Subject	Geography	**Year Group**	13	**Sequence No.**	3	**Topic**	Water and Carbon

Retrieval	Core Knowledge	Student Thinking
What do teachers need retrieve from students before they start teaching new content?	What specific ambitious knowledge do teachers need teach students in this sequence of learning?	What real life examples can be applied to this sequence of learning to development of our students thinking, encouraging them to see the inequalities around them and 'do something about them!'

From the coasts topic retrieve what is meant by a system in geography and what processes and components are part of a system From GCSE rivers retrieve key terms linked to processes change in the water cycle system From GCSE Hazards retrieve the global atmospheric circulation model to explain how precipitation changes spatially Constantly link the content learnt to concept of positive and negative feedback loops From A level coasts topic retrieve contemporary sea level rise to cyrospheric changes in the water cycle From GCSE Rivers retrieve drainage basin processes	**<u>Water cycle system</u>** • The system is closed-no water is lost or gained from space • On a local scale the system is open • Water stores-lithosphere (land), hydrosphere (rivers, oceans and lakes), cryosphere (frozen areas) and atmosphere • Water store vary across the world between aquifers (underground reservoirs) only form in sandstone and chalk • Groundwater shallow is stored for 100-200years • Groundwater deep is stored for 10000 years • Lakes 50-100 years • Rivers 2-6months • Glaciers 20-100 years • Seasonal snow 2-6 months • Soil 1-2 months **<u>Processes of change in the water cycle system</u>** • Precipitation, evaporation, condensation, sublimation (ice to water vapour), interception, overland flow, infiltration, throughflow, percolation and groundwater flow and climate change • Cloud formation and causes of precipitation-changes with time and space. • Cyrospheric-Water held in ice. Rising sea levels are leading to positive feedback • Local scale **<u>Soil water budget</u>** Shows changes within the water cycle system to know where water is being stored at different times of the year	Through the knowledge gained from this content students will develop a greater understanding and awareness of how some natural processes even though they are disruptive to human life are important to keep in balance. They will learn how human interventions can through the earth off balance as well as help to bring it back into balance. They will do this through the following tasks: • When learning about water and carbon stores discuss why it is important to manage the largest stores and assess whether we are doing this as a human population currently • Consider changes temporally and spatially when discussing the water and carbon systems • Watch documentaries and podcasts linked to current up to date research on the topic • Highlight links between the carbon and water cycle systems to see how we need an understanding of both to help the world function effectively • Assess the factors that lead to change in both the water and carbon cycle systems

From GCSE rivers retrieve knowledge on what a hydrograph is, how it works and why its useful

When discussing human drivers of change in the water cycle system retrieve from GCSE about desertification

From earlier on in this topic when discussing the carbon cycle system retrieve how the water cycle system operates

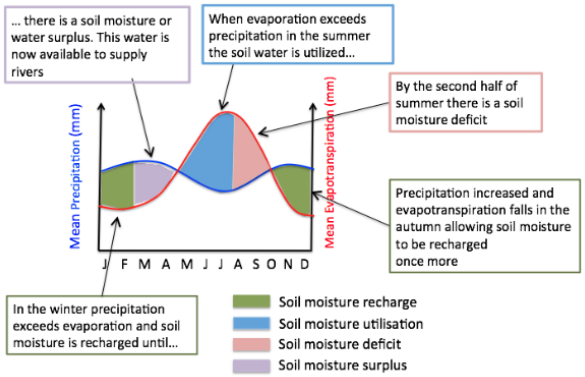
Retrieve from KS3 and GCSE the importance of the trees for carbon storage and causes, impacts and management of climate change

From GCSE and the A level coasts topic retrieve weathering when learning about carbon transfers

When learning about wildfires link the impacts of them to hazards topic

Water Budgets

Influence on Flow of a River



<u>Water balance</u>

Equation used to help understand water supply and deal with flood management
Water budgets show the annual balance between:
inputs (precipitation)
outputs (evapotranspiration and channel flow)
their impact on soil water availability
Water budgets are influenced by climate type (tropical or temperate or polar examples).
River regimes indicate the annual variation of discharge of a river and result from the impact of climate, geology and soils as shown in regimes from contrasting river basins.

