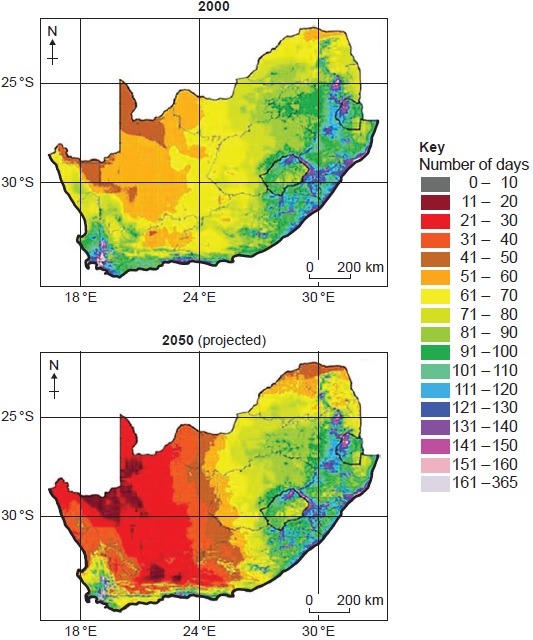
**Q1.** The map below shows the number of days when precipitation is high enough for plant growth across southern Africa in 2000 and that projected for 2050.



Using the map and your own knowledge, assess the predicted impact of climate change upon life in this region.

**[6 marks]**

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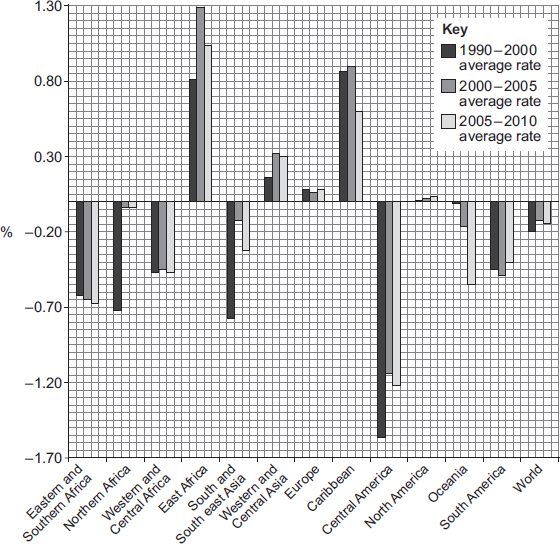
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**Q2 SECURE MATERIAL**

**Q3. Regional changes in forest cover between 1990 and 2010**

**Figure 1**



Using **Figure 1** and your own knowledge, assess the challenges arising out of the changing forest cover.

**[6 marks]**

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**Q4.** ‘Human activity needs to focus more on adapting to the expected negative impacts of climate change than on taking measures to restore atmospheric carbon to pre-industrial levels.’

How far do you agree with this view?

**[20 marks]**

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**Q5.** Assess the scale of changes to stores of carbon in a tropical rainforest you have studied.

**[9 marks]**

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**Q6. SECURE MATERIAL**

**Q7.** ‘Human activity has led to irreversible changes to the carbon cycle, causing negative impacts for life on Earth.’

To what extent do you agree with this statement?

**[20 marks]**

**Q8.** Assess the impact of natural changes to the carbon cycle upon life on Earth.

**[9 marks]**

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**Q9.** ‘Human activity has a significant impact on flows of water in tropical rainforests.’

With reference to a tropical rainforest you have studied, to what extent do you agree with this view?

**[20 marks]**

Mark schemes

**Q1.**

**AO1** – Knowledge and understanding of changes of the water cycle and how changes to the water cycle affect the ability of a region to sustain itself.

**AO2** – Application of knowledge to show how the changing rainfall characteristics are likely to affect the ability of the region to sustain life.

**Level 2 (4–6 marks)**

**AO1** – Demonstrates clear knowledge and understanding of concepts, processes, interactions and change.

**AO2** – Applies knowledge and understanding to the novel situation offering clear evaluation and analysis drawn appropriately from the context provided. Connections and relationships between different aspects of study are evident with clear relevance.

