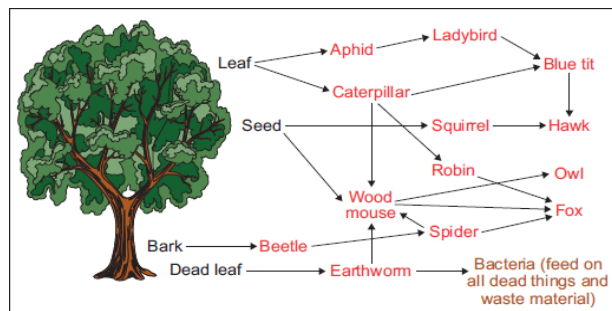
Nutrient cycle:

1. Nutrients are stored in the soil in an ecosystem and are used by plants and vegetation to grow.
2. The plants are eaten by consumers (such as a caterpillar) and the nutrients are passed on to them.
3. Then another consumer will eat another (e.g. bird eats caterpillar) and the nutrients are passed on again.
4. Then the nutrients may be passed on again to another consumer (sparrow hawk).
5. When the vegetation or animal (sparrow hawk) dies it creates **litter** (dead organic matter), **decomposers** break down the dead organic matter (litter) and the nutrients are returned to the soil again.

Ecosystems are interdependent systems

Interdependent systems means that if one organism changes this will have knock on effects on other organisms in the ecosystem.

In this ecosystem if there was a reduction of the number of leaves, then there would be fewer aphids (a small insect). This would then reduce the amount of food for ladybirds and reduce their numbers, which then reduces the number of blue tits, which then reduces the number of hawks. Similarly, if there was a reduction in the number of foxes, there would be an increase in the number of wood mice, which would then decrease the number of earthworms and caterpillars which would then lead to an increase in leaves.



Distribution of global ecosystems

Large-scale ecosystems, such as tropical rainforests and hot deserts, are known as **biomes**. Below is a description of some of the main biomes:

Linking global atmospheric circulation to ecosystems (see Weather hazards on page 15)

Polar	The main polar regions are Antarctica and Greenland where temperatures can fall below -50°C . Found 90° N/S of the Equator.
Tundra	From the Arctic Circle to about $60-70^{\circ}$ north (e.g. Canada, Northern Europe).
Coniferous forest	Found at 60° north, where temperatures in winter are extremely cold due to lack of insolation (the sun's heat) due to the Earth's tilt. Found in Northern parts of North America, Russia.
Deciduous forest	Roughly $50-60^{\circ}$ north of the Equator. Covers large parts of Europe including the UK and eastern USA. Deciduous trees lose their leaves in the autumn.
Savanna	Between $15-30^{\circ}$ north and south of the Equator.
Desert	Roughly 30° north and south of the Equator close to the Tropics of Cancer and Capricorn. Examples: Sahara - Northern Africa.
Tropical rainforest	Lie long the Equator in Asia, Africa and South America. Low pressure creates lots of rainfall, lie along the equator which creates warm weather.

Global atmospheric circulation dictates the location of global ecosystems. In areas of high pressure, we find drier environments and **deserts**. When the air reaches 30 degrees north and south of the Equator (between the Ferrel Cell at the Hadley Cell), it cools so sinks back towards the Earth under high pressure (the air is colder so is heavier) which prevents evaporation so clouds cannot form. There is very little rainfall, and the land is exposed to heat from the sun, which forms deserts.

Along the equator, there is **low pressure** and high temperatures. Constant heat causes evaporation which forms clouds, leading to rainfall every day - ideal conditions for **tropical rainforests**.

Tropical rainforests

Distribution of tropical rainforests

Rainforests cover around 2 per cent of the Earth's surface but are home to over 50 per cent of the world's plants and animals. Rainforests are found along the Equator in Asia, Africa and South America. The **Amazon Rainforest** is located in South America and runs through several countries, including Brazil, Peru and Colombia. Rainforests are found between the two Hadley Cells close to the Equator where it's hot and wet all year round - the hot conditions causes rapid evaporation leading to rainclouds and heavy rain.

Why are tropical rainforests important?

Rainforests are one of the most **biodiverse** places on the planet – home to millions of different species of plants and animals. They are huge **carbon sinks** – absorbing CO_2 and releasing oxygen so they regulate the

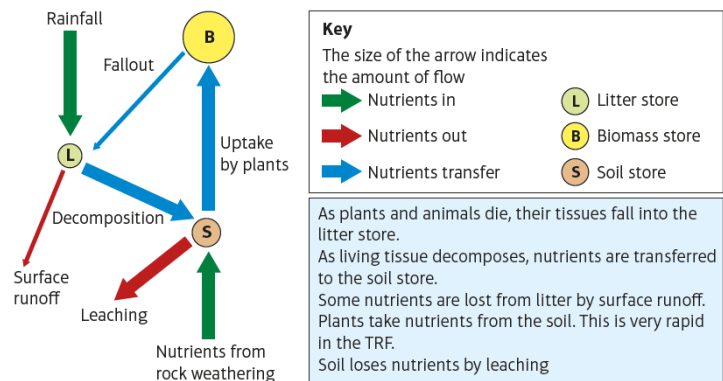
global climate and weather. If rainforests are destroyed it will release carbon dioxide which will increase the greenhouse effect and the impacts of climate change. Medicines, rubber, gold and copper can all be found in rainforests and rainforest countries can export these to improve their economies.

Tropical rainforest ecosystems have a range of physical characteristics

Climate	The climate is the same all year round — there are no definite seasons. The temperature is generally above 25°C and only varies by a few degrees over the year. This is because near the Equator, the sun is overhead all year round. Rainfall is very high, around 2000 mm per year. It rains every day, usually in the afternoon.
Soils	The soil isn't very fertile as these are taken up by plants quickly as they grow, and heavy rain washes nutrients away - known as leaching . There are nutrients at the surface due to decayed leaf fall, but this layer is very thin as decay is fast in the warm, moist conditions. Rapid nutrient cycling supports huge levels of vegetation growth.
Plants and animals	Rainforests have high biodiversity as the climate supports vegetation which in turn provides an abundant food source. Most trees are evergreen (they don't drop their leaves in a particular season) to take advantage of the continual growing season. Many trees are tall and the vegetation cover is dense — very little light reaches the forest floor. There are lots of epiphytes (plants that grow on other living plants and take nutrients and moisture from the air). Rainforests are believed to contain more animal species than any other ecosystem. Gorillas, jaguars, anacondas, tree frogs and sloths are all examples of rainforest animals. There are also huge numbers of species of insects and birds.

Nutrient recycling

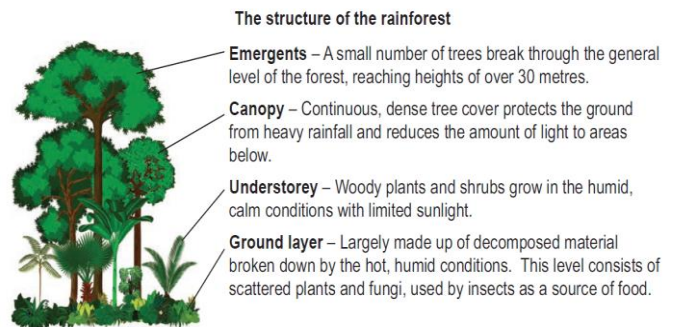
The biggest store of nutrients in the tropical rainforest is **biomass** which is made up of all the living things (biotic characteristics i.e., all the plants, trees and animals). The litter store is small because when leaves or branches drop to the ground, they decompose quickly because decomposers thrive in warm and wet conditions. As soon as the nutrients are released into the soil, the plants of the rainforest quickly start to absorb them. Regular rainfall means water constantly trickles through the soil which takes nutrients and mineral salts with it. This is called **leaching**, which makes rainforest soils low in nutrients.



Plant adaptations

Rainforests have a layered structure (see diagram).

- **Emergents**, the tallest trees up to 30m high, break through the canopy to access sunshine.
- **Buttress roots** – lie along the surface of the soil to gather nutrients. Are large to anchor the tree to the ground.
- **Drip tips and waxy leaves** allows water to flow off without breaking the leaf.
- **Lianas** – vines that grow up the trees to reach the sunlight at the top.



The structure of the rainforest

- Emergents** – A small number of trees break through the general level of the forest, reaching heights of over 30 metres.
- Canopy** – Continuous, dense tree cover protects the ground from heavy rainfall and reduces the amount of light to areas below.
- Understorey** – Woody plants and shrubs grow in the humid, calm conditions with limited sunlight.
- Ground layer** – Largely made up of decomposed material broken down by the hot, humid conditions. This level consists of scattered plants and fungi, used by insects as a source of food.

Animal adaptations

- Sloths have large claws to hang in the trees all day and are active at night (**nocturnal**) to avoid predators.
- Some animals are camouflaged to help them avoid predators.
- Flying squirrels have flaps of skin that enable them to glide between trees.

Amazon Rainforest case study

Causes of deforestation

- **Logging** - companies remove the trees in the rainforest and then sell them for profit. This leads to the clearing of large areas of the rainforest.
- **Commercial farming/cattle ranching** - forests are cleared to make way for huge cattle ranches to graze (feed) cattle. The land cannot be used for long as the quality of the grass quickly reduces so cattle farmers have to move on and destroy more rainforest leading to more deforestation. Cattle ranching is thought to make up 80% of tropical rainforest destruction in Brazil.
- **Mineral extraction (mining)** - some of the minerals that developed countries need are found beneath tropical rainforests. In the Amazon, mining is mainly about gold. In 1999, there were 10,000 hectares of land being used for gold mining. Today, the area is over 50,000 hectares. This has meant that vast areas of rainforest have been cleared to allow mining to take place.
- **Road building** - roads are needed to bring in equipment and transport products to markets to be sold so rainforest must be removed. The Trans-Amazonian Highway is 4,000 kilometres long and has opened up remote areas of the Amazon rainforest.
- **Settlement and population growth** - workers and their families need homes and services so settlements (housing) is needed for them to live creating more deforestation.

Impacts of deforestation in the Amazon Rainforest

Economic impacts (positive)	Social impacts (negative)	Environmental impacts (negative)
<ul style="list-style-type: none"> • Economic development has brought wealth to countries that were very poor. • Farming makes a lot of money for countries in the rainforest. In 2018, Brazil made \$6.5 billion from exporting beef. It is also the world's second biggest exporter of soybeans. • The mining industry creates jobs for many people e.g. the Buenaventura mining company in Peru employs over 3100 people. • Logging contributes a huge amount to Brazil's economy. 	<ul style="list-style-type: none"> • Indigenous tribes may have to move into new areas of rainforest and could come into conflict with other tribes. • They may come into contact with outsiders which could mean the tribe start experiencing new diseases and illnesses. • Younger tribe members may migrate to towns and cities leaving an ageing population behind. 	<ul style="list-style-type: none"> • The Amazon stores around 100 billion tonnes of carbon — deforestation will release some of this as carbon dioxide, which increases the rate of climate change. • Brazil loses 55 million tonnes of topsoil every year because of soil erosion caused by soy farming. This will increase flooding.

Sustainable management of rainforests

Selective logging and replanting	<p>Selective logging - only older trees are removed and younger trees are left which helps to maintain the canopy and conserve natural habitats.</p> <p>Replanting – areas of cleared forest are replanted with new trees to restore the natural environment and habitat. Replanting aims to restore 73 million trees in the Brazilian Amazon by 2023 and is sponsored by NGOs. This supports sustainable management because it will replace deforested areas which means that more CO₂ will be converted into oxygen slowing down the process of climate change.</p>
Ecotourism	<p>Small numbers of tourists visit the rainforest and learn about its importance and experience the environment and wildlife without harming the rainforest. Kapawi Ecolodge in Ecuador, South America, is an example. It can only be reached by boat on the River Amazon with the nearest road 10 days' walk away. There are only 18 lodges so it does not encourage mass tourism and the entire lodge is powered by solar energy, meaning no reliance on fossil fuels such as gas or coal. Visitors interact with the local indigenous tribe, the Achuar, and learn their ways and customs e.g. hunting, medicine.</p>

International agreements	These are a legal agreement between a number of different governments that try to reduce illegal logging. The Forest Stewardship Council® is an organisation made up of businesses, non-governmental organisations & individuals from all over the world. They mark sustainably-sourced timber products with their logo so that consumers can choose products that are not contributing to unsustainable deforestation. The International Tropical Timber Agreement (2006) restricts trade of rainforest wood to registered timber that has been felled in sustainably managed forest so it is difficult to sell illegally felled trees and therefore reduces deforestation.
Education	Educating local people and people worldwide about the importance and impact of deforestation will help raise awareness of the damage caused and help reduce deforestation in the future.
Reducing debt	Many countries with tropical rainforest are LICs with debt to other countries such as the USA. If this debt is reduced, then the country does not have to remove its rainforest to make money to pay the debt back, thus reducing deforestation. Debt for conservation swaps are more effective – debt is only reduced if the other country protects areas of the rainforest.

Hot Deserts

Distribution of hot deserts

Hot deserts can be found around 30°N and 30°S of the Equator, close to the Tropic of Cancer and Tropic of Capricorn (the Tropics). They are generally not found on the Equator because there is too much rainfall. Hot deserts can be found in western USA, South America, North Africa (the Sahara Desert, the world's largest hot desert), Southern Africa, western Asia and Central Australia.



Physical characteristics of hot deserts

The **climate** of hot deserts is hot and dry. Temperatures are extreme – they range from between 40°C and 50°C during the day to 5°C at night. Precipitation is under 250mm a year. Deserts are found between the Ferrel Cells and the Hadley Cells (see page 5). Here, colder air sinks towards the ground preventing warm air from rising to create rainclouds.

Desert soils are thin, shallow and not very fertile because there is hardly any leaf fall from vegetation. When it does rain, soils soak up water very quickly leading to sudden vegetation growth and flowering plants bursting into life. As it is so hot, water is drawn up to the surface of the soil by evaporation leaving salts behind on the surface of the soil. This is called salinisation.

Water is in short supply for most of the year. When it does rain, rainfall is often a short torrential downpour. High temperatures cause rapid evaporation so plants and animals must find ways of storing water.

People, such as the Bedouin tribe in Jordan, tend to live on the semi-arid areas of desert fringes. They use the desert fringe for livestock farming and live in open tents which keep them cool during the day but warm at night. Head scarves traditionally worn by men protect against the Sun and can cover the mouth and nose during sandstorms.

Plant adaptations

- Cacti store water in their trunk. This enables the cacti to survive for long periods without rainfall. Spikes and small leaves prevent water loss through **transpiration** which enables cacti to conserve water.
- Plants have tap roots up to 10m deep to reach groundwater.
- The seeds of some plants do not grow unless there is rainfall (they lie dormant). This enables the seeds to wait until there is enough rainfall for them to grow.

Animal adaptations

- Camels store fat in their humps which keeps them hydrated so they can walk for long periods without food or water. Camels have long eyelashes to prevent sand getting in their eyes during storms, a thick coat of hair to protect from the sun and wide, soft feet, so they can walk for a long time in the hot sand.
- The desert Jerboa is a small rodent that lives in burrows underground. This enables the Jerboa to survive the high temperatures during the day as it is **nocturnal** (they sleep during the day to stay cool and are active at night).

Hot desert case study – development in the Sahara Desert creates opportunities & challenges

The Sahara Desert covers many countries in North Africa including Morocco, Tunisia, Algeria, Mali and Libya.

Opportunities	Challenges
<p>Mineral resources: Phosphate in Morocco Phosphate is a mineral found underground. It can be used in cleaning products, mobile phone batteries, fertilisers (materials added to soil to allow better farming) and even fizzy drinks like Coca Cola for flavouring. It is estimated that 72% of the world's phosphate resources are located in Morocco. Morocco is the largest exporter of phosphate in the world which allows Morocco to trade with other countries and improve its GDP.</p> <p>Renewable energy: Noor power station, Morocco Morocco has the world's largest concentrated solar power station which can produce electricity using energy from the sun. The Noor power station is located near the city of Ouarzazate. It produces enough electricity to power over one million homes. It also provides a more reliable electricity supply, reducing flickering lightbulbs and crashing hospital equipment. The power station does not produce harmful carbon dioxide emissions so reduces the rate of climate change.</p> <p>Tourism: Morocco The Sahara Desert provides opportunities for tourists interested in exotic locations. Hotels and desert camps in Morocco offer such activities as sandboarding, carting, camel trekking and cultural performances. Some of the luxury desert camps are designed for wealthy tourists, charging up to £100 a night. Morocco's tourism industry (hotels, restaurants, souvenir shops, tourist agencies) employs 2.5 million people, providing jobs and income for people.</p>	<p>Extreme Temperatures Daytime temperatures are often higher than 40°C. Exposure to this kind of heat can lead to dehydration or death. Because of the extremely hot temperatures in summer periods, the tourism industry is only seasonal. This means fewer tourists visit during the summer and people relying on income from tourism cannot earn enough money.</p> <p>Water supply The Sahara has very low levels of annual rainfall (less than 70 mm in places). At the same time, countries in the region have an increasing need for water to support the growing population and economic development. Water is required to irrigate (water) fields and grow crops for the local population. Water is also needed to grow crops that can be exported to other countries. A lot of water is also used by industry, for example to mine natural resources or produce cement (a substance used for construction that sets and binds building materials together). Providing enough water for both industry and the population (for drinking, washing) is difficult due to the hot, dry climate.</p> <p>Inaccessibility The Sahara covers a vast area. Often, the large distances and poor infrastructure (roads, train links) means that planes must be used to transport people and materials, which is very expensive. It is hard to provide services in difficult to reach regions therefore there is often a lack of good medical care. Transporting resources and products from and to remote (distant and difficult to reach) locations can be challenging and expensive.</p>

Causes of desertification

Desertification is the process when land becomes a desert - it becomes dry and unfertile and not suitable for plants to grow. It is most common at the borderlines of deserts and is caused by the following factors:

- 1) **Climate change** — climate change means that areas at the borderlines of deserts are receiving even less rainfall and higher temperatures than before. Less rain and higher temperatures mean less water is available

for plant growth, so plants die. Plants provide shade for the soil and roots hold the soil together. When plants die the soil loses protection, dries out and is easily eroded away by wind or water.