The water budget can either have a

positive water balance (where there is a surplus of water)

negative water balance (where there is a deficit of water)

You can calculate the annual water budget using the following equation…
$P = Q + E \pm S$
P= precipitation
Q= Discharge
E= evapotranspiration (EVT)

- Evaluating the different strategies used to mitigate against climate change

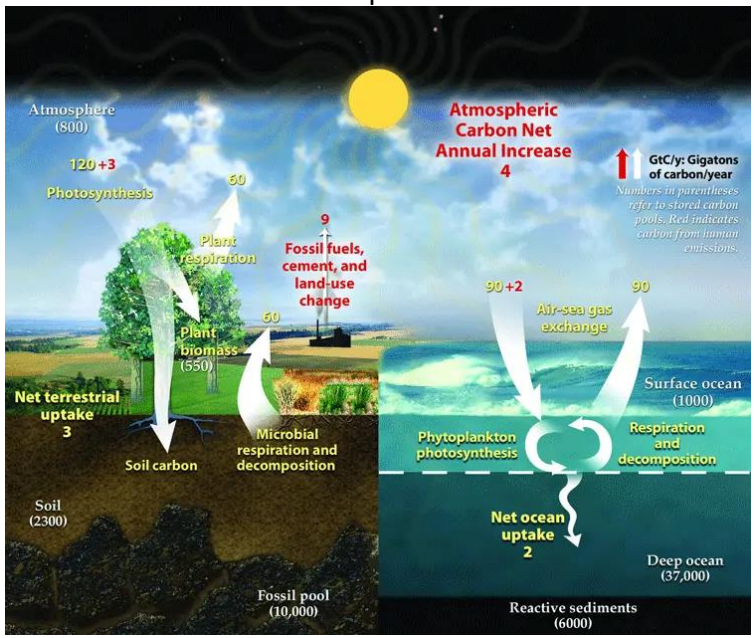
Retrieve Amazon rainforest case study from GCSE when looking at the case study	S= storage Water budgets are usually presented as a graph showing change throughout the year. **<u>Natural factors that cause change in the water cycle system</u>** Extreme weather e.g storms or droughts Seasonal variations-due to rainfall, evaporation, soil water storage **<u>Human factors that cause change in the water cycle system</u>** • Urbanaisation • Deforestation • Farming • Water abstraction **<u>Carbon cycle system</u>** • Carbon is a basic element essential for life • Stores- rock, soil, hydrosphere, cryosphere, atmosphere and biosphere (plants) • Carbon sink-a store that absorbs more carbon than it releases • A carbon source releases more carbon than it absorbs • Transfers-photosynthesis, respiration, decomposition, combustion, burial and compactions, carbon sequestration and weathering • Carbon system is closed system globally but open locally **<u>Natural factors that cause change in the carbon cycle system</u>** • Natural climate change-historical stages of cold and warm periods-during cold snaps • Volcanic activity-releases trapped carbon to the atmosphere Cold conditions • chemical weathering would be more prevalent as water holds more carbon at lower temperatures. Less decomposers when its cold • Different types of tree cover so this will impact photosynthesis and respiration • Less water reaching oceans • Soil would be frozen stopping the transfer of carbon Warm conditions • Melting of permafrost which will release carbon leading to positive feedback to the carbon system • Wildfires lead to carbon sinks turning to carbon sources	

Human causes of change in the carbon cycle

- Anthropogenic-human related
- Combustion of fossil fuels
- Land use change
- Farming practices
- Deforestation
- Urbanisation

Carbon budget

The global carbon budget is the amount of carbon gained and lost in the natural and manmade workings of the world. The global carbon budget is part of the greater carbon cycle and the ways in which the Earth's reservoirs of carbon are added to and subtracted from. The global carbon budget can be directly traced to the increases and decreases in carbon dioxide in the atmosphere.