**Level 1 (1–3 marks)**

**AO1** – Demonstrates basic knowledge and understanding of concepts, processes, interactions, change.

**AO2** – Applies limited knowledge and understanding to the novel situation offering only basic evaluation and analysis drawn from the context provided. Connections and relationships between different aspects of study are basic with limited relevance.

Notes for answers

**AO1**

•   Changes in the water cycle over time to include natural variation including storm events, seasonal changes and human impact including farming practices, land use change and water abstraction.

•   The key role of water stores and cycles in supporting life on Earth with particular reference to climate. The implications for life on Earth.

**AO2**

•   It is clear from the evidence that the west is set to experience an increase in area where plant growth days are low. Apart from the coastal region there is almost a 50/50 in coverage where there is precipitation facilitating less than 60 days’ plant growth.

•   Responses are likely to connect the reduced plant growth days in the west to increased challenges in farming. A typical growing season is around 3–5 months depending on the crop. With growing days of less than 60 days, this is sure to impact on farming yields, affecting crop growth but also livestock. Expect reference to food shortage and increased reliance on the importation of food supplies.

•   The local environment is also likely to suffer with less natural vegetation growth which supports local habitats.

•   Water supply is also likely to be considered. Whilst this information is not provided it is implicit that there must be less rainfall predicted by 2050. This is likely to impact negatively upon reservoirs and water storage for human consumption. Some may connect this to the rationing of water and the negative impact of this upon quality of life.

Credit any other valid assessment.

**AO1 = 2 AO2 = 4**

**[Total 6 marks]**

**Q2. SECURE MATERIAL**

**Q3.**

**AO1** – Knowledge and understanding of changes to the global carbon budget as a result of human activity. Awareness of deforestation, its causes and impacts.

**AO2** – Application of knowledge to show how changes to global forest cover present major local, regional and international issues.

Mark scheme

**Level 2 (4–6 marks)**

**AO1** – Demonstrates clear knowledge and understanding of concepts, processes, interactions and change.

**AO2** – Applies knowledge and understanding to the novel situation offering clear evaluation and analysis drawn appropriately from the context provided. Connections and relationships between different aspects of study are evident with clear relevance.

**Level 1 (1–3 marks)**

**AO1** – Demonstrates basic knowledge and understanding of concepts, processes, interactions, change.

**AO2** – Applies limited knowledge and understanding to the novel situation offering only basic evaluation and analysis drawn from the context provided. Connections and relationships between different aspects of study are basic with limited relevance.

Notes for answers

**AO1**

•   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, carbon sequestration in oceans and sediments, weathering.

•   The carbon budget and the impact of the carbon cycle upon land, ocean and atmosphere, including global climate.

**AO2**

•   There are a variety of potential challenges associated with this information. Most are likely to consider the challenges associated with deforestation. There are extensive areas of forest loss in Central and South America, and Eastern and Southern Africa, South East Asia. Some may support this with data, though is not essential. Others may note anomalies such as Northern Africa which lost a lot of forest between 1990 and 2000 and not much since. Some are likely to consider the impact on CO2 levels and the associated climate implications.

•   Others may consider the challenges associated with afforestation. East Asia, Western and Central Asia, Europe and the Caribbean have all experienced gain. Afforestation schemes are only possible where the land-use has not already been taken up by other human activity such as settlement transport or agriculture. These areas experiencing afforestation are likely to be sparsely populated. The much greater challenge is afforesting areas closer to human activity centres, hence the relatively small increases in Europe

•   Interestingly the Great Green Wall in Africa is not evident as an area of afforestation, but some may refer to this. Some may suggest the challenge here was in establishing a co-operative approach across many African countries, with the shared goal of limiting the process of desertification.

•   Others may consider in more generic terms the issues of competing demands on scarce resources. The encroachment into Amazonia may feature here for example. Political issues may also feature, such as the apparent change in policy by the Brazilian government, and the increasing evidence of rainforest exploitation, clearly evident in the resource.

Credit any other valid assessment.