The rest of the causes of desertification are all related to human activity.

2) **Removal of fuel wood** — many people living around the edges of deserts rely on wood for fuel to cook. Removal of trees leaves the soil exposed so it is more easily eroded, and this leads to desertification.

3) **Overgrazing** — too many cattle or sheep eat plants faster than they can re-grow. This leads to more soil erosion because the soil without plants is exposed so it is more easily eroded which leads to desertification.

4) **Over-cultivation** — this is farming too many of the same crops in the same area throughout the year. All the nutrients in the soil are used up and therefore neither crops nor plants can grow there anymore. This leaves the soil exposed so it is more easily eroded, and this leads to desertification.

5) **Population growth** — if population grows near a desert more crops need to be farmed (leading to over-cultivation), more meat and milk is needed (leading to over-grazing), as well as more fuel wood. All these activities leave the soil exposed so it is more easily eroded, and this leads to desertification.

Strategies used to reduce the risk of desertification

- **Water management:** Growing crops that don't need much water (millet, sorghum or olives) can reduce water use. Using **drip irrigation** (watering crops using drips of water rather than a lot of water) means the soil isn't eroded by lots of water being added all in one go reduces soil erosion and water use.
- **Tree planting:** Trees shelter soil from wind and rain and the roots hold soil together. Trees also provide shade, which reduces temperatures and evaporation rates.
- **Soil management:** Leaving areas of land to rest in between grazing or planting lets them recover their nutrients. Crop rotation (allowing some fields to rest and not be used for farming) means that some areas of soil are able to rest and regain their nutrients and hold vegetation so reducing desertification.
- **Appropriate technology:** this involves using low-cost, sustainable and easily available materials that are easy for local people to maintain. For example, sand fences (barriers to trap windblown sand) can be constructed to stabilise the soil and reduce erosion. Use of fuelwood can be reduced by using solar cookers which use the sun's energy to heat food.

Question 3: Physical landscapes in the UK – Coastal landscapes

The UK's physical landscape

Upland landscapes of the UK, like the Scottish Highlands or the Lake District in north west England, are mountainous areas of high relief (steep land) made of resistant hard rock such as granite.

Lowland landscapes are areas of low relief and gently rolling hills e.g. The Cotswolds in southern England. Lowland landscapes are made of weaker rocks.



Coastal processes: waves, erosion, weathering, mass movement, transportation and deposition

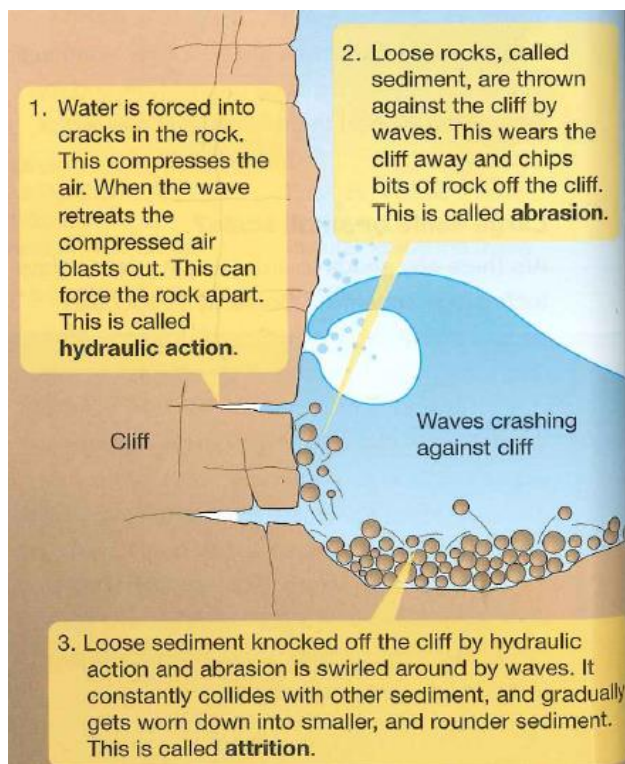
Waves are formed by the wind blowing over the sea. The energy of waves is determined by:

- Strength of the wind
- Duration of the wind
- The distance of open water over which the wind blows – called the **fetch**



There are two types of wave. **Constructive waves** have less energy with a strong swash and a weak backwash and are associated with light winds and short fetches. They are more common in the summer, so they build up a beach over time. **Destructive waves** are powerful, tall waves that are formed by storms and strong winds that have blown over long fetches so are more common in the winter. They have a weak swash and a strong backwash, so sediment is carried back out to sea and erodes a beach over time.

Erosion is the breaking down and transport of rocks by water, ice or wind. The three types of coastal erosion are hydraulic action, abrasion and attrition - see diagram below. Note that attrition only erodes sediment (pieces of rock) and does not cause a cliff to retreat and move backwards.

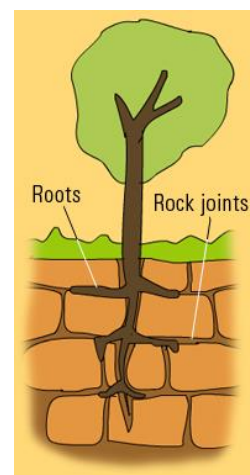


Weathering is different to erosion. It is the breaking down of rocks **in situ** (staying in the same place) by water, ice, wind or chemicals. There are three types of weathering:

Freeze-thaw (or mechanical) weathering – ice breaks rocks apart.

Chemical weathering - the disintegration of rocks caused by acid in rain.

Biological weathering - the weakening of rock by plants and animals.



Water seeps into cracks and fractures in rock.



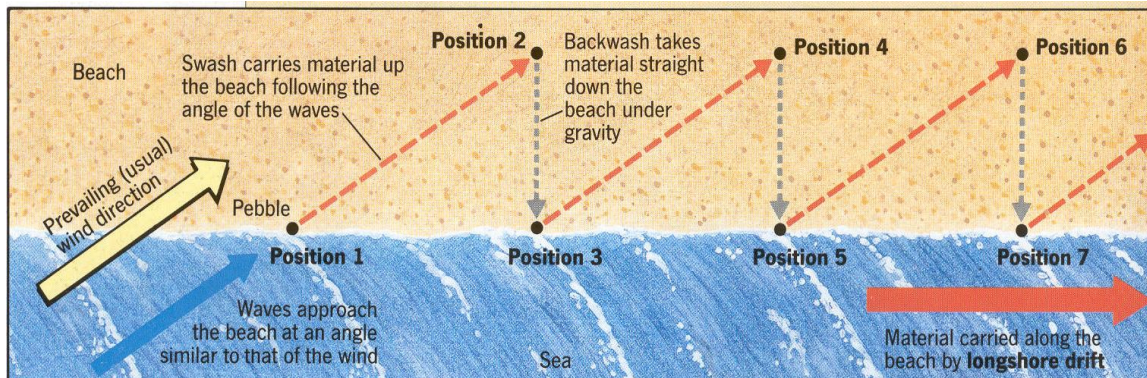
When the water freezes, it expands about 9% in volume, which wedges apart the rock.



With repeated freeze/thaw cycles, rock breaks into pieces.

Mass movement is the downward movement of rocks and soil from the cliff top under the influence of gravity. A type of mass movement is **slumping** which occurs when there has been long periods of rainfall. The rain soaks into the soil which makes the saturated (full of water) ground heavy. Gravity causes the weak soil to flow down the slope and the cliff slides downwards.

Longshore drift is the process of sediment (tiny particles of sand or rock) are transported (moved) along a coast. Sediment is transported along the beach in a zig zag movement, carried by the **swash** (waves come up the beach in the direction of the prevailing wind) and **backwash** (waves go back down the beach at right angles due to gravity).

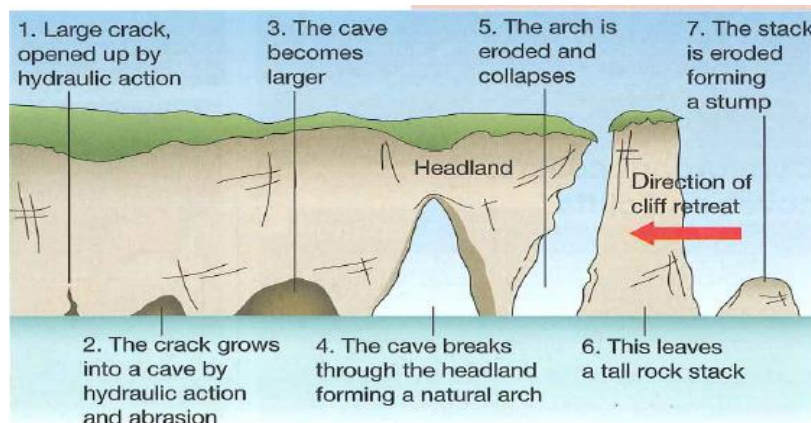


Deposition is where sediment transported by longshore drift is dropped and left behind, usually because there is lower wave energy.

Formation of erosional landforms

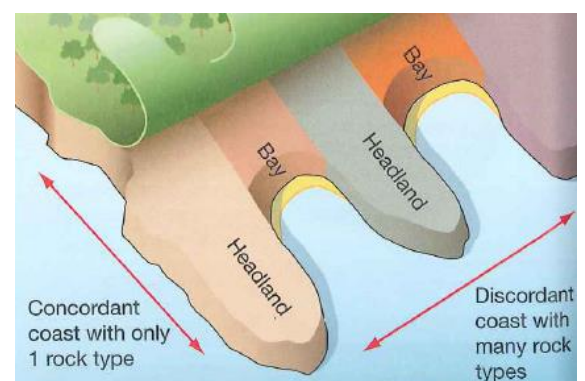
Coastal erosional landforms such as headlands, caves, arches, stacks and stumps are formed by **erosion** (mainly abrasion and hydraulic action – see page 29). See the diagram below for the sequence of landforms.

Caves, arches, stacks, stumps



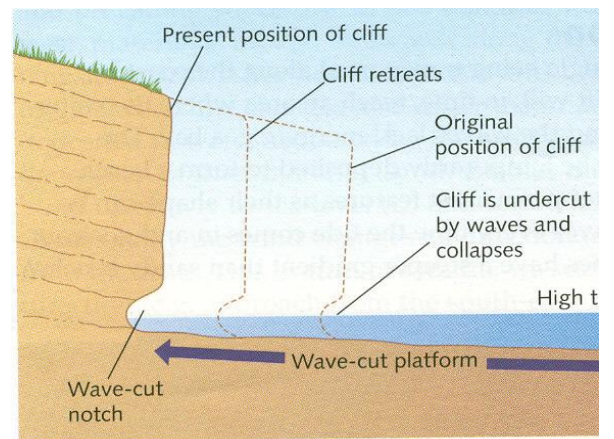
Headlands and bays

- At a **discordant coastline**, alternating bands of hard and soft rocks are at right angles to the coast. Over time, destructive waves erode the cliff through hydraulic action and abrasion.
- Different types of rock at the coastline are eroded at different rates. Weaker bands of rock (such as clay) erode more easily to form **bays**, an area of sea curved in shape which has been eroded between two headlands.
- The tougher, more resistant bands of rock (such as limestone or sandstone) are eroded more slowly so they protrude (stick out) into the sea to form headlands.



Wave cut notches and wave cut platforms

A **wave-cut notch** is formed when waves undercut a cliff through hydraulic action and abrasion. As the notch gets deeper the overhanging cliff above becomes unstable and collapses. This process continues so the coastline gradually retreats inland. A **wave-cut platform** is a gently sloping rocky area left at the bottom of a retreating cliff.



Located example: The Holderness Coast, East Yorkshire

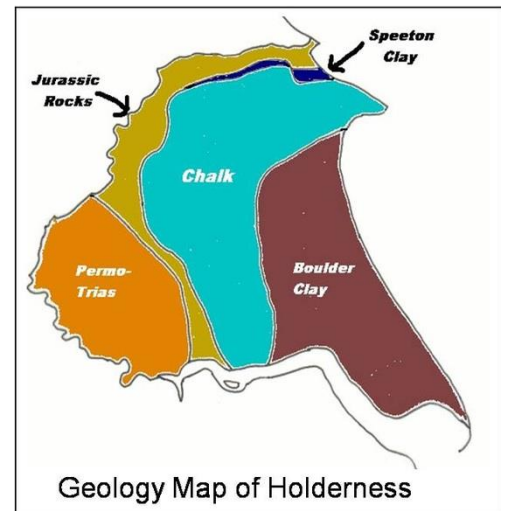
Hard rock and soft rock can be found on this coastline. Flamborough Head is a headland with white cliffs made of hard, resistant chalk. Coastal landforms such as caves, arches and stacks can be seen here. Hornsea, a small town on the Holderness Coast, is made of soft boulder clay so has to be protected by coastal management otherwise the town would eventually fall into the sea.

Formation of depositional landforms

Depositional landforms are formed when the sea loses energy and deposits, or drops, sediment.

How a spit is formed

1. Longshore drift transports sediment along a coastline.
2. When sediment reaches a bend in the coastline, waves lose energy and deposition take place.
3. Sand builds up in a straight line out from the bend and into the sea.
4. The seaward end is curved/hooked by the wind and waves.
5. A salt marsh forms behind the spit because wave energy is reduced as it is sheltered.



A **bar** is formed if a spit extends across a bay and connects two areas of coastline. The bay is now called a lagoon.

Formation of sand and pebble beaches

Sand beaches:

1. Constructive waves transport material onto the beach.
2. Strong swash transports material to the top of the beach.
3. Weak backwash leaves pebbles at the top of the beach and transports sand to the bottom of the beach.
4. Almost no material is removed from the beach due to weak backwash.

Pebble beaches:

1. Destructive waves with weak swash transport material onto the beach.
2. Strong backwash leaves heaviest pebbles at the top of the beach and smaller ones at the bottom.
3. Sand is removed from the beach due to strong backwash.

Formation of sand dunes

- Seaweed is deposited by swash in a straight line after a large storm.
- Wind energy is reduced behind the seaweed as it shelters the area behind it.
- Sand is deposited on the seaweed, creating an embryo dune.
- Marram grass grows on the embryo dune, encouraging more deposition.
- Another dune forms in front of the first one in the same way.
- Heather grows on the first dune (yellow dune) because it is sheltered by the new dune.
- Marram grass grows on the second dune.



- A third dune grows in front of the second one.
- Trees grow on the first dune as it is completely sheltered by the other two. The first dune becomes the grey dune.
- The second dune grows heather and becomes the yellow dune.
- The third dune has marram grass growing on it and becomes the embryo dune. The process takes around 400 years.

Coastal management - hard engineering strategies (using solid, man-made structures to reduce erosion)

	Description	How it works
Groynes	Wooden or rock barriers built at right angles to the beach.	Groynes prevent longshore drift and allow a beach to build up. The beach acts as a natural barrier to the power of waves and reduces the rate of erosion.
Sea wall	A concrete wall curved at the top to deflect wave power.	Made of concrete to protect the base of cliffs against erosion. 'Re-curved' part reflects wave energy back to sea.
Rock armour/rip rap	Large boulders that force waves to break around them.	Rock armour dissipates (reduces) wave energy and protects weak cliffs behind. Looks quite natural.
Gabions	Wire cages filled with rocks stacked on top of each other.	These absorb the power of waves.

Coastal management example: Management of Mableton on the Holderness coast

What did they do? In 1991 61,000 tonnes of rock were used to build a rock groyne on the coastline of the village of Mableton at a cost of £2 million.