Impacts of the carbon cycle

Land-

- The carbon cycle is responsible for the formation and development of soil.

	• Carbon in the form of organic matter (litterfall) introduces important nutrients and provides a structure to the soil. • Carbon in the form of organic matter is essential for plant growth and the production of food. • Carbon stored in grass provides fodder for animals. • Carbon provides a valuable source of energy in the form of wood and fossil fuels. **Ocean** • Carbon can be converted into calcium carbonate, which is used by some marine • organisms to build shells. • The carbon cycle has an impact on the presence and proliferation of phytoplankton, • a basic food for many marine organisms. Phytoplankton • consumes carbon dioxide during photosynthesis. • The carbon is then passed along the marine food chain. **Atmosphere** • Carbon dioxide in the atmosphere helps to warm the Earth through the greenhouse effect. Without this, there would be no life on Earth. • Increases in carbon emissions as a result of human activities (deforestation, combustion of fossil fuels) have led to the enhanced greenhouse effect, which threatens to have a profound impact on the world's climate. • Carbon stored by vegetation has a significant effect on the atmosphere, whether deforestation (carbon source) or afforestation (carbon sink). **Spatial-regional impacts** Vegetation plays a pivotal role in the carbon cycle. It also impacts on global climates, by removing carbon dioxide and releasing water and oxygen. Regions with dense vegetation (tropical rainforests) experience high rates of photosynthesis and respiration. This increases levels of humidity and the amount of cloud cover, which in turn may affect regional temperatures and rainfall. Regions experiencing widespread deforestation may become drier and less humid - fewer trees mean less Sun photosynthesis. As the Earth's surface warms, it emits infrared radiation The proliferation of plankton in the oceans may promote the formation of clouds, through the creation of a chemical substance called dimethylsulphide(DMS). Solar radiation Most solar radiation is absorbed by the Earth's surface	

Earth's surface
Volcanic eruptions release carbon dioxide into the atmosphere along with ash and other gases. This absorbs more incoming radiation from the sun and can lead to a cooling effect on Earth sometimes called a volcanic winter.

Water and carbon working together

- Carbon in rainwater causes chemical weathering, the dissolved rock is transported by rivers to the oceans where its used for shell growth to make new deposits of carbon and some is transferred back to the atmosphere.
- Ice reflects radiation so less heat is absorbed due to ice mantling this means more heat is absorbed . This heat then melts even more ice.
- Higher temperatures have led to a longer growing season. Meaning more carbon is absorbed from the atmosphere.
- Higher temps due to more carbon in the atmosphere have led to melting of permafrost
- Phytoplankton are microscopic plant-like organisms that live in water. In common with terrestrial plants they use the energy of the Sun, together with carbon dioxide (dissolved in the water), to photosynthesise, live and grow. They are the primary producers in aquatic ecosystems sustaining the food web. They are also important stores of carbon. Marine phytoplankton releases a chemical substance called dimethy|sulphide (DMS) that may promote the formation of clouds (condensation) over the oceans. Increases in phytoplankton populations associated with warmer temperatures and more sunshine could therefore lead to an increase in cloudiness and global cooling. This is because clouds reduce the amount of solar radiation reaching the Earth's surface. Of course less sunshine might lead to a reduction in the amount of phytoplankton, thereby reducing this cooling effect. This complex feedback loop (though not all phytoplankton species react in the same way) is an example of a negative feedback

Mitigating the impacts of climate change

- Modifying photosynthesis-plantation forests
- Modifying land use change-carbon farming
- Modifying deforestation
- International agreements and government polices

	See textbook and lesson plans for the case studies	