**AO1 = 2, AO2 = 4**

**[Total 6 marks]**

**Q4.**

**AO1** – Knowledge and understanding of impact of climate change, particularly regarding implications for life on earth. Knowledge and understanding of measures to mitigate the impact of climate change.

**AO2** – Application of knowledge and understanding assess the extent to which mitigation is more important than adaptation in the context of climate change.

Notes for answers

**AO1**

•   The key role of the carbon and water stores and cycles in supporting life on Earth with 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.

•   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 changes).

**AO2**

•   Responses are expected to offer a discussion around measures to mitigate against the impact of climate change as well as measures to reduce the production of CO2 and reverse the amount of atmospheric carbon.

•   In terms of mitigation, expect to see reference to measures designed to restore carbon levels to pre-industrial levels. Global agreements such as the Paris Accord may feature. Investment in carbon capture and storage, sequestration technology (for example using depleted oil and gas fields as storage for CO2) as well as fossil fuel reduction measures. Alternative energy and electric cars may also feature. Some may also consider the aviation industry and measures being taken there to reduce CO2 emissions. There should be an awareness of the challenges associated with reducing atmospheric carbon levels, but also opportunities to use technology to solve these major challenges.

•   Others may consider afforestation schemes such as the Shandong ecological afforestation scheme. The purpose of this scheme is primarily to reduce the impact of desertification but also will provide the secondary benefit of acting as a carbon store, absorbing atmospheric carbon.

•   Adaptation is more concerned with an acceptance that climate is changing and human activity being geared towards minimising the potentially negative consequences. Examples include changes to farming practices to cope with climate change. This may also present opportunities to open up new areas to agriculture which were previously too cold to exploit. Others may consider switching to crops which may absorb more carbon, thus combining adaptation and mitigation.

•   In more general terms, responses may consider approaches which seek to cope with a changing climate. Candidates may bring in other aspects of study including coastal defence or even changes to alpine tourism as measures to cope with the reduced snowfall in these locations. This is a legitimate approach.

•   Responses are free to argue either way, though the position should be based upon preceding content.

Credit any other valid approach.

**Level 4 (16–20 marks)**

•   Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent (AO2).

•   Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout (AO2).

•   Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout (AO1).

•   Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout (AO1).

•   Detailed awareness of scale and temporal change which is well integrated where appropriate (AO1).

**Level 3 (11–15 marks)**

•   Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question. Interpretations are generally clear and support the response in most aspects (AO2).

•   Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding (AO2).

•   Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Generally clear and relevant knowledge and understanding of place(s) and environments (AO1).

•   Generally clear and accurate knowledge and understanding of key concepts, processes and interactions and change (AO1).

•   Generally clear awareness of scale and temporal change which is integrated where appropriate (AO1).

**Level 2 (6–10 marks)**

•   Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question (AO2). Interpretations are partial but do support the response in places.

•   Some partially relevant analysis and evaluation in the application of knowledge and understanding (AO2).

•   Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Some relevant knowledge and understanding of place(s) and environments which is partially relevant (AO1).

•   Some knowledge and understanding of key concepts, processes and interactions and change. There may be a few inaccuracies (AO1).

•   Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies (AO1).

**Level 1 (1–5 marks)**

•   Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic (AO2).

•   Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence (AO2).

•   Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Very limited relevant knowledge and understanding of place(s) and environments (AO1).

•   Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies (AO1).

•   Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies (AO1).

**Level 0 (0 marks)**

•   Nothing worthy of credit.

**AO1 = 10, AO2 = 10**

**[Total 20 marks]**

**Q5.**

**AO1** – Knowledge and understanding of the carbon cycle in a tropical rainforest. Knowledge and understanding of changes to the size of the carbon stores in the case study tropical rainforest.

**AO2** – Application of knowledge and understanding to analyse and evaluate the extent of changes to the size of the stores of carbon in the case study tropical rainforest.

**Level 3 (7–9 marks)**

**AO1** – Demonstrates detailed knowledge and understanding of concepts, processes, interactions and change. These underpin the response throughout.