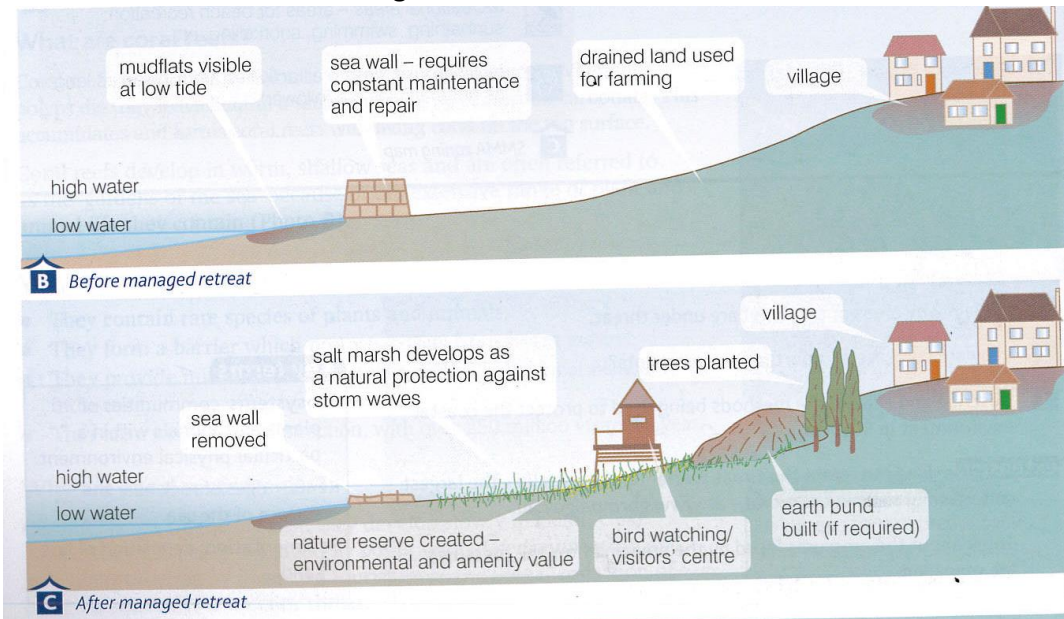
Advantages: The groyne reduced erosion in Mableton from 1.8m/year to 0m/year which saved the village.

Disadvantages: The groynes prevented longshore drift which starved areas further south of sediment. Erosion increased at the beach at Great Cowden to 10-12m per year by 2004. Cliff House Farm, Cowden petrol station and Easington Gas Terminal were under threat.

Coastal management - soft engineering strategies (usually uses smaller structures, often from natural resources. It is sustainable because it considers environmental, social and economic factors).

	Description	How it works
Managed retreat / managed realignment	A method of naturally protecting coastal areas by flooding low land to create salt marshes. These act as a natural barrier to floodwater (see diagram on page 33).	Existing sea walls are removed because they require constant repair and the land behind is allowed to flood. Over time this land becomes a salt marsh which is a natural defence that absorbs wave energy during storms. Earth bunds or sea walls can be built behind the salt marsh to give extra protection from flooding. This has been done at Wallasea in Essex where 115 hectares of new mudflats and saltmarsh has been created.
Dune regeneration	Sand dunes are natural defences along a coastline. Dunes can be stabilised by planting marram grass.	The roots bind the sand together and make it more resistant to erosion. This strategy can harm tourism because areas of dunes need to be fenced off and tourists cannot access the whole beach.
Beach nourishment	Sediment is added to build a larger beach. Sand can be taken from the seabed and sprayed onto the beach. Looks completely natural.	The beach absorbs wave energy and protects land and buildings behind from erosion. However, it can destroy habitats on the seabed and is expensive, but it increases tourism.

Managed retreat – before and after



Question 4: Physical landscapes in the UK – River landscapes

Characteristics of river landscapes

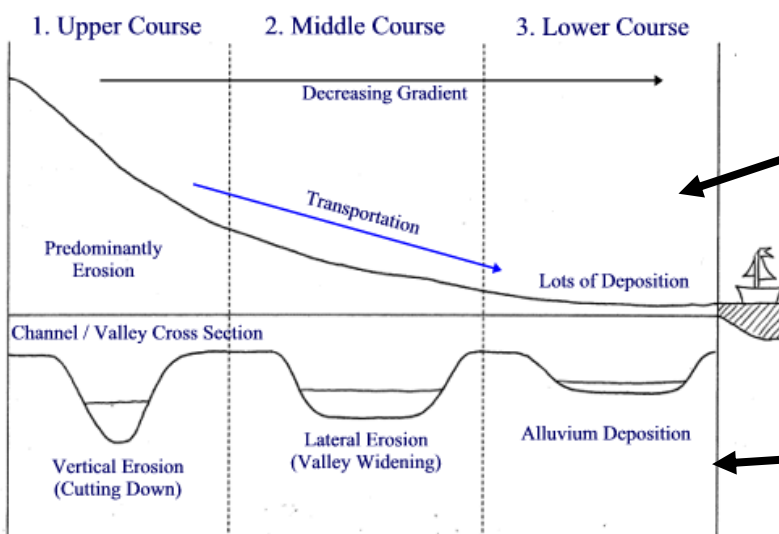
A **drainage basin** is the area of land drained by a river and its tributaries (smaller rivers that run into a larger river). A river starts at the **source** in mountains or hills in the upper course and ends at the **mouth** when it meets the sea. Rivers are made up of three sections, or courses. Each section has its own distinct features:

- **Upper course** – river channel is narrow, V shaped valleys, waterfalls
- **Middle course** – wide river channel, meanders
- **Lower course** – very wide river channel, meanders



Drainage Basin Features

Long and cross profiles



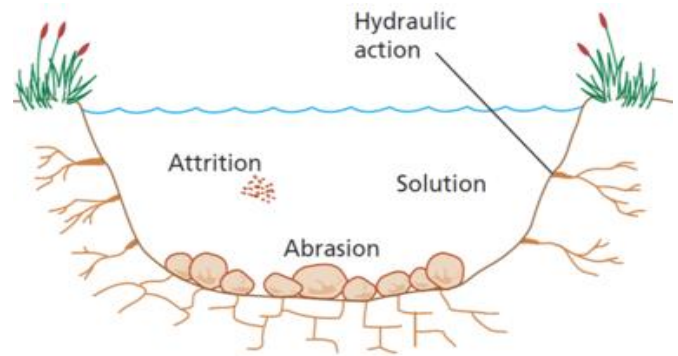
The **long profile** of a river is shown by a curve representing the gradient from the source to the mouth (see top half of the diagram below). The steepest gradient is in the upper course near the source of a river. The gradient reduces downstream as a river flows into the middle and lower course.

The **cross profile** of a river is shown the lower part of the diagram above. The river channel becomes wider and deeper with distance downstream.

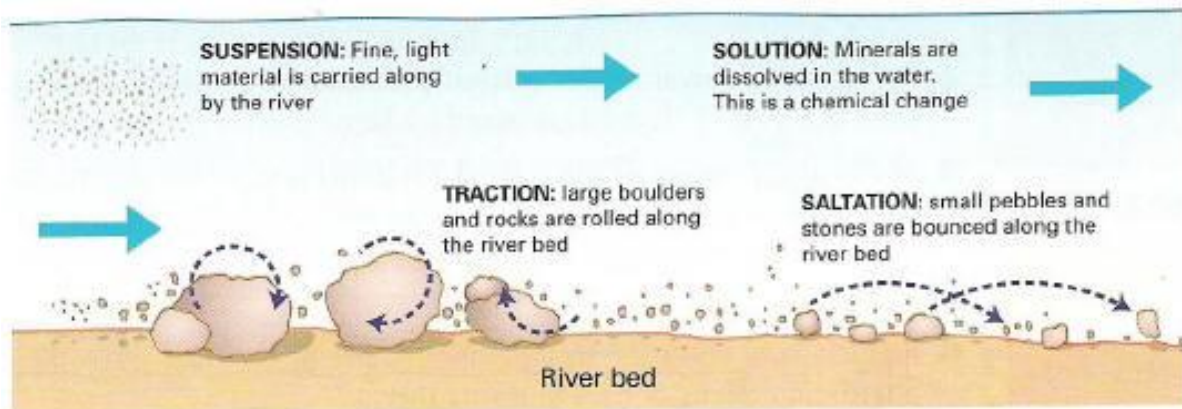
Fluvial (river) processes – erosion, transportation & deposition

River **erosion** involves the action of water wearing away the rocks and soils on the bottom of the channel and sides.

- **Hydraulic action** results from the sheer force of the water hitting the riverbed and banks, wearing them away.
- **Abrasion** is caused by material carried in the river rubbing against the bed (bottom) and banks (sides) of a river channel, wearing them away. Overall abrasion causes most erosion.
- **Solution** – river water is slightly acidic so it can dissolve some rocks and minerals in the river. Limestone and chalk are most affected.
- **Attrition** – sediment particles carried by the river collide with each other causing the edges to be knocked off. The continued collision of particles causes them to become rounder and smaller downstream.
- **Vertical erosion** is erosion downwards that makes a river deeper - common in the upper course of a river.
- **Lateral erosion** is sideways erosion – common in the middle and lower course.

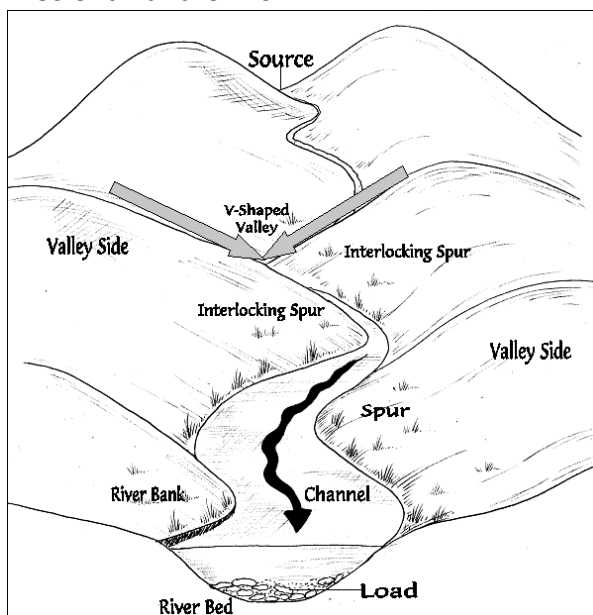


Transportation – there are four types of river transportation processes shown below



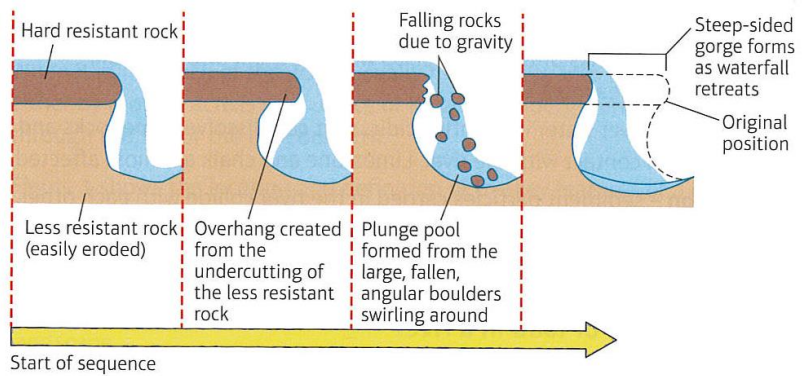
Deposition is the dropping of sediment that has been transported by a river. This happens anywhere along a river where its velocity falls (e.g. where a river becomes shallower) so it no longer has enough energy to carry the sediment load.

Erosional landforms



Valley slopes are called spurs. **Interlocking spurs** are areas of higher land jutting (sticking) out of steep valley sides in a river's upper course.

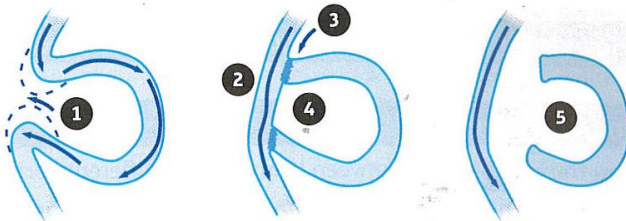
Waterfalls are formed along a river when a band of hard, more resistant rock lies over a band of soft, less resistant rock. The river erodes the soft rock at a faster rate, gradually undercutting the more resistant rock. Continued erosion of the soft rock by abrasion and hydraulic action causes an overhang of hard rock. Eventually the hard rock cannot support its own weight and collapses under the force of gravity into a plunge pool. Over thousands of years the process continues and forces the waterfall to retreat, creating a **steep-sided gorge**.



Depositional landforms

Meanders are bends in a river found in the middle and lower course. The fastest velocity (called the thalweg) is on the outside of bend of a meander. This results in lateral erosion and forms an outer steep bank called a **river cliff**. On the inside bend the velocity of the water is lower leading to deposition and the formation of a gently sloping bank called a **slip-off slope**.

Oxbow lakes are old meander bends that have been cut off by faster flowing water when it has flooded.

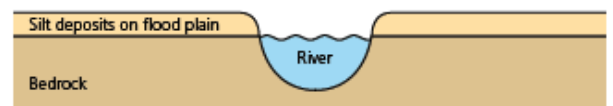


- 1 Narrow neck of the meander is gradually being eroded.
- 2 Water now takes the quickest route.
- 3 Deposition takes place, sealing off the old meander.
- 4 The meander neck has been cut through completely.
- 5 Oxbow lake – left behind when meander completely cut off

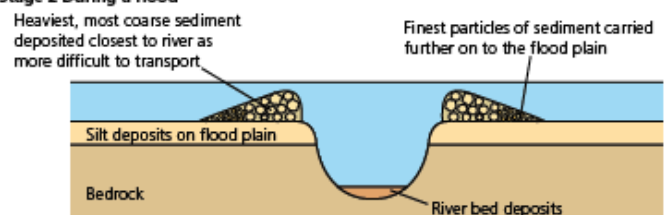
Levees are raised riverbanks. They are formed when rivers flood. A large amount of sediment is moved out of the river during the flood. When the river overflows, the larger material is deposited on the edges (banks) of the river and the lighter material is transported further away from the river channel. The finer/lighter material is eventually deposited further away once the river energy has decreased further.

An **estuary** is an area at the end of a river when it meets the sea. Fresh water from the river mixes with salt water from the sea and wide banks of mud and sand are deposited. When the river meets the sea it slows down so it deposits material. The river splits into two because it is forced to go around the deposited material in the middle. The process repeats and creates a complex network of streams called an estuary.

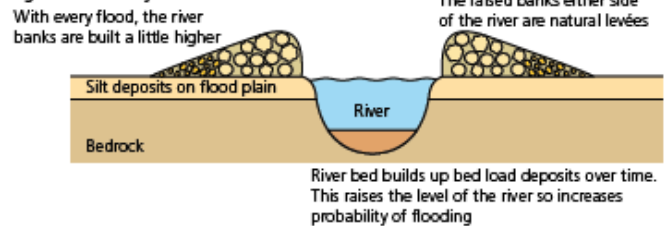
Stage 1 Before levée



Stage 2 During a flood



Stage 3 After many floods

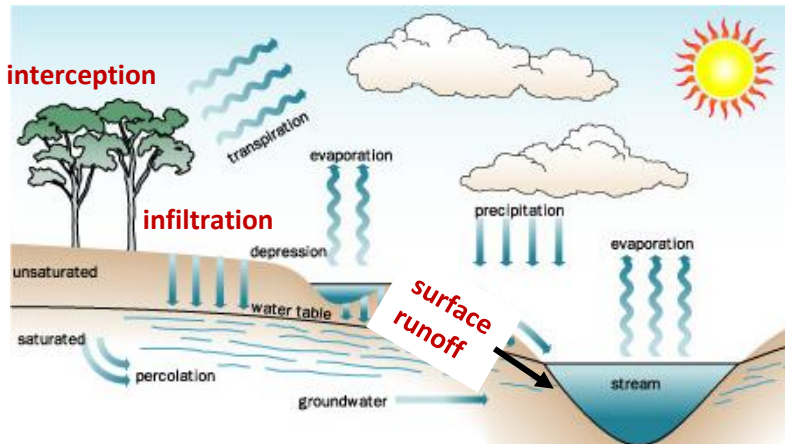


Floodplains are wide, flat areas either side of the river in the lower course. During a flood, water containing large amounts of sediment pours out over the flat valley floor. The water slowly soaks away leaving behind the deposited sediment. Over hundreds of years, repeated flooding leaves behind fertile land that is often used for farming. Lateral erosion from the movement of meanders widens the floodplain.

The River Aire – an example of a river valley

- The River Aire is a major river in Yorkshire. It is 92 miles in length.
- The source of the Aire is Malham Tarn in the Yorkshire Dales. It flows through Skipton, Keighley, Bingley, Saltaire and Shipley. The Aire then passes through Leeds and empties into the River Ouse in East Yorkshire.
- The River Aire meanders between Keighley and Shipley.
- There is a small waterfall called Janet’s Foss close to Malham.
- Leeds is built on flood plain of the River Aire.

How water reaches a river channel



Trees **intercept** precipitation (rain, sleet or snow) which means less water reaches rivers, so they are less likely to flood.

Precipitation **infiltrates** into **permeable** rocks which reduces the chances of a flood.

If the ground is already **saturated** (full of water) from previous heavy rain, precipitation flows into river channels quickly by **surface runoff** and increases the risk of flooding.

