

A Level Geography

Specification and PLC (Personal Learning Checklist)

AREA OF STUDY: 3 -Physical Systems and Sustainability

Topic 6: The Carbon Cycle and Energy Security

Sprint Term Y13

Overview: A balanced carbon cycle is important in maintaining planetary health. The carbon cycle operates at a range of spatial scales and timescales, from seconds to millions of years. Physical processes control the movement of carbon between stores on land, the oceans and the atmosphere. Changes to the most important stores of carbon and carbon fluxes are a result of physical and human processes. Reliance on fossil fuels has caused significant changes to carbon stores and contributed to climate change resulting from anthropogenic carbon emissions. The water and carbon cycles and the role of feedbacks in and between the two cycles, provide a context for developing an understanding of climate change. Anthropogenic climate change poses a serious threat to the health of the planet. There is a range of adaptation and mitigation strategies that could be used, but for them to be successful they require global agreements as well as national actions

What do I need to know?				
EQ1: How does the carbon cycle operate to maintain planetary health?				
6.1 Most global carbon is locked in terrestrial stores as part of the long-term geological cycle	Explain how the biogeochemical carbon cycle consists of carbon stores of different sizes (terrestrial, oceans and atmosphere), with annual fluxes between stores of varying size (measured in Pg/Gt), rates and on different timescales.			
	Explain why most of the earth's carbon is geological, resulting from the formation of sedimentary carbonate rocks (limestone) in the oceans and biologically derived carbon in shale, coal and other rocks.			
	Explain how geological processes release carbon into the atmosphere through volcanic out-gassing at ocean ridges/subduction zones and chemical weathering of rocks.).			
6.2 Biological processes sequester carbon on land and in the oceans on shorter timescales	Explain how phytoplankton sequester atmospheric carbon during photosynthesis in surface ocean waters; carbonate shells/tests move into the deep ocean water through the carbonate pump and action of the thermohaline circulation.			
	Explain how terrestrial primary producers sequester carbon during photosynthesis; some of this carbon is returned to the atmosphere during respiration by consumer organisms.			
	Explain how biological carbon can be stored as dead organic matter in soils, or returned to the atmosphere via biological decomposition over several years.			
6.3 A balanced carbon cycle is important in sustaining other earth systems but is increasingly	Explain how the concentration of atmospheric carbon (carbon dioxide and methane) strongly influences the natural greenhouse effect, which in turn determines the distribution of temperature and precipitation.			
	Explain why ocean and terrestrial photosynthesis play an important role in regulating the composition of the atmosphere.			

	Explain how soil health is influenced by stored carbon and why this is important for ecosystem productivity.			
	Explain how the process of fossil fuel combustion has altered the balance of carbon pathways and stores with implications for climate, ecosystems and the hydrological cycle.			
EQ2: What are the consequences for people and the environment of our increasing demand for energy?				
6.4 Energy security is a key goal for countries, with most relying on fossil fuels	Explain how consumption (per capita and in terms of units of GDP) and energy mix (domestic and foreign, primary and secondary energy, renewable versus non-renewable vary).			
	Explain how access to and consumption of energy resources depends on physical availability, cost, technology, public perception, level of economic development and environmental priorities (national comparisons: USA versus France).			
	Explain the energy players (e.g. role of TNCs, The Organisation of the Petroleum Exporting Countries (OPEC), consumers, governments) have different roles in securing pathways and energy supplies.			
6.5 Reliance on fossil fuels to drive economic development is still the global norm	Explain why there is a mismatch between locations of conventional fossil fuel supply (oil, gas, coal) and regions where demand is highest, resulting from physical geography.			
	Explain why energy pathways (pipelines, transmission lines, shipping routes, road and rail) are a key aspect of energy security and why they can be prone to disruption especially as conventional fossil fuel sources deplete (e.g. Russian gas to Europe)			
	Explain why the development of unconventional fossil fuel energy resources (tar sands, oil shale, shale gas, deep water oil) has social costs and benefits, implications for the carbon cycle, and consequences for the resilience of fragile environments			
6.6 There are alternatives to fossil fuels but each has costs and benefits	Explain how renewable and recyclable energy (nuclear power, wind power and solar power) could help decouple fossil fuel from economic growth.			
	Explain why different energy sources have costs and benefits, economically, socially, and environmentally and in terms of their contribution they can make to energy security.			
	Explain why biofuels, an alternative energy source, are increasing globally and explain why growth in biofuels however has implications for food supply as well as uncertainty over how 'carbon neutral' they are.			
	Explain how radical technologies, including carbon capture and storage and alternative energy sources (hydrogen fuel cells, electric vehicles) could reduce carbon emissions but uncertainty exists as to how far this is possible			

EQ3: How are the carbon and water cycle linked to the global climate system?

6.7 Biological carbon cycles and the water cycle are threatened by human activity	Explain why growing demand for food, fuel and other resources globally has led to contrasting regional trends in land-use cover (deforestation, afforestation, conversion of grasslands to farming) which affect terrestrial carbon stores and subsequently the water cycle and soil health.			
	Explain how ocean acidification, is increasing due to fossil fuel combustion and is at risks crossing the critical threshold for the health of coral reefs and other marine ecosystems that provide vital ecosystem services			
	Explain how climate change, resulting from the enhanced greenhouse effect, may increase the frequency of drought due to shifting climate belts, which may impact on the health of forests as carbon stores.			
6.8 There are implications for human wellbeing from the degradation of the water and carbon cycle	Explain how forest losses has implications for human wellbeing but that there is also evidence that forest stores are being protected and even expanded, especially in countries at higher levels of development (environmental Kuznets' curve model).			
	Explain how increased temperatures affect evaporation rates and the quantity of water vapour in the atmosphere with implications for precipitation patterns, river regimes and water stores (cryosphere and drainage basin stores).			
	Explain why threats to ocean health pose threats to human wellbeing, especially in developing regions that depend on marine resources as a food source and for tourism and coastal protection.			
6.8 Further planetary warming risks large-scale released of stored carbon, requiring responses from different players at different scales	Explain why future emissions, atmospheric concentration levels and climate warming are uncertain owing to natural factors, human factors and feedback mechanisms			
	Analyse the adaptation strategies for a changed climate (water conservation and management, resilient agricultural systems, land-use planning, flood-risk management, solar radiation management) and explain the different costs and risks.			
	Explain how re-balancing of the carbon cycle could be achieved through mitigation and why this requires global scale agreement and national actions both of which have proved to be problematic..			

Geographical Skills for Topic 6			
1. Use of proportional flow diagrams showing carbon fluxes			
2. Use of maps showing global temperature and precipitation distribution			
3. Graphical analysis of the energy mix of different countries, including change over time			
4. Analysis of maps showing global energy trade and flows			
5. Comparisons of emissions from different energy sources			
6. Using GIS to map land-use changes such as deforestation over time			
7. Analysis of climate model maps to identify areas at most risk from water shortages, floods in the future			
8. Plotting graphs of carbon dioxide levels, calculating means and rates of change			

NOTES/CASE STUDY INFORMATION: