

3.1.1 Water and carbon cycles

Assessment		Knowledge strands/links to previous learning		Homework/independent study	
Mini-tests will take place throughout each topic. Mini-mocks will take place throughout the unit on the following topics: <ul style="list-style-type: none"> • The water cycle • The carbon cycle • Life on earth 		Students will have some understanding of hydrology through the study of river landscapes in the UK at GCSE. Students will also have a good understanding on the concept of climate change and the basic causes, impacts and responses through the natural hazards unit at GCSE. Students will also possess an understanding of carbon cycling from science GCSE.		Will be set each week by the class teacher. Tasks will include: <ul style="list-style-type: none"> • Further reading • Guided research into tourism sectors • Guided writing practice 	
Specification content	Subject-specific skills development	Learning outcomes	Suggested Learning activities (including ref to differentiation and extension activities)	Resources	
<ul style="list-style-type: none"> • Systems in physical geography: Systems concepts and their applications to the water and carbon cycles inputs-outputs, energy, stores/components, flows/transfers, positive/negative feedback, dynamic equilibrium. 	Use of key subject specific and technical terminology. To identify connections and interrelationships between different aspects of geography. Constructing and using systems and	An overview of the concept and use of ' models ' by geographers as simplifications of a complex world. Understanding of the concept of ' systems frameworks ' as a type of model fundamental to most areas of geographical understanding. Students will be able to identify, describe and explain the elements of geographical systems, including: <ul style="list-style-type: none"> • Stores/Components 	Small group discussions followed by feedback - what models used in geography do students know? Students to draw and annotate a model system to show the key elements of a system. Students to draw and annotate a diagram of an example of a positive	Introductory presentation on Natural Systems Website with simple summaries of a number of earth systems A summary of the features of the lithosphere A summary of the features of the hydrosphere	

	<p>models.</p> <p>Labelling and annotation of diagrams.</p>	<ul style="list-style-type: none"> • Flows/Connections • Elements • Attributes • Relationships <p>Students will be able to identify, describe and explain common characteristics of systems including:</p> <ul style="list-style-type: none"> • Boundaries • Inputs • Outputs • Flows <p>Students will understand systems that are classified as:</p> <ul style="list-style-type: none"> • Isolated systems • Closed systems • Open systems <p>Students will understand systems as being in a state of dynamic equilibrium that includes:</p> <ul style="list-style-type: none"> • Positive feedback • Negative feedback <p>Students will be able to identify the four major subsystems of the earth:</p> <ul style="list-style-type: none"> • Atmosphere • Lithosphere • Hydrosphere • Biosphere <p>To understand that these are interlinked as a 'cascading system'.</p>	<p>feedback system and a negative feedback system.</p> <p>Repeat group discussion to see if students can now think of any more examples of systems in geography.</p> <p>Students to work in pairs/small groups to think of ways in which the 4 'spheres' are interlinked. To feedback and share ideas.</p> <p>Opportunity here for a short research task for interconnections between geographical systems.</p> <p>Practice low-tariff exam questions to assess learning – peer assessment opportunity.</p>	<p>A summary of the features of the cryosphere</p> <p>More information on the cryosphere</p> <p>A summary of the features of the atmosphere</p> <p>An online lesson activity investigating connections in the atmosphere</p>
<p>The Water Cycle</p> <ul style="list-style-type: none"> • Global distribution and size of major stores of 	<p>Use of key subject specific and technical</p>	<p>Students will understand that on earth water exists in three forms:</p> <ul style="list-style-type: none"> • Solid ice 	<p>Brief Q&A/paired discussion – in what 'states' does water</p>	<p>An interactive website that summarizes the water cycle</p>