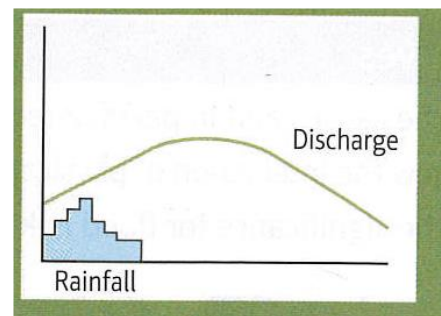
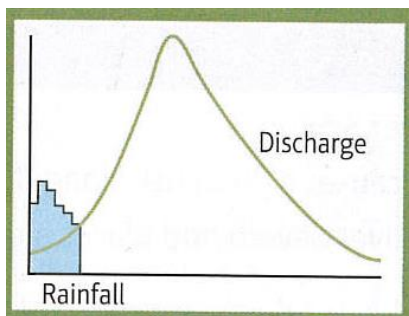
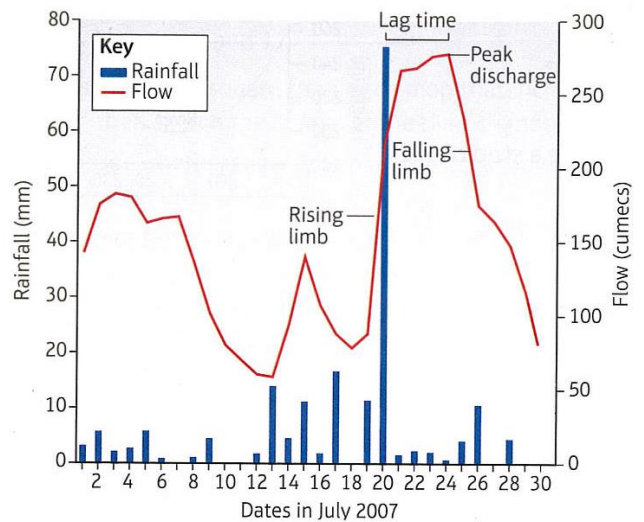
Physical and human factors affecting flooding

Factor	How it increases surface run off/flooding
Precipitation (physical)	Heavy rainfall saturates soils and makes flooding more likely as water flows quickly over the surface.
Geology (physical)	Geology (rock type) can make areas more prone to flooding if there are hard or impermeable rock types in the area. Impermeable rock does not allow water to infiltrate (soak) into it, so surface run off is higher. This means that rivers fill up with water faster making flooding more likely.
Relief (physical)	If there are steep slopes e.g. in mountainous areas, water will flow quickly downhill into rivers increasing the flood risk.
Urbanisation – building new houses (human)	Buildings and roads prevent infiltration of rain into the ground because they are impermeable. This increases surface run off as the water flows quickly over the roads and buildings and into rivers.
Deforestation (human)	Removing an area of trees, plants and grass means that there is less infiltration and transpiration. If these areas are replaced with concrete (which is impermeable) water will flow quickly over the surface instead.

Hydrographs

A hydrograph shows how a river responds to rainfall i.e. how much rainfall reaches a river and how quickly. This helps to understand flood risk and can be used to predict likely flooding, allow warnings to be issued and people to be evacuated.

- **Discharge** – this is the volume of water which flows through a river in a given time measured in cubic meters per second (cumecs). **Rising limb** – shows the rising water after rainfall.
- **Lag time** – the difference between the time of the heaviest rainfall and the point at which the river contains the largest amount of water.
- **Falling limb** – the discharge falling as less water reaches the river channel.



Flashy hydrographs pose a high flood risk. The physical/human causes for this are:

- Steep slopes resulting in fast runoff
- Heavy or prolonged rainfall
- Deforestation
- Impermeable surfaces that cause rapid surface runoff – this could be from saturated (or frozen) soils, impermeable rocks or urbanisation

Flat hydrographs posing a low flood risk. The physical/human causes for this are:

- Gentle slopes
- Permeable rocks that allow water to infiltrate so it slowly moves through the ground and into rivers
- Light rainfall

River management strategies

Hard engineering methods – man made solid structures, expensive and require regular maintenance			
	What is it? How does it work?	Advantages	Disadvantages
Dams and reservoirs	A large concrete structure built in the river to reduce the flow of water. A small hole is made in the dam which is controlled by a gate. The gate controls how much water flows through the river at any time, stopping it from overflowing.	The reservoir is a large store of water which provides drinking water to homes around the UK.	Dams are very expensive, Kielder Dam in the North East cost £167 million.
Channel straightening	When a meandering section of river is straightened, widened and deepened. This allows water to flow away from the area more quickly which reduces flooding.	People are more likely to buy homes near the river because it is less likely to flood.	Leads to destruction of animal habitats due to flooding in other parts of the river.
Embankments	An embankment is a raised (higher) riverbank. Embankments prevent flooding because they	The risk of flooding is reduced so houses are protected.	When flooding does occur, embankments prevent the water from

	make the banks of the river higher, so it can store more water before overflowing.	Embankments are less expensive compared to other strategies such as dams.	flowing back into the river. This means floodwater does not flow away quickly so any flooded homes remain uninhabitable.
Flood relief channels	Flood relief channels are artificial river channels which can divert water away from a densely populated area. This means that the river level is reduced because there is more space for the water to flow without overflowing.	The chance of flooding is reduced, so house prices increase and insurance becomes cheaper.	Relief channels often take many years to build. Animal habitats can be destroyed by the construction.
Soft engineering methods – a natural approach to managing floodwater. Aims to create space for floodwater in the landscape to reduce risk of flooding in other areas. Usually cheaper, need little maintenance and provide habitats for wildlife.			
	What is it? How does it work?	Advantages	Disadvantages
Flood plain zoning	Flood plains are divided into zones. Areas near the river can only be used for fields and activities which are less important like car parks. Housing and businesses are built further away from the river so they are less likely to flood.	If the river floods, no buildings are damaged. Having fields next to the river means that more infiltration will occur, so more water is absorbed into the ground.	Most settlements in the UK were built hundreds of years ago and many houses already exist next to rivers, so it is not possible to move them away from the river.
Flood warning and preparation	The government and Environment Agency have detailed plans about what to do if there is a flood. If heavy rain is forecasted, people are warned in advance so that they can prepare. These warnings appear on TV and social media as adverts and on the Met Office website with a map of affected areas.	The public are told in enough time to move their valuables upstairs and park their cars away from the river. This protects these items so less damage is caused by the flood and insurance costs will be lower. Emergency services are trained to evacuate people so lives are saved.	Warning systems can be incorrect or too late in some regions. A flood warning does not stop the flood from happening. People do not always take warnings seriously so when it does flood, the damage in certain places is not reduced.
Planting trees	Trees absorb rainwater and prevent it from reaching the river.	Flooding is reduced which protects homes. The new trees create habitats for animals.	In extreme floods, trees can be swept away and block the river which can increase floods in some areas. Trees cannot be planted everywhere, particularly in urban areas.
River restoration	Removing hard engineering such as channel straightening to restore the river back to its natural conditions. This involves the removal of concrete, digging the meanders back into the land and blocking off flood relief channels.	Creates new habitats and reduces risk of flooding downstream.	Loss of farmland because some areas will flood again. Can be very expensive.

An example of a flood management scheme in the UK – Boscastle, UK

Why was the scheme needed?

On 16th August 2004, the village of Boscastle in Cornwall flooded. 75mm of rain fell in 2 hours (twice the average monthly rainfall) which caused River Valency and River Jordan to overflow. The village is also situated at the bottom of a steep valley so surface runoff was fast, leading to the rivers quickly filling up with water. No one died but over 50 cars were swept into the sea and several homes were destroyed. Tourism decreased because the flood happened in the summer holiday.

The management strategy

A flood management scheme was completed in 2008. It included both hard and soft engineering strategies:

Hard engineering

- The river channel was deepened and widened so it can hold more water.
- The river embankments (sides) were strengthened.
- The old stone bridge was replaced with a new higher bridge so more water could run underneath.

Soft engineering

- The car park was raised and left as an area allowed to flood when there is heavy rainfall.
- Dead trees were removed around the river to stop them from blocking the river channel and allowing water to build up behind them in a flood.

The social, economic and environmental issues

Social issues	Economic issues	Environmental issues
<ul style="list-style-type: none">• The new defences have made Boscastle a safer place to live. However, they will only protect against smaller floods and won't prevent flooding of the same size as in 2004.• Residents' lives were disrupted for years by the construction of flood defences.• Many residents do not like the new modern bridge because it is not in keeping with the traditional character of the village.	<ul style="list-style-type: none">• Homes and businesses are now less at risk from flooding so there is less risk of expensive damage to property, loss of stock and business, and insurance costs have also reduced.• The scheme cost over £4 million but some options were still considered to be too expensive so were not used.	<ul style="list-style-type: none">• Biodiversity and river habitats have been improved.• The new river channel has been engineered to look natural and function as a normal river.

Paper 2: Challenges in the human environment

Question 1: Urban issues and challenges

Urbanisation – the pattern of urban change around the world

- Urbanisation is the process by which an increasing percentage of people live in towns and cities. It is largely caused by migration from rural areas.
- Around 54 percent of the world population currently live in urban areas, but this is forecast to rise to 66 percent by 2050. Nearly all of this growth will take place in LICs or NEEs. Africa is expected to become the region with the fastest urban growth between 2020 and 2050.
- One reason why urbanisation is much slower in HICs is that most people there already live in urban areas – 81% in 2014. Another reason is that in HICs the rate of natural increase of the population is low, or even negative (there are more deaths than births).

What factors affect the rate of urbanisation?

Urbanisation is caused by two factors – migration from the countryside (**rural-urban migration**) and **natural increase** (when birth rates are higher than death rates). Rural-urban migration is caused by push and pull factors. Some examples are below.

Push factors - something that forces a migrant to leave the countryside in search of a better way of life in an urban area	Pull factors - something that attracts migrants to move to an urban area.
1. Poverty caused by unemployment or low wages. Often this is due to drought which has caused crop failure or the death of livestock (animals such as sheep, goats and cows).	1. More well-paid employment opportunities are found in the city, as well as skilled work for those who may be educated.
2. No access to basic services such as electricity, gas (for heating) or clean, safe drinking water. This will mean that families will have to go to bed when it gets dark, meaning they cannot work e.g. making items to sell at market or study at night. No running water nearby often results in children missing school as they have to walk several miles to the nearest well to collect enough water for daily use.	2. Improved quality of life – cities give access to improved health care (higher number of hospitals and doctors/nurses) and education (schools and universities).
3. Conflict/war or natural disasters e.g. earthquake, flood can force migrants to flee their own country and become refugees.	3. Opportunities for improved housing with electricity, running water and heating.

Many people that migrate to towns and cities are 18-35 and want to start families which leads to a high birth rate and a high **natural increase**. Over time, this had led to cities increasing in population. **Megacities** have a population of over 10 million. There are now 28 megacities, compared to just 10 megacities in 1990. Tokyo is the world's largest city, with the greater Tokyo area housing about 38 million inhabitants.

Slums are settlements made of materials such as mud and wood and often lack a safe water supply, electricity and drainage. In NEEs like Brazil, slums can be found on the edges of cities like Rio de Janeiro. These are formed when migrants who have moved to the city cannot find a well-paid job as they have not had a formal education. This often means migrants cannot afford to rent a house, so they are forced to live in a slum on the edge of the city.

Case study of a major city in an LIC or NEE – Rio de Janeiro, Brazil

Location - Rio de Janeiro is located on the south east coast of Brazil in South America.

Rio is a divided city. The south part of Rio is very wealthy and is where tourist destinations are found such as Copacabana Beach. The north side of Rio is very different as it contains the **favelas**. A favela is a Brazilian word for slum. These are spontaneous settlements which often have no electricity or running water and have no sewers. Living conditions here are very poor.



Importance

- Industry and trade - Rio produces 5% of Brazil's GDP (Gross Domestic Product). GDP is the value of all the finished goods and services produced within a country's borders in a year. The main manufacturing industries are chemicals, pharmaceuticals, clothing, furniture and processed foods. The city is home to 5 major ports. Many raw materials and manufactured products are exported here and traded with other countries. This is a hugely important economic activity for the city and for Brazil as a country.
- Tourism - Rio is one of the most visited cities in the Southern Hemisphere. Its beautiful beaches (such as the famous Copacabana beach) and dramatic landscape make it a very popular tourist destination. The Christ the Redeemer statue that overlooks Rio is one of the new Seven Wonders of the World.
- Olympic Games and FIFA (football) World Cup - Rio has hosted the 2014 World Cup and the 2016 Olympic Games. These global events are very important as it has raised the global profile of the city and generated huge income, which in turn helps to generate wealth and jobs.

Opportunities created by urban growth

<p>Economic opportunities</p>	<ul style="list-style-type: none"> • Many formal sector jobs are available in the financial sector, retail (shops) and the steel industry (Rio has the largest steelworks in South America at Sepetiba Bay). Workers in formal employment usually receive a regular wage and pay tax to the government on their income. Formal workers are also likely to have employment rights such as sick pay and paid holidays. • There are also many jobs available in informal employment. These are jobs not officially recognised by the government, for example street vendors and water sellers. Workers in the informal economy do not pay taxes and have no employment protection.
<p>Social opportunities</p>	<p>Access to jobs, housing, education and healthcare services all improve when people move to a city. This will improve life expectancies as families can see a doctor when ill. If children complete their education, they are more likely to be able to access well paid formal sector jobs when they are older which will increase their family's income and quality of life.</p>

Challenges created by urban growth

<p>Economic challenges</p>	<p>Unemployment is as high as 20%. Many jobs are poorly paid in the informal sector. With average incomes less than £75 a month. This means that the government benefit less from income tax and so cannot invest as much into improving infrastructure such as education and healthcare.</p>
<p>Social challenges</p>	<ul style="list-style-type: none"> • Many favelas are built on steep slopes and heavy rain storms can cause landslides which causes homes to collapse. In 2010, 224 people were killed and 13,000 lost their homes due to a landslide. • In non-improved favelas, around 12% of homes don't have running water, 30% have no electricity and around 50% have no sewage connections. • Waste cannot be disposed of and builds up in streets increasing risk of disease. • Drug gangs dominate favelas. There is a high murder rate of 20 per 1000 people in many favelas.

Environmental challenges	<p>Air pollution</p> <ul style="list-style-type: none"> • 5,400 people died in Rio because of air pollution in 2014. By comparison, Rio's infamous murder levels resulted in 3,117 deaths in 2014. • 75% of Rio's air pollution is caused by exhaust fumes from the 2.7 million vehicles on its roads. • The steep relief around Rio (there are mountains to the north and west) trap air pollution and do not allow it to escape, making environmental conditions worse. <p>Waste pollution</p> <ul style="list-style-type: none"> • Favelas are often built on steep slopes and have few proper roads. This makes access difficult for waste collection lorries so waste piles up in the streets. <p>Water pollution</p> <ul style="list-style-type: none"> • The area around Guanabara Bay is heavily polluted due to the industry and port. Ships come into dock and release huge amount of fuel into the water. Furthermore, industry in this area releases over 50 tonnes of industrial waste into the bay each day which makes the water extremely dangerous for people and drastically affects the wildlife in the area. • Another major cause of pollution is the Petrobras oil refinery; this oil refinery has spilled large amounts of oil into the bay since it was built. • Rio's favelas create huge amount of water pollution. The favelas do not have sewers so raw sewage runs into rivers which then run into Guanabara Bay.
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Solutions to water and waste pollution

- Water pollution: 12 new sewage works have been built since 2004 to treat raw sewage; ships are fined for discharging fuel into the bay illegally; 5km of new sewage pipes have been installed around badly polluted areas.
- Waste pollution: A power plant has been built near the university of Rio that uses methane gas from rotting rubbish to create electricity. It consumes 30 tonnes of rubbish a day and produces enough electricity for 1000 homes.

How urban planning is improving quality of life for the poor – the Favela Bairro Project

The Favela Bairro project is the name of a government funded scheme to improve the favelas. The local authority provides land and basic services (roads, electricity, water and sanitation) and the residents build their own homes. Improvements made included:

- Access to loans so residents can buy materials to improve their homes.
- Installation of a cable car system to transport workers into the city. Residents are given one free return ticket a day.
- Hillsides secured to prevent landslides.
- Building of new health & education facilities.
- A Pacifying Police Unit to patrol the community to help reduce crime.
- 60km of new power lines installed to prevent blackouts.
- A hydroelectric power plant was built in 2013 which has increased Rio's electricity supply by 30%.

The quality of life and employment prospects for residents in favelas have improved. However, there are still some problems. The budget of US\$1 billion does not cover every favela. Many residents lack the skills and resources needed to make repairs to their homes and more training is needed to improve literacy and employment. Rents have increased in the improved favelas, so the poorest inhabitants are even worse off.

