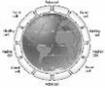


Topic 2 Weather hazards and climate change

Component	Key idea	Detailed Content	Core Knowledge & Understanding	Keywords	Skills	Icon
<p>Global atmospheric circulation and heat transfer</p>	<p>The atmosphere operates as a global system transferring heat and energy</p>	<p><i>The features of the global atmospheric circulation</i></p>	<p>Wind is caused by differences in atmospheric pressure – air moves from high pressure to low pressure – the greater the difference in pressure, the stronger the winds. Towards the poles, the Sun's energy spreads over a large area, resulting in low temperatures and high pressure. At the equator, the Sun's energy is concentrated over a small area, resulting in high temperatures and low pressure. The difference in air pressure on the Earth's surface causes global patterns of air circulation (cells) from areas of high pressure to areas of low pressure. The Tri-cellular model 1) Warm air rises from the equator, creating a belt of low pressure. As the air rises, it cools. 2) The resulting condensation creates clouds and rain that move north and south of the equator. 3) The ITCZ (Inter-tropical convergence zone) is a band of low pressure around the Earth which generally lies near to the equator. The trade winds of the northern and southern hemispheres come together here, which leads to the development of frequent thunderstorms and heavy rain. 4) At 30° north and south of the equator, the cold, dry air sinks, creating high pressure and clear skies (Hadley Cell). 5) When the sinking air reaches the Earth's surface, it moves either back to the equator or towards the poles. 6) At 60° north and south of the equator, the surface air meets colder air from the poles, which causes it to rise, creating a belt of low pressure (Ferrel Cell). 7) The air rises and cools. At a high level, this moves either back to the equator or towards the poles. 8) At the poles, the cool air sinks to the Earth's surface, creating high pressure. The air then moves back towards the Equator (Polar Cell).</p>	<p>Air Atmosphere Wind Air pressure Global Circulation Angle of incidence Tr-Cellular model Equator Inter-Tropical Convergence Zone (ITCZ) hemisphere Latitude Longitude Hadley cell Ferrel Cell Polar cell</p>	<p>Use and interpretation of line graphs/bar charts showing climate change</p>	
		<p><i>How circulation cells and ocean currents transfer and redistribute heat energy across the Earth.</i></p>	<p>Ocean currents are large scale movements of water that transfer heat energy from warmer to cooler regions. Surface currents are caused by winds and help transfer heat away from the equator. The Gulf Stream is an example of surface ocean movements from the Caribbean to the UK. Deep ocean currents, known as Global Thermohaline Circulation, also transfer heat from the equator to the poles but are driven by differences in water density. When water freezes at the poles, the surrounding water gets saltier, increasing its density. As it gets denser it sinks, causing warmer water to in at the surface – creating a current. This warmer water is cooled and sinks, continuing the cycle. The Humboldt Current brings cold water back from the poles to the equator, where it is heated.</p>	<p>Ocean currents Surface currents Gulf Stream Global Thermohaline Circulation Humboldt current Density Salt</p>		
	<p><i>How climate has changed in the past over different time scales: glacial and interglacial periods during the Quaternary period.</i></p>	<p>The average climatic conditions of the Earth change naturally over time, creating both warmer and colder periods. The Quaternary Period is the most recent geological time period from 2.6 million years ago to the present day and includes the whole of human history. Before the Quaternary, global temperatures were warmer and quite stable. During the Quaternary global temperatures have shifted between cold glacial periods that last for around 100,000 years, and warmer interglacial periods that last for around 10 000 years.</p>	<p>Climate Geological time Quaternary Glacial Interglacial</p>			