**AO2** – Applies knowledge and understanding appropriately with detail. Connections and relationships between different aspects of study are fully developed with complete relevance. Assessment is detailed and well-supported with appropriate evidence.

**Level 2 (4–6 marks)**

**AO1** – Demonstrates clear knowledge and understanding of concepts, processes, interactions and change. These are mostly relevant, though there may be some minor inaccuracy.

**AO2** – Applies clear knowledge and understanding appropriately. Connections and relationships between different aspects of study are evident with some relevance. Assessment is evident and supported with clear and appropriate evidence.

**Level 1 (1–3 marks)**

**AO1** – Demonstrates basic knowledge and understanding of concepts, processes, interactions and change. This offers limited relevance with inaccuracy.

**AO2** – Applies limited knowledge and understanding. Connections and relationships between different aspects of study are basic with limited relevance. Assessment is basic and supported with limited appropriate evidence.

Notes for answers

**AO1**

•   Factors driving change in the magnitude of stores of carbon, over time and in space, including flows and transfers at plant and sere scale. Photosynthesis, respiration, decomposition, combustion and carbon sequestration.

•   Changes in the carbon cycle over time, to include natural variation (including wildfires, volcanic activity) and human impact (including hydrocarbon fuel extraction and burning, farming practices, deforestation, land use changes).

•   Case study of a tropical rainforest setting to illustrate and analyse key themes in carbon cycles and their relationship to environmental change and human activity.

**AO2**

•   Responses are likely to be heavily influenced by the exemplification and case study material.

•   Assessment of the impact of deforestation/logging/mining on the size of the biospheric store of carbon and any reduction in the amount of carbon stored in trees is likely to be a prominent feature of responses.

•   Assessment may be given of the spatial scale of change in the named rainforest. A judgement of the geographical area of forest cleared would allow the response to come to a view on the extent of change to that store of carbon.

•   Assessment may be given of the temporal scale of change in the named rainforest. A judgement of the speed with which the forest is being cleared would allow the response to come to a view on the rate of change to that store of carbon.

•   Assessment may be given of the impact of the removal of trees and subsequent impact of the interruption of transfers of carbon to the soil, and soil erosion, on the amount of carbon stored in the soil.

•   Others may provide assessment of the impact of possible afforestation and the replanting of trees on the scale of stores of carbon.

Credit any other valid assessment.

**AO1 = 4, AO2 = 5**

**[Total 9 marks]**

**Q6. SECURE MATERIAL**

**Q7.**

**AO1** – Knowledge and understanding of systems theory and its application to understanding the carbon cycle. Knowledge and understanding of impacts of the carbon cycle on life on Earth.

**AO2** – Application of knowledge and understanding to assess the extent to which human activity has led to irreversible changes to the carbon cycle and caused negative impacts for life on Earth.

Notes for answers

**AO1**

•   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 changes).

•   Systems in physical geography: systems concepts and their application to the water and carbon cycles, inputs – outputs, energy, stores/components, flows/transfers, positive/negative feedback, dynamic equilibrium.

•   The key role of the carbon and water stores and cycles in supporting life on Earth with 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 of Earth.

•   Human interventions in the carbon cycle designed to influence carbon transfers and mitigate the impacts of climate change.

•   The carbon budget and the impact of the carbon cycle upon land, ocean and atmosphere, including global climate.

**AO2**

•   Candidates are free to argue in any direction in relation to the question. Some may remain neutral.

•   Allow any changes to the carbon cycle that are reasonably derived from the chosen human activities.

•   There should be some recognition of unique characteristics of the chosen human activity/ies and the specific impacts the resulting changes to the carbon cycle have on life on Earth.

•   It is acceptable for responses to refer to any forms of life on Earth, including vegetation, animal or human life.

•   Changes to the carbon cycle relating to changing concentrations of atmospheric CO2 resulting from human activity are likely to feature strongly. Responses could assess changes to the carbon cycle over time resulting from human activities including:

-   Hydrocarbon fuel extraction and burning, farming practices, deforestation and land use changes.

Whichever human activities are included in the response there should be assessment that comes to a clear view as to whether the changes they caused in the carbon cycle are in fact irreversible.