UK city case study – Liverpool

Distribution of population in the UK

There are many mountainous areas in Scotland, so this part of the UK has fewer urban areas because it is harder to build in steep areas. The climate here is also cooler. Southern England is flatter and has a warmer climate so more urban areas are found here.

Location and importance of Liverpool

The city of Liverpool is located in the north west of England on the River Mersey. It is south west of Bradford north west of London.

- The city developed as an important city in the UK and the world in the 1700s because it was a major port for cotton, sugar and slavery. The port fuelled economic growth in the area and created many jobs for local people in the port and ship building industry.
- Today, many imported goods arrive in Liverpool on ships. This supplies thousands of businesses in the north of England and parts of Scotland and is vital to the local and national economy.
- Liverpool is also home of the world famous 1960s music band The Beatles. There are many famous landmarks in Liverpool linked to The Beatles such as The Beatles Story Museum and the Cavern Club (where The Beatles played their first ever show). Tourism due to The Beatles is estimated to be worth over £80 million a year to the city.



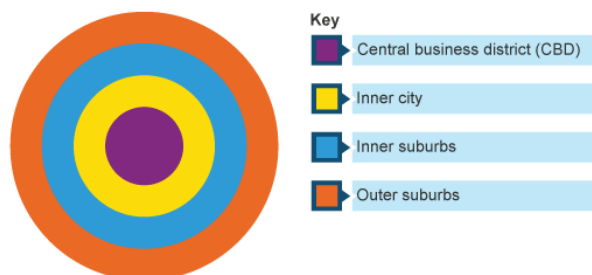
Impacts of national and international migration on the character of Liverpool

- In the 1700s many people started to migrate to Liverpool for work. The two places most migrants moved from were Ireland and Wales. These are examples of **national migration** (within the UK). Migrants left Wales to work building railways and canals whereas migrants were forced to leave Ireland due to famine (lack of food). By 1850 around a quarter of people in Liverpool were Irish immigrants. This has helped to change and character of Liverpool today and may also have led to the development of the ‘scouse’ accent.
- Due to large numbers of ships from around the world arriving at the port in Liverpool, many people from different parts of the world settled in the city. This included large numbers of Chinese people that settled and created ‘Chinatown’ which has created a cultural mix and changed the character of Liverpool. This is an example of **international migration**.
- In the 1970s the docks were closed, and this also led to the closure of 350 factories. Many people were left unemployed so left the area to look for work and Liverpool’s economy declined. Most of the people that left the city at this time were young, skilled workers.

Urban land use

The Burgess model shows a simple **land use pattern** that is found in many UK towns and cities.

- **The CBD** is the most accessible part of the city with main transport links found here. High-end shops, tall office blocks and multi-story car parks are found in the CBD, with train and bus stations and public buildings such as the town hall.
- **The inner city** can be recognised by industrial buildings and terraced housing (a row of houses that occupy a street connected by a single wall on either side). These were originally built in the 1800s to house factory workers who worked in factories. Many of these factories closed in the late 1900s, leading to poverty and high levels of unemployment.
- Houses in the **suburbs** are usually larger than inner city terraced houses and most have a garden. Facilities such as schools, places of worship and parks are often available, and many are served by a local supermarket. The suburbs are often home to **commuters** who need access to the CBD along main roads and railways, and they are also within easy reach of the countryside.



How urban change in Liverpool has created opportunities through urban regeneration

<p>Economic opportunities</p>	<ul style="list-style-type: none"> • Liverpool ONE is an example of an urban regeneration project. It is a £500 million shopping and leisure complex which involved the redevelopment of 42 acres of land in the city centre. It has over 170 stores, bars and restaurants, a 14- screen cinema, indoor golf course and a five-acre park. It opened in 2008 and has created thousands of jobs. The income from these shops brings a lot of tax money to the local government which is used to improve the city further. It is an example of regeneration because the area was derelict unused land before. • Liverpool2 is a new container port built in 2016. Around 5000 jobs have been created which adds around £5 billion to the economy each year. This is an opportunity because the increased revenue from taxing jobs can be used to improve infrastructure and services such as education and healthcare.
<p>Social opportunities</p>	<ul style="list-style-type: none"> • The Beatles Story, situated in the Albert Dock, is a museum which tells the story of how the Beatles became one of the most well-known bands in musical history. The museum is a tourist attraction which attracts people from around the world to Liverpool. <u>Tourism due to The Beatles is worth over £80 million a year to the city.</u> • Cultural opportunities in Chinatown. In the late 1850s, many Chinese sailors decided to stay in Liverpool as the UK had strong trade links with China. There are many Chinese businesses located in this area now including restaurants, supermarkets, dry cleaners and souvenir shops. Other areas of Liverpool are now home to a Chinese Gospel Church (Christianity) book shops and community events celebrating Chinese culture. This has led to an increased cultural mix through international migration.
<p>Environmental opportunities</p>	<p>Chavasse Park is a 5 acre park created next to Liverpool One shopping centre. It is an example of urban greening – this means increasing the amount of green space in towns and cities. Advantages of more green spaces include:</p> <ul style="list-style-type: none"> • Providing a relaxing, cleaner environment with no air pollution that improves peoples’ health. • Providing community space and meeting places. • Increasing permeable surfaces to absorb rainfall, therefore reducing the risk of flooding in urban areas. • Absorbing excessive heat in the summer to make areas more comfortable.

How urban change has created challenges in Liverpool

<p>Social challenges – inequalities in the inner city</p>	<ul style="list-style-type: none"> • As industry started to decline in Liverpool in the 1970s and the docks closed, it left many people in inner city areas like Toxteth and Anfield unemployed. This created social and economic problems and inequality (when some groups of people in society have more opportunities than others). • People forced to leave the city - as areas of the inner city were redeveloped the price of houses in the area increased. This meant that poorer people in the area couldn’t afford the new housing and were forced to leave the city to find affordable housing. • Unemployment and unhealthy lifestyles – many children in deprived areas of inner city Liverpool have left school without basic qualifications. This meant that they were unable to find employment (about 9% of adults in Anfield are unemployed) or the employment they did find was low paid. This has also led to unhealthy lifestyles such as high levels of alcohol consumption, poor diets and smoking. People in wealthier areas are expected to live up to 10 years longer than Toxteth.
<p>Environmental challenges – commuter settlements</p>	<ul style="list-style-type: none"> • The city of Liverpool has expanded into the surrounding countryside and onto greenfield sites (areas not previously built on before). This is known as urban sprawl. Aughton is a small village on the rural-urban fringe (an area of land found at the edge of a town or city where it meets the countryside) of Liverpool. In recent years, large numbers of housing developments have been built for commuters. Commuters are workers that travel from their home to their place of work in a different

	<p>town/city. Commuters drive from Aughton to Liverpool city centre (and back) every week day which increases traffic, air pollution and parking problems in Aughton.</p> <ul style="list-style-type: none"> • Unhappy with these problems, some residents of Aughton chose to move away and were replaced by more commuters from the city. The new residents will do most of their shopping and socialising in Liverpool city centre which has caused local businesses in Aughton to close and the character of the village is slowly being lost.
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Impacts of traffic in Liverpool

Environmental	Social	Economic
<ul style="list-style-type: none"> • High levels of air pollution • Air pollution contributes to climate change 	<ul style="list-style-type: none"> • Increased risk of breathing related diseases • Increased risk of cancer • Increased accidents • Traffic congestion causes increased levels of frustration and ‘road rage’ 	<ul style="list-style-type: none"> • People may be late for work • Deliveries may be delayed which affects how well businesses can operate and can cause them to lose money

Traffic management - London

London is home to around 9 million people and its transport systems are used by millions of people each day. Several strategies are used to manage the traffic in London.

- **Boris Bikes (officially called Santander Cycles)** is a bike rental scheme which aims to encourage people to ride bikes instead of using a car to reduce traffic on roads. There are over 5,400 bicycles available for hire. A credit or debit card is used in a docking station to release a bicycle. The first 30 minutes of each journey is free, longer journeys cost £2 for each extra 30 minutes. Bikes can be returned to any docking station in London. If the bicycle is damaged or not returned the card is charged to replace the bike which means very few bikes are damaged or stolen each year.
- An **Oyster card** is a card or app that can be pre-loaded with money so travellers can get around London on the Tube (underground railway) or the bus quickly. Passengers simply swipe the card or scan the app to go through the barriers, or on the bus to make a payment. This makes travelling on public transport faster as a ticket for each journey does not have to be purchased and reduces traffic by encouraging travellers to use public transport rather than drive. This means that there are fewer cars on the roads.
- **The London Underground** (also known as the Tube) transports around 3 million passengers a day on underground trains. It does not use the roads so reduces car use.

Sustainable urban living – East Village (Olympic Park in London)

One of the more sustainable urban communities in the UK is East Village in London. It was built as flats and apartments for the Athletes’ Village for the 2012 Olympic Games and then converted into new homes after the Games. A key aim of the 2012 Olympics was for London to be ‘the most sustainable Games ever’. East Village provided 2,800 new homes for both local residents and newcomers to the area.

- **Modern apartments** were built to high standards of insulation and energy efficiency. Less heat is lost from apartments than from standard houses.
- **Efficient transport system** - bus services and trains connect to the London Underground and Stratford international station provides fast routes to central London and Europe. This means that residents of East Village do not have to own a car to travel around the city. Car parking space is provided but residents must pay extra. There are good cycling and walking routes to encourage residents out of cars.
- **Green open spaces** were built. 10 hectares of parkland, with hundreds of planted trees and ponds, encourage wildlife and help purify the air. This is environmentally sustainable because trees act as a **carbon sink** (convert carbon dioxide into oxygen) so East Village has high levels of air quality.
- **Green roofs** encourage more wildlife and intercept rainfall, which helps to prevent flooding by slowing down the rate at which water drains off.
- **Affordable housing** - East Village is **economically sustainable**. Half of the homes are rented at lower rates so people on lower wages can afford them. Local shops and services are run by small, independent businesses which keeps money in the local economy by avoiding the need to shop elsewhere.

Question 2: The changing economic world

Measuring development

Development describes when a country is improving. Development means the progress in economic growth, social welfare and technology in a country. When a country develops it gets better for the people living there and their **quality of life** improves e.g. their wealth and health. The difference in development between more and less developed countries is called the global **development gap**.

Gross National Income (GNI) per capita - an economic measure of development

- GNI is the total value of goods and services produced in a country over a year, including overseas investment. It is measured in US\$. Per capita means per person so the total GNI is divided by the population. As a country develops, GNI per capita increases.
- Limitations – just using wealth to determine the development of a country can cause problems. GNI can be misleading when used on its own because it is an average so variations within a country don't show up. For example, wealthy people in big cities may have much higher measures of development than the poor in rural areas. GNI per capita also does not consider any social measures of development.

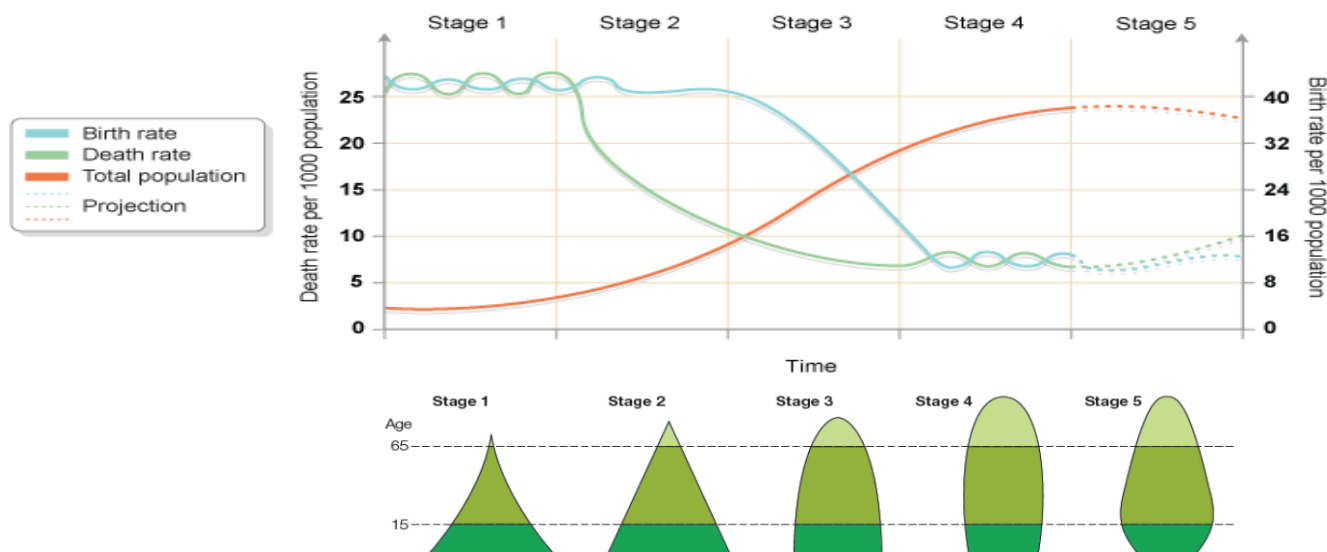
Social measures of development – these measure the health of a population

Life expectancy	The average number of years a person is expected to live. As a country develops, life expectancy increases.
Literacy rate	The percentage of people who can read and write. As a country develops, literacy rate increases.
Infant mortality rate	The number of babies who die under one year old per 1,000 births a year. As a country develops, infant mortality rate decreases.
People per doctor	The average number of people per doctor. As a country develops, people per doctor decreases.
Access to safe water	The percentage of people who have access to clean water. As a country develops, access to safe water increases.

HDI: Human Development Index – measures life expectancy, average years of schooling and GNI per capita. This is more reliable than GNI because it combines both social and economic measures.

Global groupings by economic development	
LIC (Low Income Country)	A group of around 30 countries classified by the World Bank as having low average incomes (GNI per capita). Agriculture is a large part of their economies.
NEE (Newly Emerging Economy)	Around 80 countries that have begun to experience higher rates of economic growth, usually due to rapid growth of factories and industrialisation (when a country's economy shifts from agriculture to manufacturing).
HIC (High Income Country)	A group of around 80 countries classified by the World Bank as having high average incomes. Their economies are mainly based around office work rather than factories.

The Demographic Transition Model (DTM)



- The DTM shows how changing birth rates and death rates affect population growth.
- When the birth rate is higher than the death rate, more people are being born than are dying, so the population grows — this is called **natural increase**. It is called **natural decrease** when the death rate is higher than the birth rate.
- Birth rates and death rates differ from country to country. This means that population growth is faster in some countries than others, especially in LICs.
- Changing birth and death rates are linked to a country's economic development.

Stage 1	<ul style="list-style-type: none"> • Stage 1 is the least developed. • Birth rate is high because there's no use of contraception. People also have lots of children because poor healthcare means that many infants die. • Death rate is also high due to poor healthcare or famine, and life expectancy is low (few people reach old age). • The economy is based on farming, so income is very low.
Stage 2	<ul style="list-style-type: none"> • Stage 2 is not very developed — many LICs are in stage 2. • The economy is based on agriculture, so people have lots of children to work on farms, which means that birth rates are high. • Death rates fall due to improved healthcare and diet so life expectancy increases.
Stage 3	<ul style="list-style-type: none"> • Stage 3 is more developed — most NEEs are at stage 3. • The birth rate falls rapidly as women have a more equal place in society and better education. The use of contraception increases, and more women work instead of having children. • The economy also changes to manufacturing, so income increases and fewer children are needed to work on farms. • Healthcare improves so life expectancy increases.
Stage 4	<ul style="list-style-type: none"> • Stages 4 and 5 are the most developed — most HICs are at one of these stages. • Birth rates are low because people want possessions and a high quality of life, and may have dependent elderly relatives, so there is less money available for having children. • Healthcare is good so the death rate is low and life expectancy is high. Income is also high.
Stage 5	<ul style="list-style-type: none"> • Birth rates become lower than death rates causing a natural decrease. This results in an ageing and declining population. This has happened in Germany and Japan. Here, the population is ageing and there are fewer young people. • This is caused by increasing numbers of women choosing to follow a career rather than have a large family.

Causes of uneven development

Economic

- **Poor trade links** - Global trade is when one country buys (imports) or sells (exports) goods to another country. If a country is trading more with other countries, its economy will grow. If a country's economy grows it can then invest more in healthcare, education and other infrastructure to improve the quality of life for people. If a country trades less, then these improvements happen at a much slower rate.
- **Economy based on primary products** - primary products are natural raw materials that are "extracted" from the land or ocean, for example; bananas, cocoa, apples, iron ore, tin, gold, oil, fish. When a primary product is processed (or manufactured) into another product, for example cocoa into chocolate, it increases in value drastically. Processing adds value to a product, and this takes place in HICs. In this way, HICs get richer and but LICs are not able to develop.
- **Debt** – many LICs borrow money from other countries and international organisations e.g. to help cope with the aftermath of a natural disaster. This money must be paid back with interest. Any money a country makes is used to pay back the debt, so isn't used to develop their own country.