<p>water – lithosphere, hydrosphere, cryosphere and atmosphere.</p> <ul style="list-style-type: none"> Processes driving change in the magnitude of these stores over time and space, including flows and transfers: evaporation, condensation, cloud formation, causes of precipitation and cryospheric processes at hill slope, drainage basin and global scales with reference to varying timescales involved. Drainage basins as open systems – inputs and outputs, to include precipitation, evapotranspiration and runoff; stores and flows, to include interception, surface, soil water, groundwater and channel storage; stemflow, infiltration overland flow, and channel flow. Concept of water balance. Runoff variation and the flood hydrograph. Changes in the water cycle over time to include natural variation (including storm events, 	<p>terminology.</p> <p>Opportunities to develop skills such as drawing, labelling and annotating diagrams.</p> <p>Opportunity to study soil infiltration rates.</p> <p>Online research.</p> <p>Construct and interpret line graphs and bar graphs.</p>	<ul style="list-style-type: none"> Liquid water Gaseous water vapor <p>Students will understand the idea of latent heat and energy in the context of evaporation and condensation and how they relate to major atmospheric processes like cloud formation and precipitation.</p> <p>Students will understand the distribution of water on earth in terms of:</p> <ul style="list-style-type: none"> Oceanian and fresh water The limited amount of water economically and physically accessible for human use. <p>Students will understand that the Earth’s water is distributed between:</p> <ul style="list-style-type: none"> Oceanic water Cryospheric water Terrestrial water Atmospheric water <p>Students will explore the nature of the dynamic equilibrium between these stores.</p> <p>Students will be able to describe and explain the characteristics of each of these stores.</p> <p>Students will be able to describe and explain the characteristics and inputs, stores, transfers and outputs of a drainage basin system,</p>	<p>exist?</p> <p>Construct a diagram to illustrate water changing state, including latent heat.</p> <p>An opportunity to conduct research into each of the major stores of water – in small groups each student given one store to research and return to the group to share and snowball.</p> <p>Construct and annotate a range of diagrams to illustrate hydrological cycles, drainage basin hydrological cycles and slope drainage systems</p> <p>Construct and annotate a model of the soil moisture budget – opportunity to stretch students with thinking skills to identify and analyse factors affecting the SMB.</p> <p>Opportunities to study local level case studies of drainage basins, storm hydrographs, etc.</p> <p>Opportunities to assess all aspects with a full range of exam style Qs.</p>	<p>A simple summary of the changing state of water including latent heat</p> <p>More detailed information on the properties of water</p> <p>A link to some lesson ideas on the hydrosphere</p> <p>A summary of some of the key themes within the water cycle</p> <p>A summary of cloud formation</p> <p>Information on cloud formation and precipitation</p> <p>Met Office video clip on precipitation</p> <p>A range of Met Office videos on many aspects of the weather and atmosphere</p> <p>A summary of global water stores</p> <p>Further information on global water stores / hydrosphere and global water stores</p> <p>A summary of the characteristics of drainage basins</p> <p>A resource for creating a storm hydrograph: Impacts of flooding activity</p> <p>Search for information on and flow data for gauging stations in the UK – data can</p>
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<p>seasonal changes) and human impact (including farming practices, land use change and water abstraction).</p>		<p>including:</p> <ul style="list-style-type: none">• Precipitation• Interception store• Throughfall• Stemflow• Infiltration• Soil storage• Vegetation storage• Transpiration• Infiltration• Surface storage• Evapotranspiration• Overland flow/sheet flow• Throughflow• Percolation• Groundwater store and flow• Channel flow• Run off <p>Students to be able to describe and explain the global water cycle.</p> <p>Students will be able to describe and explain the water balance to include:</p> <ul style="list-style-type: none">• Inputs, outputs and stores• River regime• Soil moisture budget <p>Students will be able to describe and explain the characteristics of and human and physical factors affecting a storm and flood hydrograph. To include:</p> <ul style="list-style-type: none">• Rising limb• Peak discharge• Lag time		<p>be downloaded to create hydrographs: Search for gauging stations</p> <p>The National river flow archives and UK river and flow regimes</p>
