A Level Geography: Personal Learning Checklist Spring term Yr 13

AREA OF STUDY: Physical systems and sustainability Topic 5. The carbon cycle and energy security

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.

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| What do I need to know? | | | | |
| Enquiry question 1: How does the carbon cycle operate to maintain planetary health? | | | | |
| Key Idea | Detailed content | PLC | | |
| RED | AMBER | GREEN |
| 6.1 Most global carbon is locked in terrestrial stores as part of the long-term geological cycle | a. 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. (1) |  |  |  |
| b. 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. |  |  |  |
| c. 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. | a. 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 |  |  |  |
| b. Terrestrial primary producers sequester carbon during photosynthesis; some of this carbon is returned to the atmosphere during respiration by consumer organisms. |  |  |  |
| c. 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 altered by human activities | a. 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. (2) |  |  |  |
| b. Ocean and terrestrial photosynthesis play an important role in regulating the composition of the atmosphere. Soil health is influenced by stored carbon, which is important for ecosystem productivity. |  |  |  |
| c. The process of fossil fuel combustion has altered the balance of carbon pathways and stores with implications for climate, ecosystems and the hydrological cycle. |  |  |  |

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| Enquiry question 2: What are the consequences for people and the environment of our increasing demand for energy? | | | | |
| Key Idea | Detailed content | PLC | | |
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| 6.4 Energy security is a key goal for countries, with most relying on fossil fuels. | a. Consumption (per capita and in terms of units of GDP) and energy mix (domestic and foreign, primary and secondary energy, renewable versus non-renewable). (3) |  |  |  |
| b. 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). |  |  |  |
| c. Energy players (P: 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 | a. There is a mismatch between locations of conventional fossil fuel supply (oil, gas, coal) and regions where demand is highest, resulting from physical geography |  |  |  |
| b. Energy pathways (pipelines, transmission lines, shipping routes, road and rail) are a key aspect of security but can be prone to disruption especially as conventional fossil fuel sources deplete (⎫ Russian gas to Europe). (4) |  |  |  |
| c. 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. (⎫ Canadian tar sands, USA fracking, Brazilian deep water oil) (P: role of business in developing reserves, versus environmental groups and affected communities) |  |  |  |
| 6.6 There are alternatives to fossil fuels but each has costs and benefits. | a. Renewable and recyclable energy (nuclear power, wind power and solar power) could help decouple fossil fuel from economic growth; these energy sources have costs and benefits economically, socially, and environmentally and in terms of their contribution they can make to energy security. (⎫ changing UK energy mix |  |  |  |
| b. Biofuels are an alternative energy source that are increasing globally; growth in biofuels however has implications for food supply as well as uncertainty over how ‘carbon neutral’ they are. (⎫ Biofuels in Brazil) (5) |  |  |  |
| c. 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 |  |  |  |
| Enquiry question 3: How are the carbon and water cycles linked to the global climate system? | | | | |
| Key Idea | Key Idea | Key Idea | | |
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| 6.7 Biological carbon cycles and the water cycle are threatened by human activity. | a. 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) affecting terrestrial carbon stores with wider implications for the water cycle and soil health. (6) |  |  |  |
| b. Ocean acidification, as a result of its role as a carbon sink, is increasing due to fossil fuel combustion and risks crossing the critical threshold for the health of coral reefs and other marine ecosystems that provide vital ecosystem services |  |  |  |
| c. 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. (⎫ Amazonian drought events |  |  |  |
| 6.8 There are implications for human wellbeing from the degradation of the water and carbon cycles. | a. Forest loss has implications for human wellbeing but there is evidence that forest stores are being protected and even expanded, especially in countries at higher levels of development (environmental Kuznets’ curve model). (A: attitudes of global consumers to environmental issues |  |  |  |
| b. 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) (⎫ Arctic) (F: uncertainty of global projections). (7) |  |  |  |
| c. 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 |  |  |  |
| 6.9 Further planetary warming risks large-scale release of stored carbon, requiring responses from different players at different scales. | a. Future emissions, atmospheric concentration levels and climate warming are uncertain owing to natural factors (the role of carbon sinks), human factors (economic growth, population, energy sources) and feedback mechanisms (carbon release from peatlands and permafrost, and tipping points, including forest die back and alterations to the thermohaline circulation). (8) (F: uncertainty of global projections |  |  |  |
| b. Adaptation strategies for a changed climate (water conservation and management, resilient agricultural systems, land-use planning, flood-risk management, solar radiation management) have different costs and risks |  |  |  |
| c. Re-balancing the carbon cycle could be achieved through mitigation (carbon taxation, renewable switching, energy efficiency, afforestation, carbon capture and storage) but this requires global scale agreement and national actions both of which have proved to be problematic. (A: attitudes of different countries, TNCs and people |  |  |  |

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| Geographical Skills for Topic 6 |  | | |
| Note: These skills are not exclusive to the topic areas under which they appear; you will need to be able to apply these skills across any suitable topic area throughout their course of study. | PLC | | |
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| (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 source. |  |  |  |
| (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 |  |  |  |

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| NOTES/CASE STUDY INFORMATION: |