Physical factors

- **Climate related diseases** - Tropical Africa, South America and Asia have more climate related diseases and pests than cooler parts of the world. Malaria is a disease transmitted by mosquitoes in many tropical regions. Malaria affects the ability of the population to stay healthy enough to work, and the costs and medical care needed to are a drain on the economy of a country.
- **Landlocked countries** - The most landlocked countries on Earth are in Africa. This means a country is only bordered by land, with no access to the sea. If a country cannot access the sea without travelling through another country, trade is slower because of the longer time it takes to transport goods.
- **Extreme weather** - Extreme weather, such as cyclones, droughts and floods, often hits tropical regions – Africa in particular is badly affected by drought. Drought is a prolonged period of abnormally low rainfall, leading to a shortage of water. Droughts can lead to a loss of livestock which leads to farmers losing income and struggling to feed their families. Droughts can also lead to a lack of food which makes people unable to work. An extreme weather season can slow development and it can be costly to repair damaged infrastructure, meaning money cannot be spent on education or healthcare and other essential services that support development.

Historical factors - colonialism

A colony is a country or area under political control of another country and occupied by settlers from that country. These colonies were exploited for their natural resources and as a result this slowed the rate of their economic development. During the 1700s and 1800s, most of the 'global south' was colonised by European nations such as Britain, France and Spain.

- **Slavery** - The transatlantic slave trade involved the removal and transportation of people from Africa to North America to work as slaves. The slaves were then traded for goods such as coffee, tobacco and sugar which were taken back to Britain and sold. Most Africans taken as slaves were young, fit and healthy as these people would obtain the highest price and profit. The removal of such a large amount of people from a continent seriously limited the availability of people available within the country to work.
- **Removal of raw materials** - Many valuable natural resources and raw materials were also taken by colonial powers such as cotton, gold and coffee. This meant that the country that these were removed from did not have the opportunity to exploit these resources themselves and therefore could not trade with other nations to support their economy and develop. These raw materials were manufactured by the colonial powers into more expensive goods and sold back to African nations which meant that they were dependent on Europe.
- **Conflict** - Today, Africa contains 54 countries, most of which have borders that were drawn during the era of European colonialism. Since colonialism, African states have frequently been hampered by instability, corruption and violence. The modern borders of many African countries fit badly with the distribution of different ethnic groups across these regions. Five million deaths have been linked with ethnic conflicts in DR Congo, Uganda and Rwanda in the 1990s.

Consequences of uneven development

Wealth - there is a global disparity in wealth. North America (USA and Canada) holds 35% of total global wealth but Africa's share of global wealth is only around 1%. **Inequalities** (differences in wealth) exist at all scales but also within all countries. Areas of poverty can be found in parts of the UK and USA, and areas of great wealth can also be found in some of the world's poorest countries.

Health - there is a strong link between development and the quality of healthcare in a country. If a country is wealthy then it can invest in healthcare which in turn **increases life expectancy**. In LICs, this investment in healthcare cannot take place and therefore its population are more likely to die from disease. The main causes of death in HICs are heart/lung disease, cancer, dementia and diabetes. In LICs, the main causes of death are lung infections, malaria and HIV/AIDS.

International migration - migration is the movement of people from one place to another. The **host country** is the country that migrants move to. The **source country** is the country that migrants move from e.g. if migrants move from Poland to the UK - Poland is the source country and the UK is the host country.

- Since the start of the Syrian Civil War in 2011, 5 million people have migrated to other European countries in search of a better life. Over 17,000 Syrian refugees have settled in the UK since 2015.
- **Positive consequences** of international migration - migrants from LICs/NEEs often send home **remittances** which significantly increases the economy of source countries. In Nepal, remittances contribute 25% of GNI.
- **Negative consequences** of international migration – the migration of highly skilled workers from LICs or NEEs, such as doctors, causes a '**brain drain**' of skilled human resources. This can lead to uneven development because there are fewer **formal workers** left in the source country who can be taxed.

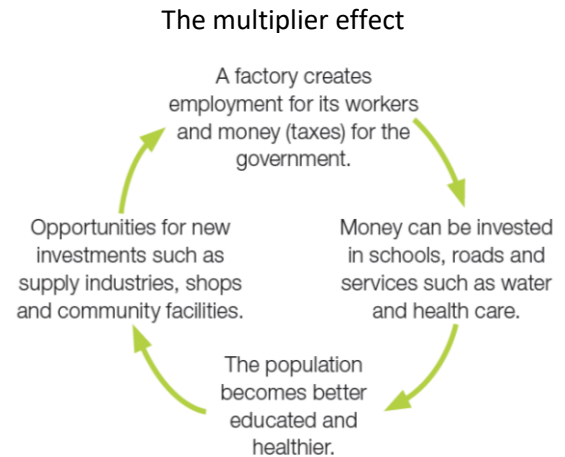
Strategies used to reduce the development gap

Strategy	What is it?	How it reduces the development gap
FDI (Foreign Direct Investment) and industrial development	Where a country or a TNC invests money in another country. (TNC - transnational corporation - a company that operates worldwide.	Over 2000 Chinese TNCs have invested billions of dollars of FDI in African countries, for example by funding a power plant in Zimbabwe. This leads to industrialisation where a country's economy moves away from agriculture into manufacturing. This creates the multiplier effect (see diagram on page 51) from employment in new industries and workers are taxed by the government. Tax is invested in improving infrastructure such as schools, hospitals and roads which leads to a healthier and better educated population.
Intermediate technology – Afridev handpump	Technology that is small-scale, easy to use and can be maintained/repaired by the local community.	Water Aid provided a village in Tanzania (Africa) with a well fitted with an Afridev hand pump . Villagers can now drink safe underground water resulting in an increase in life expectancy due to fewer deaths caused by drinking unclean water, and children miss fewer days of school from illness.
Aid	When a country or organisation donates money or resources to help a country develop.	Goat Aid from Oxfam in Malawi bought families a goat which is a food source, providing both milk and meat. The milk can be sold to pay for food and education, and goats can be bred easily and sold at market.
Microfinance	A small loan that is given to people in poor communities to improve their quality of life.	The Grameen Bank in Bangladesh has provided 8.4 million people with small loans. 97% of these people are women. Some women in a Bangladeshi village have used a microfinance loan to purchase a mobile phone. Villagers pay to use the phone to keep in touch with relatives who have moved to the city, check prices before they go to market, and receive health advice.

Debt relief	When a poor country's debt is written off (they don't need to pay it back).	LICs often borrow money from another countries. However, the money borrowed must be paid back with interest. Debt relief means the money borrowed does not need to be paid back and instead can be spent on developing the country e.g. improving hospitals and schools. For example, in Tanzania free education is now available, resulting in a 66% increase in attendance.
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Fairtrade

- The result of international trade is that producers of **primary products** - such as tea, coffee, sugar, cocoa or cotton - in LICs lose out with low wages and poor working conditions. With little money they cannot afford essentials such as primary education for their children.
- Fairtrade means that **producers receive a guaranteed and fair price for their products** - the price will not decrease once it has been agreed. Small scale producers (farmers) group together to form a cooperative then deal directly with companies such as Tesco or Sainsbury's. This gives them better prices for products such as bananas, coffee, tea and cocoa. This means that farmers will improve their income and their family's quality of life.
- Fairtrade products usually cost more in supermarkets (e.g. Fairtrade coffee will cost more than a standard coffee brand), but many consumers (us) consider this a small price to pay for the benefits they bring.
- However, Fairtrade only accounts for 1% of world trade, possibly because products are more expensive.



How tourism can reduce the development gap in LICs and NEEs - Tunisia

In 2019, around 9.5 million international tourists visited Tunisia. These are some of the reasons why:

- Climate – hot summers and mild, warm winter.
- Links with Europe – Tunisia's northern coastline is close to Europe.
- History and culture – Tunisia contains seven UNESCO World Heritage Sites.
- Tunisia's physical geography is diverse, ranging from Mediterranean beaches to the Dorsal Mountains and Saharan Desert. Many films, such as the Star Wars films, were shot there.

Economic benefits of tourism in Tunisia	Social benefits of tourism in Tunisia
<ul style="list-style-type: none"> • In 2016, the industry provided 370,000 jobs. • In addition to money spent on hotels, tourism boosts the income of many Tunisian businesses. • Increase in profit for local farmers that provide food for hotels. 	<ul style="list-style-type: none"> • 4% of GDP invested into healthcare so life expectancy in Tunisia has risen from 42 to 75. • Literacy rates have increased from 66% to 79% because families can afford to send children to school and even university. Schooling is now compulsory for girls, and women are entering higher education in increased numbers.

Negative impacts of tourism in Tunisia

- **Pollution of the environment** – some of Tunisia's Mediterranean beaches have been polluted with untreated sewage from hotels.
- **'Leakage' of profits** – foreign companies like Thomas Cook send holidaymakers to Tunisia but keep a large percentage of the profits. Less money is reinvested locally and slows down the rate of economic development.
- **Terrorism** – in 2015, there were two terrorist attacks aimed specifically at tourists. As a result, European governments say Tunisia is no longer a safe destination for their citizens. This sadly means less foreign investment in Tunisia's economy. The terrorists have attacked the tourist industry because they object to some of the ways in which Tunisia is developing, such as greater equality for women.

Nigeria case study - a NEE that is experiencing rapid economic development

Location and importance of Nigeria

- Nigeria is located in West Africa. The south coast of Nigeria is on the Atlantic Ocean. Located just to the north of the Equator, Nigeria has a range of climates and natural environments, with tropical rainforests in the south and semi-desert in the north.
- Nigeria is the most populous and economic powerful country in Africa. The population of Nigeria in 2018 was 196 million, three times that of the UK. In recent decades economic growth, mostly based on oil, has transformed the country from an LIC to a NEE.



Global importance	Regional importance
<ul style="list-style-type: none"> • Nigeria is the world's 21st largest economy and has experienced a rapid growth in GNI. • Nigeria is ranked 7th in the world by size of population. • Nigeria is the world's 12th largest oil producer. It exports over \$40 billion in oil every year. • Nigeria plays an important peacekeeping role in world affairs. 	<ul style="list-style-type: none"> • Nigeria is one of Africa's fastest-growing economies and has the highest GNI on the continent. • Nigeria has the third-largest manufacturing sector in Africa and the continent's highest population. • Nigeria has the highest farm output in Africa and has the highest amount of cattle.

Nigeria's wider context

- **Political** - For many years, Europeans exploited African resources and promoted slavery. Nigeria achieved independence from the UK in 1960 but then experienced political instability with a civil war between 1967-1970. From 1999 the country has been largely stable with fair elections held in 2011, 2015 and 2019. This stability has encouraged investment from foreign TNCs in China (construction projects), South Africa (banking) and the USA (IBM and Microsoft). However, the rise of the Islamic fundamentalist group Boko Haram has hindered the economic development in the north of Nigeria.
- **Social** - Nigeria is a multi-cultural, multi-faith society including the Yoruba (mainly Christian) and the Hausa (mainly Muslim).
- **Cultural** - Nigeria has a thriving music and film sector, with its own version of 'Bollywood', called 'Nollywood' – one of the largest film industries in the world. The Nigerian football team has won the African Cup of Nations on three occasions and several players play for Premier League clubs in the UK.
- **Environmental** – To the south, high rainfall means there is tropical rainforest. Cocoa, rubber and palm oil are grown in this region. Further north, rainfall decreases and grassland (savanna) replaces trees. Here, local people grow crops such as millet and cotton, and cattle graze on the savanna. The far north has semi-desert conditions where farmers move around the region with their cattle.

Nigeria's changing industrial structure and economy

- Despite Nigeria having the largest economy in Africa, almost 100 million people live on less than \$1 a day. Wealth is focused in the south around Lagos, with greater poverty in the north.
- Nigeria's industrial structure has significantly changed. The economy used to be dominated by farming but increased rural-urban migration and rapid industrialisation means that over 50% of Nigeria's GNI now comes from the manufacturing and service sectors (finance, communications and retail).
- The oil and gas industry are vital to Nigeria's economy. Discovered in the 1950s, oil and gas attracted huge amounts of FDI from foreign TNCs and account for about 95% of Nigeria's export earnings.

New manufacturing industries stimulate economic growth by:

- encouraging the establishment of other linked industries that supply raw materials and components.
- increasing employment opportunities and higher wages that increases consumer demand (more people can buy luxuries from shops). This increases the market and leads to further growth of industry.
- increased employment results in higher taxes that is used by the government to improve social conditions.

The role of TNCs in Nigeria's economic development

Advantages of TNCs	Disadvantages of TNCs
<ul style="list-style-type: none"> TNCs bring new investment (FDI) into the country's economy. Companies often invest in the local area and improve local services e.g. roads and electricity. TNCs provide skilled jobs and introduce modern technology and training which benefits the local workforce. The government benefits from export taxes that can be spent on improving education and health care. 	<ul style="list-style-type: none"> Working conditions may be poor because of fewer rules and regulations than in HICs e.g. long working hours and unsafe conditions. TNCs may take profits out of the country to pay shareholders or to invest elsewhere so it does not benefit Nigeria. Can cause environmental damage and deplete natural resources (e.g. Delta region oil spill).

Effects of economic development on quality of life in Nigeria

Royal Dutch Shell, a British/Dutch oil and gas company is one of the largest TNCs in the world. FDI and expertise from Shell helped to develop Nigeria's oil and gas industry.	
Advantages	<ul style="list-style-type: none"> Shell provided direct employment for 65,000 Nigerian workers and a further 250,000 jobs in related industries. This has given many Nigerians a higher disposable income to spend on schooling, home improvements, food and clothes. 91% of Shell contracts were given to Nigerian companies. The company have made major contributions in taxes and export revenue which the government can invest in education and health infrastructure.
Disadvantages	<p>Environmental impacts of economic development</p> <ul style="list-style-type: none"> In 2008, the Bodo oil spill in the Niger Delta was caused by leaks in a major pipeline. 11 million gallons of oil spilt over a 20 km² area of creeks and swamps, destroying natural habitats and contaminating local water sources. 40,000 residents of the Bodo community relied on fishing as way of life. Local fish farmers lost their source of income and the price of fish rose as much as ten times. The oil spill caused fires, sending carbon dioxide and other harmful gases into the atmosphere.

Due to investment by Shell in Nigeria, overall quality of life has improved:

- Life expectancy has improved from 46 years in 1990 to 55 years in 2020.
- Access to safe water has increased from 46% to 64%.
- Healthcare has improved with more funding for doctors and better-equipped hospitals which has reduced the infant mortality rate.

However, not every Nigerian citizen's quality of life has improved due to economic development.

- There have been cases of government corruption where money from oil wealth was not invested in improvements that will benefit society.
- Income from oil does not always remain the same so price drops may threaten Nigeria's economy and future economic development.
- Many people in rural parts of Nigeria are still poor. Access to services such as safe water, sanitation and reliable electricity is still a problem.

Nigeria's political and trading relationships with the wider world

Political

- Until 1960 Nigeria was part of the British Empire. Since becoming independent in 1960, Nigeria has become a member of the British Commonwealth. Although Nigeria is a republic, it recognises the Queen as the Head of the Commonwealth.
- Nigeria's political role has changed in recent decades. It has an important role as peacekeepers as part of the United Nations.

- Nigeria has developed strong links with China, for example benefitting from US\$12 billion to develop a new 1400km railway. China is investing in Nigerian infrastructure as the country needs resources, such as oil, that it cannot provide itself.

Trading

- Nigeria belongs to several economic trading groups including OPEC (Organisation of Petroleum Exporting Countries).
- Main exports – almost 50% of Nigeria’s exports are to the EU which include crude oil, natural gas, rubber, cocoa and cotton. Most of Nigeria’s crude oil is exported to India, China, Japan and South Korea.
- Main imports - refined petroleum from the EU and the USA, cars from Brazil, mobile phones, rice and wheat. One of the fastest-growing imports is mobile phones. Imported from China, these are in demand from Nigeria’s growing population and emerging middle class. Nigeria ranks 7th in the world for the number of mobile phones used (the UK is 16th).

Impacts of international aid on Nigeria

<p>Official Development Assistance (ODA) - this is aid given by governments that is paid for by taxes. The UK gave 0.7% of its GNI as international aid in 2017, around £14.1 billion.</p>	<ul style="list-style-type: none"> • Multilateral aid is given by countries through international organisations like the World Bank or the International Monetary Fund (IMF). • Bilateral aid is given directly by one country to another. Sometimes it is tied aid with conditions attached e.g. the recipient country may be required to buy goods from the donor country with the aid money.
<p>Voluntary Aid - this is given by individuals or companies and distributed through charities or non-governmental organisations (NGOs) like Oxfam.</p>	<ul style="list-style-type: none"> • Short term emergency relief is to cope with immediate problems caused by disasters e.g. earthquakes or war. • Long-term development assistance helps people improve their lives through education and healthcare.