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<p>The Carbon Cycle</p> <ul style="list-style-type: none"> • Global distribution and size of major stores of carbon – lithosphere, hydrosphere, cryosphere biosphere, atmosphere. • Factors driving change in the magnitude of these stores over time and space, including flows and transfers at plant, sere and continental scales. Photosynthesis, respiration, decomposition, combustion, burial, compaction, carbon sequestration in oceans and sediments, weathering. • Changes in the carbon cycle over time, to include natural variation (including wild fires, volcanic activity) and human impact (including hydrocarbon fuel extraction and burning, farming practices, deforestation, land use 	<p>Interpreting a variety of charts, data, graphs and maps (especially atlas maps).</p> <p>To develop extended writing skills to explore issues relating to changes in the carbon cycle.</p> <p>Opportunity to create line graphs of amounts of CO₂ in the atmosphere over time.</p> <p>Opportunity to discuss the nature of geographical data and methods of collection of the type of data relevant here, including GIS.</p> <p>Opportunity to analyse and present geographical data employing a variety of graphical</p>	<p>Students to understand the features of carbon as an element, its versatility and importance as a component of organic and inorganic compounds.</p> <p>Students to understand that as geographers the study of carbon dioxide (CO₂) is of most importance currently due to its perceived role in controlling climate.</p> <p>Students to understand the origins of the carbon that we study in the carbon cycle.</p> <p>Students to be able to describe and explain the global stores of carbon, including:</p> <ul style="list-style-type: none"> • Lithosphere • Hydrosphere • Cryosphere • Biosphere • Atmosphere <p>Students to be able to describe and explain the movement of transfer between the carbon stores, studied above, at a range of scales. Including:</p> <ul style="list-style-type: none"> • Plant • Sere 	<p>Introductory discussion/Q&A to establish what students know about carbon and its importance and versatility as an element.</p> <p>Opportunity for group research activity, with each student given a carbon store to study and then feedback shared with the group.</p> <p>Opportunity for students to engage with a range of charts, diagrams, graphs and maps to be able to describe the characteristics of different carbon transfers.</p> <p>Opportunity for independent research into natural and human impacts on the carbon cycle. With illustrations of examples from different places around the world.</p> <p>Opportunity for students to read around the impacts of changes in the carbon cycle and the possible impacts. Students to categorize the</p>	<p>An article that summarizes many of the key aspects of the carbon cycle: Global carbon cycle</p> <p>Web page with a diagram summarizing the main stores of carbon</p> <p>An interactive multiple choice quiz on the carbon cycle (with links to other reading and resources)</p> <p>The full length lesson on the carbon cycle from TED Ed lessons: ‘The carbon cycle’ full length by Nathan Manning</p> <p>‘The carbon cycle’ A summary of changing carbon emissions and sinks since 1750: Global carbon emissions and sinks since 1750 (2013)</p> <p>Changes in the carbon cycle over different time scales, including natural cycles</p> <p>Links between carbon and climate (links include an interactive carbon budget between 1960 and 2100)</p>

<p>changes).</p> <ul style="list-style-type: none"> The carbon budget and the impact of the carbon cycle upon land, ocean and atmosphere, including global climate. 	<p>techniques and descriptive statistics. (see skills checklist).</p>	<ul style="list-style-type: none"> Continental. <p>Students to be able to describe and explain the processes involved in these transfers, including:</p> <ul style="list-style-type: none"> Photosynthesis Respiration Decomposition Combustion Burial Compaction Carbon sequestration Weathering. <p>Students to be able to describe, explain, analyse and comment on factors leading to change in the carbon cycle, including:</p> <ul style="list-style-type: none"> Wild fires Volcanic activity Hydrocarbon fuel extraction Land use changes. <p>Students to be able to describe and explain, and draw conclusions about the nature of the impacts of carbon cycle, and possible future changes, for:</p> <ul style="list-style-type: none"> the land the oceans the atmosphere and global climate. <p>Students to be introduced to the idea of “enhance greenhouse effect”.</p>	<p>impacts according to:</p> <ul style="list-style-type: none"> Human or physical Social, economic, environmental, demographic, political, etc. <p>With an opportunity for students to investigate the possible effects of the disruption of the North Atlantic ocean currents on the climate of NW Europe.</p> <p>The greenhouse effect should be prior knowledge for A-level students – in pairs ask students to produce a diagram and accompanying annotations and text to explain to each other the Greenhouse effect. Students to ‘peer assess’ each other and identify strengths and weaknesses of each other’s explanation.</p> <p>Ensure all students have access to a “correct” description and explanation, followed by multimedia or research opportunity to explore the idea of the “enhanced greenhouse effect”.</p>	<p>Met Office summary of a range of impacts of climate change</p> <p>Interactive resource on the greenhouse effect, with various articles on climate change</p> <p>Interactive map of possible impacts of climate change</p>
<p>Water, Carbon, Climate and</p>	<p>Comparative</p>	<p>Students to understand the</p>	<p>An opportunity for students</p>	<p>Website with resources, lesson ideas and</p>

<p>Life on Earth</p> <ul style="list-style-type: none"> The key role of the carbon and water stores and cycles in supporting life on Earth and particular reference to climate. The relationship between the water cycle and carbon cycle in the atmosphere. The role of feedbacks within and between cycles and their link to climate change and implications for life on Earth. Human interventions in the carbon cycle designed to influence carbon transfers and mitigate the impacts of climate change. 	<p>graphing techniques.</p> <p>Extended writing to levels descriptors.</p> <p>Collect, analyze and interpret information from a range of secondary sources – including factual, numerical and spatial data.</p> <p>Critical questioning of information, and sources of information.</p> <p>Evaluating and presenting findings from research.</p>	<p>positive feedback between CO₂ led warming leading to higher evaporation rates and a wetter atmosphere.</p> <p>Students to understand the significance of water (water vapour and clouds) and carbon (CO₂) as greenhouse gases.</p> <p>Students to understand the dominance of CO₂ in controlling the <i>scale</i> of the greenhouse effect.</p> <p>Students to understand and explain why there is a lag between increased emissions of CO₂ and any resulting temperature increase.</p> <p>Students to have a clear understanding of the concept of “mitigation”.</p> <p>All students will be able to identify a range of possible human interventions to reduce or prevent emissions. Differentiation could be used when getting students to identify categories or groupings of strategies/approaches – eg local, regional, national, global etc.</p> <p>Students to be able to describe and explain in detail a range of specific strategies that are employed to mitigate greenhouse gas emissions. Possibly including:</p> <ul style="list-style-type: none"> Carbon Capture and Sequestration (CCS) Changing rural land use Improved transport 	<p>to construct comparative graphs – to show increases in greenhouse gases and atmospheric temperatures.</p> <p>Students could construct feedback diagrams to illustrate relationships between water and carbon cycles and climate change.</p> <p>Following discussion and reading students to write an extended prose exam style answer to explain the role of carbon and water in the greenhouse effect. Opportunity for peer assessment.</p> <p>Opportunity for group work for students to identify as many mitigation strategies as possible, and to then categorise. This information once shared could be used to produce a summary Mind map.</p> <p>An opportunity for a research or individual learning activity for students to explore different mitigation strategies – this learning could be shared with the group in a range of ways including wall display, group/individual presentation, PowerPoint/Prezi</p>	<p>interactive activities about a range of issues relating to the role of carbon</p> <p>Website with a range of pages exploring links between the water and carbon cycles and climate</p> <p>Studying the effects of changes in the carbon cycle</p> <p>Met Office climate scientist explores the idea of climate feedbacks</p> <p>Video clip of Met Office climate scientist exploring the idea of climate feedbacks (9 mins): ‘Climate feedback’ by Ben Booth (2009)</p> <p>Ted-Ed video exploring the role of clouds in climate change: ‘Cloudy climate change’ by Jasper Kirkby (2014)</p> <p>Video looking at the Human Role in climate change (11 mins): ‘Human role in climate change’ Richard Alley (2008)</p> <p>Carbon capture and sequestration in the USA</p> <p>Link to the Imperial College Centre for Carbon Capture and Storage website</p>
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		practices.	presentation, YouTube video, or blog, etc. An opportunity to discuss the differing views relating to climate change, and any ethical, moral or socio-political issues arising. Also to be critical of the sources of data.	<p>A lengthy 2005 IPCC report on Carbon capture and storage, runs to +400 pages, but the “Summary for Policymakers” introduces a range of key ideas with accompanying diagrams: Carbon dioxide capture and storage report</p> <p>The UNEP website for Climate Change Mitigation, with links to different sectors including Agriculture and Transport:</p> <p>IPCC video clips:</p> <p>Working Group II – Fifth Assessment Report – Climate change 2014: Impacts, Adaptation and Vulnerability: Climate Change: Impacts, Adaptation and Vulnerability (2014)</p> <p>Working Group III – Fifth Assessment Report – Climate change 2014: Mitigation of climate change: Climate change: Mitigation of climate change (2014)</p>