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Component	Key idea	Detailed Content	Core Knowledge & Understanding	Keywords	Skills	Icon
	<p>The global climate was different in the past and continues to change due to natural causes</p>	<p><i>Causes (Milankovitch cycles, solar variation, volcanism) and evidence (ice cores, pollen records, tree rings, historical sources) for natural climate change.</i></p>	<p>These variations were caused by natural events:</p> <p>Milankovitch Cycles</p> <ul style="list-style-type: none"> - Earth's orbit changes approx. every 100 000 years from a circular orbit (warmer) to a more elliptical orbit (colder) (Eccentricity) - Roughly every 40 000 years the Earth's tilt varies = greater angle of tilt = hotter summers and colder winters (Axial tilt) - The Earth 'wobbles' on its axis roughly every 24 000 years resulting in differences between seasons. (Precession) <p>Solar variation</p> <p>Lower solar radiation output levels result in glacial periods, higher solar radiation output levels result in interglacial periods.</p> <p>Tectonic activity</p> <p>Large-scale volcanic eruptions can eject ash and dust into the atmosphere blocking out solar radiation causing temperatures to fall</p> <p>Evidence</p> <p>Historical sources such as diaries and painting</p> <p>Ice Cores trap volcanic bubbles, revealing information on climate when the ice is formed</p> <p>Tree rings show climate conditions by the size of their growth – thick rings mean warm, wet conditions</p> <p>Pollen records provides evidence on warm and cold growing conditions</p>	<p>Variations Natural Causes Milankovitch Cycles Eccentricity Axial tilt Precession Circular orbit Elliptical orbit Seasons Solar radiation Tectonic Volcanic eruptions Evidence Historical sources Ice cores Tree rings Pollen</p>	<p>Use and interpretation of line graphs/bar charts showing climate change</p>	
<p>Global atmospheric circulation and heat transfer</p>	<p>Global climate is now changing as a result of human activity</p>	<p><i>How human activities (industry, transport, energy, farming) produce greenhouse gases (carbon dioxide, methane) that cause the enhanced greenhouse effect.</i></p> <p><i>Negative effects that climate change is having on the environment and people (changing patterns of crop yield, rising sea levels and retreating glaciers).</i></p>	<p>The Greenhouse Effect – how the atmosphere keeps the Earth warm and sustains life on Earth. Heat energy (insolation) passes through the atmosphere and heats the Earth's surface and oceans. Heat is radiated back into space from the Earth. Greenhouse gases such as CO₂, H₂O, and CH₄ trap some of the heat in the Earth's atmosphere.</p> <p>Enhanced Greenhouse effect</p> <p>Human activities have increased the levels of greenhouse gases and therefore increased temperatures since the Industrial Revolution through:</p> <ul style="list-style-type: none"> - Industry – production of consumer goods using fossil fuel energy releases greenhouse gases. Cement made from limestone contains carbon which is released when cement is produced. Industrial waste releases methane through waste decay - Transport – most transport runs on fossil fuels. Increased car ownership increases greenhouse gas emissions. Residential and business properties rely on fossil fuels for electricity and heating - Agriculture including rice production and livestock produce lots of CH₄. Deforestation for agriculture reduces the amount of CO₂ trees absorb and store. <p>Negative effects Environment</p> <ul style="list-style-type: none"> - melting ice sheets, retreating glaciers = sea level rise = coastal flooding = contamination with salt causing plants to die. - Arctic melting could change the Gulf Stream bringing colder temperatures in Western Europe. <p>People</p> <ul style="list-style-type: none"> - Changes in climates near the equator e.g. The Sahel means longer periods of drought so lower crop yields. - Many low-lying islands like the Maldives face greater flood risk from rising sea levels. 	<p>Greenhouse effect Insolation Atmosphere Radiated Enhanced Greenhouse effect Greenhouse gases Industrial Revolution Industry Consumer Fossil fuels Waste decay Transport Residential Agriculture Livestock Deforestation Glaciers Flooding Contamination Drought Crop yields Sea level</p>		 

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Global atmospheric circulation and heat transfer	The UK has a distinct climate which has changed over time	<i>Climate of the UK today and changes over the last 1000 years</i>	UK climate has varied a lot over the last 1000 years. Medieval Warm Period - between 900 and 1300 Little Ice Age - cooling followed the Medieval Warm period	Medieval		
		<i>Spatial variations in temperature, prevailing wind and rainfall within the UK.</i>	North and west are generally cooler and wetter than the south and east The prevailing wind is from the south west, across the Atlantic Ocean	Cardinal points Prevailing wind		
	The UK has a distinct climate which has changed over time	<i>The significance of the UK's geographic location in relation to its climate.</i>	Prevailing winds from the south west bring warm moist air across the Atlantic Ocean resulting in higher rainfall in the west Higher elevation tends to have higher areas of rainfall (orographic rainfall)	Elevation Orographic	Use and interpretation of line graphs/bar charts showing climate change	