- Nigeria receives about 4% of total aid given to African countries. The amount of aid to Nigeria is around US \$5000 million a year which comes from the World Bank and countries like the USA and the UK.
- Aid has benefitted many Nigerian people, often through small community based projects supported by small charities and NGOs. An example is **60 million mosquito nets** were given out by a World Bank, IMF and USA funded scheme. This reduced the number of deaths by malaria and increased life expectancy.
- However, corruption in the government, and by individuals, is a major factor in loss of aid. The government may divert money to be used for other purposes. For example, there are claims that aid may have been used to build up Nigeria’s navy.

Economic change in the UK

How has the economy of the UK changed?

- Before 1800 most people in the UK worked in farming or mining – the **primary sector**. Over 75% of jobs were in the primary sector.
- In the 1800s, the Industrial Revolution caused many people to migrate from rural areas of the UK to towns and cities for work – for example, construction work in the ship and train industries, or textiles (clothes). This is the **secondary or manufacturing sector**.
- From the 1980s, there was a big shift from manufacturing to jobs in the **service (or tertiary) sector**. Examples of this are health care, office work, financial services and retail. In 2015, 78% of jobs were in the service sector with only around 2% of work in the primary sector. Retail is the UK's largest sector, employing over 4 million workers.
- More recently, the **quaternary sector** has developed, and the UK is now a world centre for financial services, media, research and IT. In 2015, 10% of jobs were in the quaternary sector.

Why has the economy of the UK changed?

De-industrialisation	<p>The decline in manufacturing (secondary) industry and the subsequent growth in tertiary and quaternary sectors. In the UK this has happened because:</p> <ul style="list-style-type: none"> • machines and technology have replaced many workers in modern industries, such as car production. • LICs/NEEs, for example China, Bangladesh, and Indonesia, can produce cheaper goods because labour there is less expensive. • high labour costs and outdated machinery made it too expensive to manufacture products in the UK.
Globalisation	<p>Globalisation is the growth and spread of cultures, people, money, goods and information around the world. Globalisation has been made possible by developments in transport and the internet. It has boosted world trade and led to more products being imported to the UK, which has led to the decline in UK manufacturing.</p>
Government policies	<p>Since 2010, the UK government has tried to rebuild the UK's manufacturing sector and rely less on service industries, in particular the financial sector. Government policies have included improvements to transport infrastructure such as the high-speed rail connection HS2, more investment in manufacturing industries and encouraging global TNCs to locate within the UK.</p>

The UK's post-industrial economy

A post-industrial economy is where manufacturing industry declines and is replaced by growth in the service sector and the quaternary sector. This happened in the UK from the 1970s. By 2015, 78 per cent of UK employment was in the tertiary sector and 10 per cent in the quaternary sector. Only 10 per cent of employment in 2015 was in manufacturing compared to 55 per cent in 1900.

- **Development of information technology** - the use of information technology (IT) is one of the main factors in the UK's move to a post-industrial economy. Over 1.3 million people work in the IT sector in the UK for global companies such as Google, Microsoft and IBM. High-speed broadband enables many people to work from home and communicate instantly across the world. The UK is one of the world's leading digital economies, attracting businesses and investment from abroad.
- **Service industries and finance** - workers in the service sector produce services rather than products. The UK service sector has grown rapidly since the 1970s and contributes over 79 per cent of UK economic output, compared with 46 per cent in 1948. Finance is an important part of the service sector, which includes banking and insurance. The UK is the world's leading centre for financial services, with the City of London as the UK's financial centre. The financial services sector employs over 2 million people and contributes around 10 per cent to the UK's GDP.
- **Research and development (R&D)** – this is part of the quaternary sector and employs over 60,000 highly qualified workers, contributing an estimated £3 billion to the UK economy each year. Research takes

place in British universities, such as Cambridge, Manchester and Edinburgh, as well as by private companies. In 2013, around £30 billion was spent on R&D in the UK.

- **Science and business parks** (examples of quaternary industries) - a **science park** is a group of scientific and knowledge-based businesses located on one site. There are over 100 science parks in the UK employing around 75,000 people. Most are associated with universities which allows them to use research facilities and employ skilled graduates. A **business park** is an area of land occupied by a cluster of businesses. Business parks are usually located on the edges of towns because land tends to be cheaper than in town centres and there are good transport links to motorways, A roads and airports for the distribution of goods. Businesses can also benefit by working together as they are on the same site.

Impacts of industry on the physical environment – the car industry

- The car industry is one of the few large-scale manufacturing industries left in the UK. More than 1.5 million new cars are made in the UK every year by companies such as Nissan (a Japanese TNC). The car industry has a large impact on the environment. In cities, car emissions are one of the main causes of air pollution. The main pollutants from burning fuel in cars are carbon dioxide (the main greenhouse gas), nitrogen dioxide (a cause of breathing problems) and particulates (tiny particles, which also cause breathing problems).
- Cars also have other environmental impacts during their lifetime, including the resources required for their manufacture (which includes steel, rubber, glass, plastic, paint and fabric). At the end of the life of a car, some components are hard to recycle while the acid in batteries can leak into the environment.

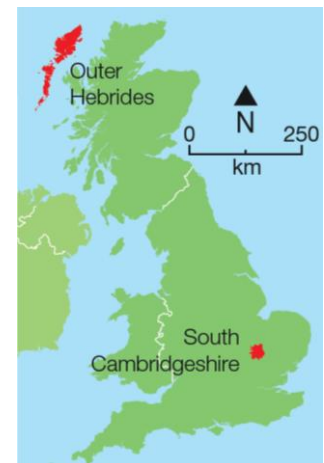
How modern industrial development can be more environmentally sustainable - the Nissan Leaf

- The average CO₂ emissions from new cars are falling, the amount of energy and water used in production has declined, and there has been a large decrease in the amount of waste going to landfill sites at the end of a car's life.
- Nissan provides 8000 jobs in Sunderland in north east England, and thousands more jobs in related industries. The **Nissan Leaf** is an electric car which is powered by battery instead of fossil fuels so emits no carbon dioxide. The Leaf is also manufactured from easily recyclable materials.

The social and economic changes in rural areas of the UK

Population growth in a rural area – South Cambridgeshire

South Cambridgeshire surrounds the city of Cambridge in southern England. The population of 150,000 is increasing due to migration into the area. Migrants have mostly come from Cambridge and other parts of the UK, with more migrants arriving from Eastern Europe. The population of South Cambridgeshire is estimated to reach 182,000 by 2031.



Social effects of increasing population

- The proportion of people in South Cambridgeshire aged 65 or over is growing – by 2031 this will reach nearly 29 per cent of the population. This means the area will have an **ageing population**.
- 80% car ownership is leading to increased traffic on narrow country roads and reducing demand for public transport.
- Young people cannot afford the high cost of houses so are forced to move to urban areas with more affordable rents.

Economic effects of increasing population

- South Cambridgeshire has some of the highest petrol prices in the country due to the high demand.
- The increasing number of migrants from relatively poor parts of Europe leads to increased pressure on local services e.g. longer wait times for GP appointments and fewer school places for children.
- Lack of affordable housing, especially for young people.

Population decline in a rural area: The Outer Hebrides

The Outer Hebrides is a chain of 65 islands off the north west coast of Scotland. It has a population of 27,400 people, with most living on the island of Lewis. Despite a small population increase in recent years, there has been an overall decline of more than 50 per cent since 1901 when 46,000 people lived on the islands. The decline is mainly due to outward migration. With limited opportunities, younger people were forced to move away from the area in search of better-paid employment elsewhere.

Social effects of a declining population	Economic effects of a declining population
<ul style="list-style-type: none"> The number of school children is expected to fall over the next few years which may result in school closures. Younger people moving away will lead to fewer people of working age. An increasingly ageing population with fewer young people to support them may lead to care issues in the future. 	<ul style="list-style-type: none"> Essential services, such as post offices and bus services, have been forced to close or reduce in number. Agriculture and fishing industries are declining, reducing profits and money made through taxes. Fishing boats have declined from 900 in 1901 to under 10 today.

Improvements in the UK's transport infrastructure

Improvements in transport have enabled the UK's economy to grow and there are plans to continue to develop transport into the future.

Road improvements	<ul style="list-style-type: none"> In 2014 the government announced the Road Investment Strategy, a £15 billion project to increase the capacity and improve the condition of UK roads. A smart motorway is a stretch of road where technology is used to control traffic flow and ease congestion. The aim of smart motorways is to improve road links between London and the north, making travelling faster for commuters and HGVs transporting goods across the country. Smart motorways removed the hard shoulder (a spare lane for vehicles to use in case of breakdown) to provide an extra lane. Emergency refuge areas are provided at regular intervals for cars that get into trouble. The project created thousands of construction jobs and boosted local and regional economies, as well as aiming to improve road links between the north and London. In April 2023, the building of all new smart motorways was cancelled over cost and safety concerns. Smart motorways use the hard shoulder as an extra lane of traffic - critics claimed this has led to more road deaths.
Rail improvements	<ul style="list-style-type: none"> HS2 (High Speed 2) is a planned high-speed rail network, from London to Birmingham and Birmingham to Manchester. It is expected to be fully completed by 2040. HS2 aims to spread wealth from the south to northern areas through the multiplier effect. Commuters who live in northern England can take advantage of fast travel times to work in London but live in the north where the cost of living is lower. Journey times between main cities will be reduced. For example, the journey time from London to Manchester would be reduced by almost 1 hour. However critics argue that places further away from the line, like Wales and Scotland, aren't expected to see any economic benefits. In November 2021, the government announced that the originally planned eastern leg connecting Birmingham to Leeds would be scrapped. Many people are against the plan as the HS2 route passes through several areas of countryside and close to many homes. In addition, the budget of the scheme was initially £36 billion but is likely to increase to over £100 billion (or even more if HS2 is not completed by the deadline).
Port improvements	<ul style="list-style-type: none"> The UK port industry is the largest in Europe with most of the ports handling container ships that import and export goods. About 32 million passengers travel through UK ports each year and employ around 120,000 people. Felixstowe, in south

	<p>east England, is the UK's busiest container port dealing with 48% of Britain's containerised trade.</p> <ul style="list-style-type: none"> • Liverpool2 is a new £300 million container terminal that opened in 2016 at the Port of Liverpool. The project more than doubled the port's capacity to over 1.5 million containers a year to compete with other major UK ports. Construction of the new terminal created thousands of jobs, has reduced the amount of freight traffic on roads and boosted the economy of the north-west.
Airport improvements	<ul style="list-style-type: none"> • Airports are vital to the economy of the UK as they create global links to other countries. The aviation sector accounts for 3.6 per cent of the UK's GDP and employs over 300,000 people. Over two million tonnes of freight pass through the UK's airports each year, and more than 750,000 international flights depart from the UK annually, to almost 400 airports in 114 countries. • There has been much controversy about the need to expand London's airport capacity. Many options have been discussed in recent years including the development of a third runway at Heathrow Airport. According to the Department for Transport, the expansion would boost the wider economy by up to £61bn and create up to 77,000 local jobs by 2030. • Residents that live nearby Heathrow are concerned about noise from planes using the new runway. Environmentalists are concerned that the new runway will lead to increased carbon emissions, which does not fit with the government's commitments to tackle climate change.

The north-south divide

- The north-south divide is the cultural and economic differences between the south of England (the South East, Greater London, the South West and parts of eastern England) and the north of England (Yorkshire, the North East and North West) and the rest of the UK.
- In general, the south has a longer life expectancy and higher incomes. For example, life expectancy for male babies born in Glasgow in 2012 was 72.6 years, but in East Dorset it was 82.9 years. Another example is the 2014 average weekly wage was 40% lower in Huddersfield than London. GCSE results are generally better in the south of England than the Midlands or the north.

Why is there a north-south divide in the UK?

- During the Industrial Revolution the UK's growth was centred on coal mines in Wales, northern England and Scotland. Heavy industries and engineering thrived in cities such as Manchester, Sheffield and Glasgow, generating wealth in these areas.
- Since the 1970s many industries such as steel-making and ship building have declined (deindustrialisation) and renewable sources of energy have reduced the importance of coalfields.
- London and the South East developed rapidly due to a fast-growing service sector. London is a major global financial centre and has grown faster than the rest of the UK leading to high house prices across the South East.



How can regional strategies address the issue?

There have been many attempts to address the problems caused by de-industrialisation in the north. In 2015 the government launched a new strategy for a 'Northern Powerhouse' to help balance the wealth and influence of London and the South East by developing the economies of major cities in northern England.

- **Foreign Direct Investment (FDI)** has been encouraged in the north – for example, the Japanese car maker Nissan in Sunderland opened in 1984.
- **Improvements in transport infrastructure** (see previous page) - the HS2 project aims to dramatically reduce travel times between London and the north so commuters can work in London, benefit from the high salaries, and live in the North where living costs are lower.
- **Local Enterprise Partnerships**, such as **Lancashire LEP** - 400 businesses in Lancashire were given funding and infrastructural improvements in order to boost the economy in the North. De-industrialisation led to many factory closures and job losses. The Lancashire LEP will promote new businesses and create 50,000 new jobs by 2023. £20 million of transport improvements are planned in urban areas such as Preston and Blackburn, including the major new Heysham to M6 link, and a £62 million BT investment will extend superfast broadband across 97% of the region.

The place of the UK in the wider world

The UK has global links through trade, culture, transport and electronic communications. In the past the British Empire was one of the world's superpowers with colonies in the Americas, Africa and Asia and Australia. Today, the UK is an influential member of important international organisations such as the G7 (Group of 7, an economic organisation consisting of seven HICs), NATO and the UN Security Council.

Trade involves the movement of goods and services across the world transport by air, sea, road and rail. The internet is becoming more important for trade, for example in finance, communications and the creative industries. The UK's most important trading links are with the EU, the USA and China.

Culture is the values and beliefs of a society and includes writing, painting or creativity in the form of film, fashion, architecture or music. Television is one of the UK's most successful media exports. In 2013–14 it accounted for over £1.28 billion of export earnings. The most successful recent programmes worldwide are Downton Abbey, Dr Who and the Peppa Pig cartoons which are screened in more than 170 countries earning US\$1bn (£640m). Today the UK is a multi-cultural society with many citizens from other countries. The global importance of the English language has given the UK strong cultural links with other parts of the world. Migrants have brought their own culture to the UK including food (such as Indian, Chinese and Thai), fashion (from France and Italy), music and films (from the USA) and festivals such as Eid and Diwali.

Transport - London Heathrow is one of the busiest airports in the world. It is an important aircraft hub where people transfer between flights within Europe and worldwide. There are important transport links between the UK and mainland Europe via the Channel Tunnel and sea ferries. Southampton is a major port for cruise ships that take thousands of tourists around the world to destinations such as the Caribbean.

Electronic communication is a vital part of the global economy and fast reliable connections are essential. 99% of all internet traffic passes along a multi-billion-dollar network of submarine (underwater) high-power cables. The UK is a focus for these cables, with connections concentrated between the UK and the USA. There is a further concentration in the Far East connecting Japan, China and other countries in the region.

The UK's links with the European Union (EU)

In 1973 the UK became a member of the European Union. The EU began as a small trading group of industrial countries in north-west Europe. Over the years it expanded to 28 countries, but the UK withdrew on 31 January 2020 following a UK-wide referendum in June 2016 in which 52% voted to leave. However, the EU remains an important trading partner with the UK. During its membership, the EU affected the UK in several important ways:

- Free movement of people and goods between member states (without additional tariffs/taxes) to encourage trade.
- There are EU laws on crime, pollution and consumer rights (but these rules can be restrictive for some individuals and companies in the UK).
- Wealthier members (including the UK) had to support poorer member countries by paying more money to the EU.

The UK's links with the Commonwealth

The UK is a member of the Commonwealth, a voluntary group of 53 countries, most of which were once British colonies under the rule of the British Empire between the late 16th and early 18th centuries. The Commonwealth has 2.2 billion citizens and includes some of the world's largest, smallest, richest and poorest countries. Members of the Commonwealth include Canada, Australia, New Zealand, India, Nigeria and South Africa. 31 members of the Commonwealth are small states, many of them island nations, such as the Maldives and Samoa.

There are important trading and cultural links between the UK and the Commonwealth countries. The Commonwealth Games are an international multi-sport event involving athletes from the Commonwealth of Nations. The event was first held in 1930, and has taken place every four years since.

Question 3: The challenge of resource management

Why resources are important

Resources are anything that we can use. The three most valuable resources for humans are food, water and energy. Food provides energy for humans. Water is used to **irrigate (water)** agriculture, to produce food and clothes in industry, and for washing and drinking. Energy provides electricity that allows businesses, manufacturing and transport to operate, and gas heats homes and buildings. **Social well-being** is the condition in which needs and wants of a given population are satisfied.

Global inequalities in the supply and consumption of resources

In general, HICs/affluent nations are well nourished, consume more energy and experience little or no water scarcity. LICs, in particular African nations, are undernourished, consume less energy and often experience economic water scarcity. HICs have an affluent population therefore there is a high demand for energy, for example electricity to power electronic goods. However, much of the population in LICs live in rural areas so electricity supply is not accessible. Central Africa suffers from a lack of food because it is often difficult to grow crops due to drought.