Case Study 1 Case study of a tropical rainforest setting to illustrate and analyze key themes in water and carbon cycles and their relationship to environmental change and human activity.	Collect, analyse and interpret a range of qualitative and quantitative data from a range of primary and secondary sources – this could include	Students will be able to describe, explain and evaluate a number of themes relating to water and climate in the Amazon tropical rainforest, including: <ul style="list-style-type: none"> • how changes in the water and carbon cycles have changed the tropical 	Opportunity for individual, paired or group research task, using a range of textual, digital or audiovisual resources. Findings could be shared in traditional classroom approaches or shared through a VLE on a	Deforestation and carbon cycles in the Amazon rainforest: Deforestation: facts, causes & effects Amazon river breathes carbon dioxide from rain forest

<p>Case Study 2 Case study of a river catchment(s) at a local scale to illustrate and analyze the key themes above, engage with field data and consider the impact of precipitation upon drainage basin stores and transfers and implications for sustainable</p>	<p>discursive/creative material when looking at the experiences of people in place.</p> <p>As above, including fieldwork data collection, presentation and analysis techniques, to come to valid conclusions.</p> <p>Techniques to</p>	<p>rainforest environment</p> <ul style="list-style-type: none"> the relationships between hydrology, the carbon cycle and the environment how human activity affects the tropical rainforest. <p>Students will be able to describe and evaluate a range of strategies employed in the Amazon tropical rainforest to reduce the effects of climate change.</p> <p>Students could either study a local river through the use of secondary data sources – including online and digital mapping, or students could engage first hand and complete fieldwork to collect primary data, or a combination of both. The aim of such work is to:</p> <ul style="list-style-type: none"> illustrate how the hydrological system affects channel flow 	<p>blog for example.</p> <p>For a more active learning approach students could research from the point of view of different stakeholders. Feedback could then take the form of a debate/roleplay or construction of SWOT analysis in groups etc.</p> <p>An opportunity to either create a “virtual fieldwork investigation” and provide students with a range of data relating to a local river for students to investigate and address the themes of the enquiry.</p> <p>Or, an opportunity for</p>	<p>Simple introductory video clip about the Amazon rainforest and water and carbon</p> <p>Presentation exploring the impacts of land use change on the hydrological cycle in the Brazilian Amazon region: ‘The Hydrological cycle’ by Woods Hole Research Centre (2014)</p> <p>Exploring the impacts of climate change in the Amazonian tropical rainforest:</p> <p>Amazon and climate change</p> <p>Understanding climate change impacts on the Amazon rainforest</p> <p>Climate change and the Amazon rainforest</p> <p>Addressing climate change</p> <p>Search for information on flow data for gauging stations in the UK – data can be downloaded from the National to create hydrographs.</p> <p>The National river flow archives and UK river and flow regimes: UK river and flow regimes</p> <p>The Field Studies Council (and other similar organizations) may also provide guidance</p>
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<p>water supply and/or flooding.</p>	<p>evaluate the geographical enquiry process.</p>	<ul style="list-style-type: none"> • analyze the relationships between inputs and outputs in a local river. • to understand implications for flooding on a local river. <p>If students complete a fieldwork investigation they will be able to follow through a complete geographical investigation and route to enquiry.</p>	<p>students to conduct a short fieldwork enquiry of a local river to investigate the main themes of the lesson.</p> <p>Students could write up a mini-fieldwork enquiry to act as a case study of a local river.</p> <p>(This could feed into the completion of coursework for the Non-examination assessment element of the specification).</p>	<p>and resources to help undertake fieldwork here.</p>
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Quantitative and qualitative skills

Students must engage with a range of quantitative and relevant qualitative skills, within the theme water and carbon cycles. Students must specifically understand simple mass balance, unit conversions and the analysis and presentation of field data.