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Tropical cyclones	Tropical cyclones are extreme weather events that develop under specific conditions and in certain locations		<p>Tropical cyclones develop in a band of low pressure and warm temperatures between 5° and 30° north and south of the equator through global atmospheric circulation</p> <p>Sea temperature = 26°C or higher Water depth = 60-70m Low wind shear</p> <p>Warm, moist air rises, leading to condensation and low air pressure, increasing surface winds. Easterly trade winds move tropical storms to the west near the equator. Coriolis effect (Earth's rotation) makes storms spin. Energy increases over warmer water, loses strength over land. Majority of storms occur in northern hemisphere</p> <ol style="list-style-type: none"> 1) Warm, moist, unstable air above the ocean rises, creating an area of low pressure below 2) Surrounding cooler air is drawn into the area of low pressure, causing winds 3) The cool drawn-in air warms up and takes on moisture, causing it to rise 4) The large mass of rising, warm air cools and condenses, forming large cumulonimbus clouds and heavy rain 5) Latent heat released during condensation helps to power the storm 6) As more air is drawn in the area of low pressure, the Earth's rotation causes wind to spiral in the storm's centre, or eye (Coriolis effect) 7) Colder, drier air sinks in the eye of the storm, creating calm conditions. Prevailing winds then push the storm inland 8) The storm continues to get bigger and stronger until it reaches land or colder seas. Landfall and friction slow the storm down. <p>The centre is called the eye – descending air, low pressure light winds, no rain, high temperature</p> <p>Eye wall – spiralling rising air, very strong winds, storm clouds, torrential rain, low temperatures Edge – lower wind speed, smaller clouds, scattered rain, temperature increases</p>	Tropical cyclones Latitude Wind hear Moist Trade winds Coriolis effect Rotation Hemisphere Evaporation Condensation Precipitation Cumulonimbus clouds Spiral Vortex Landfall Friction Eye Eye wall Edge	Use of GIS to track the movement of tropical cyclones	
Tropical cyclones		<p><i>Characteristics, frequency and geographical distribution of tropical cyclones and how these change over time</i></p>	<p>Names and locations</p> <ul style="list-style-type: none"> - Hurricanes = Atlantic Ocean - Typhoons = Pacific Ocean - Cyclones = Indian Ocean <p>June – November = northern tropics November – April = southern tropics</p> <p>Circular in shape, hundreds of kilometres wide, lasting 7-14 days, spin anti-clockwise in the north and clockwise in the south</p> <p>Increased frequency and intensity due to the enhanced greenhouse as a result of increased greenhouse gases released into the atmosphere through human activities</p>	Hurricanes Typhoons Cyclones Clockwise Anti-clockwise Frequency Intensity	Use of GIS to track the movement of tropical cyclones	
		<p><i>Reasons why tropical cyclones are natural weather hazards (high winds, intense rainfall, storm surges, coastal flooding and landslides).</i></p>	<p>Measured using the Saffir-Simpson Scale – Cat 5 is the strongest</p> <p>High winds – up to 250 km/h Rainfall – trillions of litres of water per day Storm surges – rise in sea level through low pressure and high winds Coastal flooding - result of storm surges Landslides – rainfall makes hills unstable</p>	Saffir-Simpson scale Storm surges	Use of weather and storm surge data to calculate Saffir-Simpson magnitude	