- HIC countries have much less undernourishment than LIC countries e.g. UK <5% and Botswana 35%+.
- LIC countries also have higher levels of water scarcity e.g. Somalia, Kenya.
- LIC and NEE countries are consuming more energy as they develop and industrialize e.g. China 53% increase between 2003 and 2011.
- Average calories consumption in the UK is 3,200kcal per person and in Somalia it is 1,580kcal per person. There is a strong correlation between areas with high population growth and high levels of undernourishment.

Food in the UK

Demand for food in the UK has increased due to a higher population. We now eat unseasonal products all year round such as strawberries which are imported from Spain and Morocco. Organic food has become more popular in the UK as many believe it is healthier because it does not contain harmful pesticides and fertilizers.

Why the UK imports food

- High cost of food production in the UK
- Demand for seasonal produce all year round
- UK climate means we cannot grow certain produce
- Imported food from abroad is often cheaper than food grown within the UK. This is due to supply and demand – a high supply of food is imported from abroad, so prices are lower.

Impacts of importing food on the environment

A **carbon footprint** measures the impact human activities have on the environment in terms of the amount of greenhouse gases (carbon dioxide) they produce. **Food miles** are the distance food travels from source (where it is grown/made) to markets (shops/supermarkets). Importing food adds to our carbon footprint

because more energy is used to cultivate crops and transport it on planes and lorries, leading to increased levels of carbon dioxide in the atmosphere.

Agribusiness

In order to reduce food miles, more food can be produced locally within the UK. This can be achieved through agribusiness and organic farming.

Agribusiness	Organic farming
<ul style="list-style-type: none"> • Intensive farming on a large scale. • Produced locally so food miles reduced. • Farmers use pesticides and fertilizers to produce as many crops from the land as possible. <p>Example – Lynford House Farm in Eastern England is a large farm of 570 hectares. Chemicals are widely used as pesticides and fertilisers. Machinery costs are high but make the farm efficient. The farm only employs a small number of workers.</p>	<ul style="list-style-type: none"> • Farms usually small in size so organic food is more expensive than food created on larger farms that use pesticides (agribusiness). • Produced locally so food miles reduced. Does not use chemical fertilisers. <p>Example – Riverford Organic Farm in Devon (SW England) delivers organic vegetables to homes in around the UK.</p>

Water in the UK

How water is distributed across the UK

Annual rainfall is highest in western areas of the UK, in particular in the Scottish Highlands in northwest Scotland. Rainfall is also high in Wales. The reason for this is **relief rainfall** – a type of rainfall caused when air is forced to rise over mountains. Air cools to form clouds and relief rain falls in areas surrounding the mountains. Rainfall is much lower in central and eastern England in areas such as London, Nottingham and East Anglia.

Water stress is when there is not enough water to meet demands of the population, or when the water available is poor quality and unsuitable for human consumption. Areas of the UK experience water stress, especially in recent summers when there has been little rainfall. The prolonged dry weather throughout the summer of 2022 depleted rivers, reservoirs and aquifers. On 12 August 2022, a drought was officially declared in eight of the 14 Environment Agency areas and Yorkshire Water became the fifth water company to announce a hosepipe ban, their first in 27 years.

Why has the demand for water in the UK increased?

Daily demand for water in England and Wales in 2018 was **14 billion litres**. But each day, another three billion litres is lost through leakage. Tackling leaks is a big challenge as some of the 216,000 miles of water pipes date back to the 19th century, according to **Water UK**. By the 2050s, demand for water in England is expected to exceed supply, due to climate change and population growth.

The average person in England and Wales used **152 litres of water a day in 2021**. This means that a household of four could potentially use more than 500 litres of water a day.

1. The **increase in affluence** (wealth) leading to increased use of domestic appliances such as dishwashers and washing machines (older dishwasher models use a lot of water but newer models are more water efficient).
2. **Increased industrial production** (industry uses a lot of water in manufacturing).
3. **Changes in personal hygiene**: most people now shower several times a week. In the past, when houses did not have inside bathrooms, a weekly bath was the norm (shared between family members).
4. The **demand for out-of-season food**, which requires additional watering (irrigation), usually in greenhouses.

5. **Increased leisure use:** for example, golf courses require a great deal of watering to maintain the grass.
6. The **increased UK population** - more people use more water.

Solutions to the UK's water supply problems?

1. One way to meet the demand for water is **water transfer schemes**. These would move water from existing reservoirs, rivers and underground water sources in areas of water surplus to areas of water stress. In the UK, most water transfer schemes move water towards the south where there are higher populations. However, the Environment Agency state only 4% of water supplies are transferred between individual water companies. Scotland has 90% of the UK's freshwater reserves. Transferring or selling water from Scotland to England has been raised but in 2020, the Scottish government said this would not be economically viable.

Concerns about water transfer schemes include:

- dams constructed to create reservoirs on rivers may disrupt habitats
- the increased carbon emissions linked to pumping water over long distances
- potential droughts in river source basins caused by the removal of water to other areas
- the high costs involved in building the infrastructure.

2. Building new **reservoirs** is expensive and planning permission takes a long time. The last new reservoir - at Carsington, in Derbyshire - was built in 1992. Since then, the UK population has risen by about 10 million people and the effects of climate change are being felt.

Water pollution

Common sources of water pollution include:

- Pesticides and fertilisers that run off from farmland
- Oil leaks from boats and ships entering rivers and coastal waters
- The general public putting inappropriate items into the water system e.g. disposing of cooking fat in sinks which can form huge 'fatbergs' in the sewer system
- Untreated waste from industries being released into rivers
- Rubbish such as supermarket trolleys and bicycles being dumped in rivers

A type of water pollution is **eutrophication**. This happens when fertilizers from farms runs off into rivers or lakes when it rains which leads to algae blooms growing rapidly on the surface of the water (algae is a plant that lives in water and can grow rapidly). The algae bloom blocks sunlight which kills other plants in the water. The plants decompose using oxygen taken from the water, causing fish and other animals to die.

Solutions to water pollution

1. **Legislation** – The UK and EU have strict laws which ensure that factories and farms are limited in the amount and type of fluids they put into rivers. Water companies which provide our drinking water and sewage systems have clear regulations and penalties – fines are issued to anyone polluting the water.
2. **Education campaigns** – These inform the public about the damage caused by putting inappropriate items into the sewage system, such as engine oil and baby wipes, and advise how to dispose of them correctly.
3. **Waste water treatments** – Local water treatment plants remove suspended solids such as silt and soil, bacteria, algae, chemicals and minerals, to produce clean water for human consumption. They use a number of processes to do this.
4. **Building better treatment plants and investing in new infrastructure** – Better sewers and water mains can prevent spills and accidents, but can lead to higher water and sewage bills in order to pay for the investment. For example, Thames Water in London is investing heavily in its sewage works, and new tunnels to prevent the overflow of the current sewers.
5. **Pollution traps** – For example, when new roads and motorways are built close to rivers and watercourses, pollution traps such as reed beds are often installed to 'catch' and filter out the pollution.

Question 6: Energy

The **energy mix** of the UK refers to the different sources of energy used by households, industry and other commercial users such as shops and offices.

- Most of the energy we use in our homes is in the form of electricity.
- In 2015, over half of the UK's energy was generated by burning fossil fuels such as oil and coal with 22% of energy generated by renewable sources such as wind and solar.
- ***But by early 2020 this changed – renewables increased to 39% of the UK's energy mix, gas-fired power was also 39%. Coal-fired power only created around 2% of energy.***

How the UK heats homes and workplaces

Until before 2015, the UK mostly relied on coal-fired power stations to generate electricity. This involved burning large amount of coal to create steam. The steam turned turbines which powered a generator that made electricity. In 2020, gas-fired power stations create almost 40% of electricity in the UK. Gas is burnt to produce steam that turns turbines to generate electricity.

Gas is also used to keep our homes and workplaces warm. Most homes use gas boilers to run central heating systems that pump hot water through radiators.

Energy consumption

Energy consumption means use of energy. The more developed a country, the higher the energy consumption. HICs and NEEs consume more energy than LICs. In HICs, the population are more affluent (wealthy) so can afford to buy more electronic devices, and many own cars so consume more fuel. A lot of food is imported so has high food miles. In LICs, fewer people can afford electronic devices or cars so less energy is consumed. More of the population of LICs live in rural areas so do not have access to electricity. Demand for energy is increasing as the world population increases (7.8 billion in 2020).

The **distribution of energy consumption** is uneven and varies across the world. Countries with the highest energy consumption are in the northern hemisphere, in particular the USA and Canada. Some nations have access to an abundance of energy resources such as Russia (gas) and Middle Eastern countries like Iran, who are oil rich. Some countries do not have access to these resources so have to import much of their energy.

Factors that affect energy supply and security

Energy security is the uninterrupted availability of energy sources at an affordable price. A country's energy security can be affected by the following factors below:

- **Cost of exploitation and production** - oil rigs and pipelines are expensive to build so oil can be expensive to extract. Nuclear power plants are expensive to build and so are renewable energy options such as solar plants and wind farms. If a country cannot afford this, then this will affect their energy security.
- **Physical factors** - coal and oil are formed over millions of years and are stored underground. Gas is trapped inside folded layers of rock. Geothermal energy (energy using the heat from volcanoes) can only be used if a country has areas of tectonic activity (on a constructive /destructive plate margin). If countries are not located near these resources, energy security will be reduced.
- **Political factors** - an energy-importing country needs to choose its foreign suppliers carefully. Above all else, they need to be politically stable countries where an uninterrupted supply is guaranteed. Political instability in the Middle East has meant that many oil-consuming HICs are looking for alternative sources of energy. For example, exports of oil from Libya have been almost cut off by the civil war there.
- **Climate** - renewable energy sources, such as solar energy, rely heavily on a lot of sun. Wind turbines require large open space and high wind speeds. HEP (hydroelectric power) needs rivers and mountainous areas to create the energy using the fast flowing water. A country's climate may not be always suitable for energy creation in this way.

Impacts of energy insecurity

- **Environmental impact** - the Arctic has great potential to supply energy in the future. The region holds an estimated 13% (90 billion barrels) of the world's undiscovered oil resources and 30% of unexploited

natural gas. Extracting these resources is likely to lead to damage to habitats and the natural environment.

- **Impacts on industry** - In Pakistan, regular power cuts can last for 20 hours a day which costs the country an estimated 4% of its GDP. Energy shortages have led to the closure of more than 500 companies in Faisalabad.
- **Impact on food production** - food production uses 30% of global energy. Energy is used to power farm machinery, store farm produce in refrigerators, and to manufacture fertilisers and chemicals. If there is not enough energy, food prices will increase in HICs.
- **Political impact** - around 20% of the world's oil is transported through the Strait of Hormuz in the Middle East, much of it exported to Japan and China. This creates the potential for conflict if the movement of oil is prevented. Countries that rely on regular imports of oil could become energy insecure.
- **Economic and social impacts on people** – if a country becomes energy insecure, the cost of living could rise including the price of food. Jobs could be lost as the sales of goods falls.

Renewable energy

- Most renewable energy does not create direct air pollution and produces much lower carbon emission than fossil fuels.
- The renewable energy industry is increasing, and the UK government is investing more into low carbon alternatives as the government aims to meet targets for reducing emissions.
- Many jobs are becoming available in the manufacture of renewable energy infrastructure and in further research and development of renewable energy.

Strategies used to increase energy supply

	Energy	How it works	Advantages	Disadvantages
Non-renewable	Fossil fuels	Coal, oil and gas are extracted from the earth and burnt in power stations to create electricity. <i>There are currently 4 remaining coal-fired power stations in the UK - the UK plans to phase out coal-fired power stations by 2025.</i>	Industries linked to fossil fuels create many jobs which improves the economy of an area.	Fossil fuels are finite resources and will eventually run out. Burning fossil fuels releases huge amount of carbon which contributes to climate change.
	Nuclear power	Uranium is used to create nuclear energy. In 2020 the UK had 15 reactors generating about 21% of electricity but almost half of this is to be retired by 2025. <i>However, a new n power plant is being built (Hinkley Point) which will cost around £19bn.</i>	Many jobs are created in nuclear power research and development. Cleaner than fossil fuels and doesn't create direct air pollution.	Risk of a nuclear accident which could release large levels of radiation into the environment; nuclear waste is expensive to store and transport; decommissioning (closing down) a nuclear power plant is expensive.
Renewable	Solar	Solar panels turn solar energy into electricity.	Effective in sunny locations.	Poor weather/low light leads to reduced energy.
	Wind	Wind turbine turns & turns turbine to create electricity. Offshore wind farms can be built in the sea. Hornsea One, off the coast of East Yorkshire, will be the world's largest offshore wind farm	Effective in windy locations, can be located offshore.	Wind farms are often located in remote countryside areas. Some people think they spoil the landscape so could reduce house prices. Can affect migratory birds.

		when opened in 2020. Will power over 1 million homes.		Turbines in the sea may affect fish and birdlife.
	Hydro Electric Power (HEP)	Dam built on a river to create reservoir behind. Water let through dam, turns turbine.	Energy always created (not weather dependent) can create a lot of energy.	Reservoir can flood huge areas including animal habitats. Very expensive to build dams.
	Biomass	Wood and other waste produce burnt to create heat to create energy.	Low-cost, waste material usually available.	Releases CO2 and greenhouse gases.
	Geothermal	Uses hot water and steam from deep underground to turn turbines. Often used in tectonic areas to heat water e.g. Iceland.	100% clean energy.	Only available in tectonic areas (areas with volcanoes).
	Tidal	Uses the sea/ocean tide to turn turbine to make energy.	Produces energy when tide comes in regularly.	Tidal schemes are costly to build. Changes the movement of water in and out of estuaries which disrupts marine habitats.

An example of the extraction of a fossil fuel – fracking for shale gas

Hydraulic fracturing, or ‘fracking’, is where water is used to extract a type of natural gas (called shale gas) from rocks underground. Fracking involves injecting water and chemicals deep underground to force out shale gas, which is then supplied to homes and businesses by energy companies.

Advantages of fracking - fracking releases shale gas, which cleaner to burn than coal so does not cause as much air pollution. This will in turn reduce the amount of air pollution a country emits. The government believes gas from fracking could also be used in power stations in the future, which would mean the UK wouldn't depend on importing expensive fuel from other countries such as Russia. Fracking also provides many jobs in the energy industry.

Disadvantages of fracking - environmental groups think fracking could pollute water supplies as the chemicals used in the process could leak into water sources. There is also evidence that suggests fracking can cause minor earthquakes which can cause damage to housing and other buildings. Fracking sites create additional traffic in areas close to villages and towns which can disrupt the lives of local people.

Moving towards a sustainable resource future

A **carbon footprint** measures the amount of greenhouse gases produced by an individual. It includes **direct emissions** (produced by products that use energy) and **indirect emissions** (produced when making products).

- **Direct emissions:** having the heating on, using electrical appliances, driving cars and air travel.
- **Indirect emissions:** those produced making products e.g. food miles and clothing (making and transporting).

Reducing personal carbon footprints – how individual actions can reduce energy use

We can help reduce the amount of energy that we consume by **reducing energy demand** which will then reduce our carbon footprint. For example:

- Turn off lights when not needed and turning all electric devices off standby.
- Walk, use public transport or cycle instead of using a car – fewer cars on the road require less fuel.
- Car sharing - two or more people travel together by car rather than taking a car each. This means that there are fewer cars on the road so less fuel is used.
- Limiting the amount of air travel

Energy conservation: designing homes, workplaces and transport for sustainability

Sustainable building design:

- **Insulation** — this is a material that reduces heat loss in a building. For example, special foam can be injected into walls to prevent heat escaping which means that less gas is required to heat homes.
- **Modern boilers** are more efficient than older models, so use less gas.
- **Solar panels** can be fitted to the roofs of homes providing renewable, low-carbon energy.
- Installing **double glazed windows** will reduce heat lost through windows and will keep houses warm.

Use of technology to increase efficiency in the use of fossil fuels

Hybrid cars have a petrol engine and an electric motor, so use less fuel. Petrol and diesel, the most common types of fuel for cars, are both made from oil which is a fossil fuel. One example is the BMW i8. It is efficient because the car uses only 2.5 litres of fuel per 100km which is a lot less fuel than standard cars that run on petrol or diesel. The BMW i8 also has **regenerative braking** — a device to store energy lost under braking to be used later.

Example of a sustainable local renewable energy scheme in an LIC – Micro Hydro Scheme, Ghandruk, Nepal

Ghandruk is a small village located high in the Himalayan mountains in Nepal. Ghandruk has benefitted from a small hydro-electricity power plant that supplies it with electricity. It works when water from a river is channelled through a pipe which turns a turbine to create electricity.

Social benefits for local people

- Energy created is used for cooking and heating water which has improved the personal hygiene of local people. **This means that people are less likely to become ill so can spend more time working and earning money to support their family.**
- Medicines can now be refrigerated in the local health centre so last for longer.

Economic benefits

- Hotels are now able to use electricity to power washing machines, fridges, microwaves and toasters. Tourists are more likely to stay in the hotels and spend money in the local area which will improve the local economy.