•   Responses could assess changes to the carbon cycle that cause impacts to life on Earth on land, in the sea or in the atmosphere.

•   Effects of changes to the carbon cycle are likely to relate to changes in the carbon budget and could include:

-   Assessment of the melting of permafrost, acidification of the oceans, warming of the oceans, melting of sea ice, changes to ocean salinity, sea level rise (due to melting of ice on land or thermal expansion), or increased concentrations of atmospheric greenhouse gases and an enhanced greenhouse effect.

Whichever changes to the carbon cycle are included in the response there should be assessment that comes to a clear view as to whether these changes are in fact irreversible.

•   Responses could assess impacts for life on Earth that include assessment of impacts on:

-   marine life due to ocean acidification and ocean warming.

-   vegetation on land resulting from climatic changes due to atmospheric warming due to an enhanced greenhouse effect.

-   animal life on land resulting from direct and indirect climatic changes due to atmospheric warming due to an enhanced greenhouse effect.

-   humans may stem from the impacts noted on other areas of life on Earth, but they could also be reference to impacts relating to sea level rise.

Whichever impacts on life on Earth resulting from changes to the carbon cycle are included in the response there should be assessment that comes to a clear view on the extent to which these impacts are negative.

Responses should have clear assessment of whether the changes to the carbon cycle relating to human activity are irreversible AND that the impacts these have on life on Earth are negative.

•   Any view is acceptable, as long as it is supported with reasoned argument and illustrative examples and evidence.

Credit any other valid approach.

**Level 4 (16–20 marks)**

•   Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question (AO2).

•   Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout (AO2).

•   Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout (AO1).

•   Full and accurate knowledge and understanding of key concepts and processes throughout (AO1).

•   Detailed awareness of scale and temporal change which is well-integrated where appropriate (AO1).

**Level 3 (11–15 marks)**

•   Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question (AO2).

•   Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding (AO2).

•   Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Generally clear and relevant knowledge and understanding of place(s) and environments (AO1).

•   Generally clear and accurate knowledge and understanding of key concepts and processes (AO1).

•   Generally clear awareness of scale and temporal change which is integrated where appropriate (AO1).

**Level 2 (6–10 marks)**

•   Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question (AO2).

•   Some partially relevant analysis and evaluation in the application of knowledge and understanding (AO2).

•   Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Some relevant knowledge and understanding of place(s) and environments which is partially relevant (AO1).

•   Some knowledge and understanding of key concepts, processes and interactions and change (AO1).

•   Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies (AO1).

**Level 1 (1–5 marks)**

•   Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question (AO2).

•   Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence (AO2).

•   Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Very limited relevant knowledge and understanding of place(s) and environments (AO1).

•   Isolated knowledge and understanding of key concepts and processes.

•   Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies (AO1).

**Level 0 (0 marks)**

Nothing worthy of credit.

**AO1 = 10, AO2 = 10**

**[Total 20 marks]**

**Q8.**

**AO1** − Knowledge and understanding of a range of natural changes to the carbon cycle. Knowledge and understanding of factors impacting life on Earth over time.

**AO2** − Application of knowledge and understanding to assess how natural changes to the carbon cycle affect life on Earth.

**Level 3 (7−9 marks)**

**AO1** − Demonstrates detailed knowledge and understanding of concepts, processes, interactions and change. These underpin the response throughout.

**AO2** − Applies knowledge and understanding appropriately with detail. Connections and relationships between different aspects of study are fully developed with complete relevance. Analysis is detailed and well-supported with appropriate evidence.

**Level 2 (4−6 marks)**

**AO1** − Demonstrates clear knowledge and understanding of concepts, processes, interactions and change. These are mostly relevant, though there may be some minor inaccuracy.

**AO2** − Applies clear knowledge and understanding appropriately. Connections and relationships between different aspects of study are evident with some relevance. Analysis is evident and supported with clear and appropriate evidence.

**Level 1 (1−3 marks)**

**AO1** − Demonstrates basic knowledge and understanding of concepts, processes, interactions and change. This offers limited relevance with inaccuracy.