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Tropical cyclones	There are various impacts of and responses to natural hazards caused by tropical cyclones depending on a country's level of development	Different social, economic and environmental impacts that tropical cyclones can have on a named developed* and a named emerging* or developing* country	<p>Case Study Developed and developing country What: Hurricane Irma, Category 5 When: 8th to 11th September 2017 Where: Gulf of Mexico Who: Barbuda, Caribbean Islands (developing), Florida, USA (developed) Why/How: Causes - Tropical depression formed in the Atlantic Ocean. Spinning vortex of winds as heat energy is evaporated from the ocean to fill gap of very low air pressure. Sea temperatures 32°C in Gulf of Mexico. Air pressure 915mb. Trade winds blowing away from the Equator. Impacts Caribbean – Barbuda (developing) Up to 185mph winds 600 students had to go to school on other islands 90% properties damaged 68 sq. miles covered by Category 5 hurricane No water or communications – island considered uninhabitable 3 deaths Most people evacuated from Barbuda to Antigua \$250 million in damages = 12% of islands GDP 1,800 residents evacuated 3m storm surge causing significant flooding</p> <p>Impacts USA – Florida Keys (developed) 7 direct deaths in USA 85 indirect deaths of which 80 were in Florida 77,000 people in shelters 6.5 million ordered to evacuate 70% buildings built before 1994 6.9 million homes left without power 2 – 3 m storm surge causing significant flooding 250 to 300mm rainfall an hour \$62.5 million in damages Loss of tourism trade</p>	Tropical depression Developed country Developing country Uninhabitable Evacuated Significant Tourism Colony	Use of social media source, satellite images and socio-economic data to assess impact		
			Different responses to tropical cyclones of individuals, organisations and governments in a named developed and a named emerging or developing country			<p>Responses Caribbean – Barbuda (developing) 60 tons of relief supplies sent by USA and British Aid Agencies British military troops sent to support restoration of electricity Many NGO's remain in situ to provide relief Antiguan and Barbudan government trying to force people to leave, stating the land they share as 'common land' should be bought and developed. Locals resisting 'disaster capitalism' Responses USA – Florida Keys (developed) The five living former US presidents have raised more than \$31m (£23.5m) for victims in the US. Various aid agencies remain involved in providing support</p>	Relief supplies NGO's - Non-Government Organisations Disaster capitalism
							

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Drought	<p>The causes of drought are complex with some locations more vulnerable than others</p>	<p><i>Characteristics of arid environments compared to the extreme weather conditions associated with drought</i></p>	<p>Arid environments are places which normally have very low rainfall e.g. deserts. Many are also hot, causing water to evaporate before it can be replaced by rain</p> <p>Characteristics of arid environments</p> <ul style="list-style-type: none"> - plant growth is sparse short, low shrubs, few trees - soil is shallow and not very fertile as there is hardly any leaf litter <p>Characteristics of droughts</p> <ul style="list-style-type: none"> - severe shortage of water over an extended period of time for a particular location - water supplies become depleted as they are not replenished with rainfall but still used often - high temperatures which increases evaporation rates 	<p>Arid Desert Characteristics Sparse Leaf litter Drought Depleted Replenished</p>	<p>Use and interpretation of graphs showing medium term rainfall trends</p>	
Drought		<p><i>Different causes of the weather hazard of drought: meteorological, hydrological, and human (agricultural, dam building, deforestation).</i></p>	<p>Causes of droughts</p> <p>- Meteorological changes in atmospheric circulation (see Milankovitch cycles)</p> <p>El Niño can slow down the trade winds in the Pacific Ocean from east to west, resulting in less warm water reaching Australia</p> <p>Blocking high pressure systems can stop depressions that cause rain moving across the Atlantic Ocean to the UK</p> <p>- Hydrological</p> <p>Lack of water in rivers, lakes, reservoirs and aquifers (stores) mean abstraction without replenishment</p> <p>Water evaporates quicker in high temperatures meaning stores are depleted quicker</p> <p>- Human</p> <p>Irrigation for farming uses large volumes of water</p> <p>Building dams to create reservoirs limits water supply downstream</p> <p>Deforestation reduces water held in the soil and reduces transpiration back into the atmosphere</p>	<p>Meteorological El Niño High pressure systems Depressions (low pressure systems) Hydrological Aquifers Abstraction Replenishment Depletion Irrigation Dam Reservoir Deforestation Transpiration</p>		 
		<p><i>Why the global circulation makes some locations more vulnerable to drought as a natural hazard than others and how this changes over time.</i></p>	<p>Vulnerability</p> <p>Most severe droughts found at 30° north and south of the equator</p> <p>Pattern is caused by cool, dry air sinking, creating belt of high pressure with very little rainfall (between Hadley and Ferrel cells)</p> <p>Drought pattern is spreading to larger areas as a result of climate change</p>	<p>Vulnerability Hazard Water-borne disease Cholera Malnutrition Famine</p>		
		<p><i>Reasons why droughts are hazardous</i></p>	<p>Hazards</p> <p>Low water levels causing animals and plants to die</p> <p>Stagnant water unable to flush out waste materials leading to water-borne disease such as cholera</p> <p>Lack of food supplies leads to malnutrition, famine and death</p> <p>Soil exposed to wind erosion</p> <p>Soil hardens so when the rains do come it is unable to infiltrate, leading to flooding</p> <p>Wildfires</p>	<p>Wind erosion Infiltration Wildfires</p>		

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Component	Key idea	Detailed Content	Core Knowledge & Understanding	Keywords	Skills	Icon
<p>The impacts of, and responses to drought vary depending on a country's level of development</p>	<p><i>How the impacts of drought on people and ecosystems can vary for a named developed and a named emerging or developing country</i></p>	<p>Case Study Australia Early 21st Century (developed) What: Severe, long-term drought Where: South-east Australia When: 2001 to 2009 Who: Murray-Darling Basin – known as the 'Big Dry' Impacts on people - water levels in rivers and lakes fell so water supplies greatly reduced - crop yields fell – increased food prices - livestock died - farmers' income fell - 100000 people lost jobs Impacts on ecosystems - dust storms in land - wildfires – over 30000km² of land burned - vegetation loss and soil erosion - toxic algae - river and marshlands dried up - plants and animals died - some invertebrates need floods to breed – some near extinction - wildfires destroyed habitats</p>	<p>Crop yields Livestock Income Dust storm Vegetation Toxic algae Marshlands Invertebrates Extinction Habitats Pasture Cattle Migration Food insecurity Malnutrition Starvation Desertification</p>	<p>Use and interpretation of socio-economic data</p>		
		<p>Case Study Ethiopia 2016 (developing) What: Severe, almost continuous, long-term drought Where: Ethiopia, Horn of Africa When: Continued decline in precipitation since 1980's but most severe in 2016 Who: 85% of people in Ethiopia depend on agriculture as their main income Impacts on people - farmers in some regions lost 50-90% of their crops - lack of pasture for animals - 2 million cattle died, reducing milk production - migration to urban areas for work - food insecurity and malnutrition - 70000 people at risk of starvation. In 2017 7.8 million people needed emergency assistance to meet their basic needs Impacts on ecosystems - water sources dried up and plants died - loss of vegetation damaged habitats for wildlife - vulnerable to wildfires, flooding, wind erosion and desertification</p>				

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Drought	The impacts of, and responses to drought vary depending on a country's level of development	<i>Different responses to drought from individuals, organisations and governments in a named developed and a named emerging or developing country</i>	<p>Case Study Australia Early 21st Century (developed)</p> <p>Responses</p> <p>Individuals</p> <ul style="list-style-type: none"> - water saving measures such as re-using grey water and using water-efficient showers - farmers using drip-irrigation - diversifying farming incomes <p>Organisations</p> <ul style="list-style-type: none"> - media campaigns in schools and on TV to encourage reducing water usage - CSIRO (research institute) to developed and breed drought-tolerant types of wheat <p>Government</p> <ul style="list-style-type: none"> - water conservation measures through reduction in water allocation - desalination plants built - income support to 23000 rural families and 1500 small businesses - improved investment in forecasting and preparing for droughts <p>Case Study Ethiopia 2016 (developing)</p> <p>Responses</p> <p>Individuals</p> <ul style="list-style-type: none"> - migration to new livelihoods in urban areas - farmers switched from growing cereal crops to a more resistant crop called chat <p>Organisations</p> <ul style="list-style-type: none"> - charities and international organisation provided humanitarian aid - FAO of the UN requested US\$20 million for seeds and to reduce pests - FAO treated livestock and humanely slaughtered those too ill to survive to prevent disease - the Great Green Wall, in conjunction with other nations in The Sahel, are planting a wall of trees in the semi-arid region to increase transpiration and then precipitation <p>Governments</p> <ul style="list-style-type: none"> - Ethiopian Government distributed food from its national food reserve through the Productive Safety Net Program, in which people work on public building projects in return for food or money - provided permanent housing to rural-to-urban migrants near to sources of water 	<p>Grey water</p> <p>Water-efficient</p> <p>Drip-irrigation</p> <p>Diversify</p> <p>Drought-tolerant</p> <p>Conservation</p> <p>Desalination</p> <p>Investment</p> <p>Forecasting</p> <p>Livelihoods</p> <p>Humanitarian aid</p> <p>Great Green Wall</p> <p>Semi-arid</p> <p>Rural-to-urban migration</p>	Use and interpretation of socio-economic data	