**AO2** − Applies limited knowledge and understanding. Connections and relationships between different aspects of study are basic with limited relevance. Analysis is basic and supported with limited appropriate evidence.

Notes for answers

**AO1**

•   Systems concepts and their application to the carbon cycle: inputs − outputs, energy, stores / components, flows / transfers, positive / negative feedback and dynamic equilibrium.

•   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 in space, including flows and transfers at plant, sere and continental scales. Photosynthesis, respiration, decomposition, combustion, carbon sequestration in oceans and sediments, weathering.

•   Changes in the carbon cycle over time, to include natural variation (including wild fires, volcanic activity) and their impact upon life on Earth.

•   The carbon budget and the impact of the carbon cycle upon land, ocean and atmosphere and thus life on Earth.

•   The key role of the carbon cycle in supporting life on Earth with particular reference to climate. The relationship between the carbon cycle and the atmosphere. The role of feedbacks within the cycle and their link to climate change and implications for life of Earth.

**AO2**

Assessment:

•   The carbon cycle is a natural cycle of carbon between land, ice, oceans and the atmosphere.

•   Carbon is essential for all known life on Earth. Any natural variation in the cycle can have significant effects of life on Earth.

•   The carbon cycle is affected by natural events such as volcanic eruptions and wild fires leading to transfers of carbon to the atmosphere.

•   The carbon cycle is affected by long term cycles of natural warming and cooling of climate causing cycles of glacials and interglacials altering the various stores and transfers of carbon, and thus affecting climate and life on Earth.

•   Atmospheric concentrations of carbon (as carbon dioxide and methane) are significant factors in controlling the natural greenhouse effect. Natural changes to the concentrations of either / both natural greenhouse gases will affect both climate and life on Earth.

•   Natural variations to climate could affect vegetation cover and the scale of the biosphere carbon store. Natural sequestration stores carbon in trees. Natural factors can disrupt the role of vegetation in cycling and storing carbon, which in turn will affect the amount of atmospheric carbon and thus global climate, thus affecting both climate and life on Earth.

•   Expect some responses to assess how natural changes will disrupt various natural systems within the carbon cycle causing feedback. Responses then may assess the impact of both negative and positive feedback on the climate and life on Earth.

•   Responses could address a broad range of natural changes to the carbon cycle, this is valid, and responses could assess a broad range of effects. All valid changes and effects will be credited.

Overall assessment may come to a view as to which factors may be more or less important in affecting life in Earth.

**AO1 = 4, AO2 = 5**

**[Total 9 marks]**

**Q9.**

**AO1** – Knowledge and understanding of human activity in a tropical rainforest setting. Knowledge and understanding of the flows of water in a tropical rainforest setting.

**AO2** – Application of knowledge and understanding to assess the extent to which human activity has a significant impact on flows of water in a tropical rainforest.

Notes for answers

**AO1**

•   Case study of a tropical rainforest setting to illustrate and analyse key themes in the water cycle and their relationship to environmental change and human activity.

•   Systems in physical geography: systems concepts and their application to the water cycle, inputs, outputs, energy, stores / components, flows / transfers, positive / negative feedback, dynamic equilibrium.

•   Global distribution and size of major stores of water – lithosphere, hydrosphere, cryosphere and atmosphere.

•   Processes driving change in the magnitude of these stores over time and in 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.

•   Changes in the water cycle over time to include natural variation including storm events, seasonal changes and human impact including farming practices, land use change and water abstraction.

**AO2**

•   Allow any potential impacts that are reasonably derived from the chosen human activities within a tropical rainforest.

•   There should be some recognition of the unique characteristics of the chosen case study and how human activity has / is impacting upon flows of water in this tropical rainforest.

•   Deforestation is likely to feature strongly in most responses. There are many impacts of this on flows of water in a tropical rainforest, these could include:

-   Reduced evapotranspiration from plants leading to less condensation, cloud cover and reduced precipitation levels.

-   Reduced precipitation over continental scales reduces overall river discharge at that scale.

-   Air warms more quickly over land in cleared areas of forest creating localised low pressure and thunderstorms so increasing precipitation rates at a local scale.

-   Less interception by vegetation leads to increased overland flow and increased discharge (channel flow) in local rivers.

-   Exposed soils may lead to increased rates of infiltration, percolation and soil water and ground water flows.

-   Exposed soils may experience increased rates of soil erosion which may lead to the sedimentation of local rivers and so affecting channel capacity.

Expect reference to the impact of the above on runoff variation and elements of river hydrographs.

•   Responses may consider the impact of the building of dams on rivers in tropical rainforests and then explore the significance of these impacts of this on flows such as evaporation, precipitation and channel flow.

•   Responses may consider the impact of land use changes, for example the building of settlements and the significance of these impacts on flows within the affected drainage basin hydrological system such as overland flow, infiltration and river discharge. There should be direct reference to the candidates own case study in this regard.

•   Responses may also consider water abstraction and other uses, such as for agriculture or other industry, and how this lowers the water table and so reduces channel flow (discharge) in local rivers.

•   Responses should have clear assessment of the perceived significance of specific impacts of specific human activities in named tropical rainforest settings.

•   Assessment should focus on the significance of these impacts.

**Credit any other valid approach**.

**Level 4 (16–20 marks)**

•   Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question (AO2).

•   Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout (AO2).

•   Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout (AO1).

•   Full and accurate knowledge and understanding of key concepts and processes throughout (AO1).

•   Detailed awareness of scale and temporal change which is well-integrated where appropriate (AO1).

**Level 3 (11–15 marks)**

•   Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question (AO2).

•   Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding (AO2).

•   Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Generally clear and relevant knowledge and understanding of place(s) and environments (AO1).

•   Generally clear and accurate knowledge and understanding of key concepts and processes (AO1).

•   Generally clear awareness of scale and temporal change which is integrated where appropriate (AO1).

**Level 2 (6–10 marks)**

•   Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question (AO2).

•   Some partially relevant analysis and evaluation in the application of knowledge and understanding (AO2).

•   Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Some relevant knowledge and understanding of place(s) and environments which is partially relevant (AO1).

•   Some knowledge and understanding of key concepts, processes and interactions and change (AO1).

•   Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies (AO1).

**Level 1 (1–5 marks)**

•   Very limited and / or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question (AO2).

•   Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence (AO2).

•   Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts (AO2).

•   Very limited relevant knowledge and understanding of place(s) and environments (AO1).

•   Isolated knowledge and understanding of key concepts and processes.

•   Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies (AO1).

**Level 0 (0 marks)**

Nothing worthy of credit.

**AO1 = 10**

**AO2 = 10**

**[Total 20 marks]**

Examiner reports

**Q1.**

In this question too many tried to analyse the data presented rather than consider the implications of the expected drier conditions on life in the region.

**Q3.**

The average mark was 3 for this question. The main issue holding back weaker responses was that many thought it was a AO3 skills question, rather than an application of knowledge AO1/AO2 question. For those responses, the challenges simply did not feature. Those responses that related the reduction of forest cover to a whole plethora of challenges around habitat loss, species diversity issues, soil related issues and climate challenges, readily scored marks and accessed Level 2.

**Q4.**

Most understood that this was essentially a question about mitigation versus adaptation in relation to increased atmospheric carbon. Those arguing for mitigation considered a whole range of strategies ranging from electric cars, carbon capture and storage as well as global agreements. Adaptation was probably less well covered. Students mainly considered agricultural changes, coastal management and changes in settlements to cope with warmer temperature and less predictable weather patterns.

**Q5.**

This question combined both AO1 and AO2 elements. This expected students to make links beyond the Water and Carbon Cycles specification content. Students had to make an evidence-based assessment of the scale of changes to stores of carbon in their named tropical rainforest case study. This question proved accessible to many, and over 40% of students scored in Level 3. These high-level responses gave clear detailed support to the points made, with good use of specific illustrative material. Some weaker responses were limited by a lack of differentiation between the different states of carbon in different stores, and often simply referred to “CO2”, when it would have been more accurate to simply refer to carbon.

**Q8.**

This question combined both AO1 and AO2 elements. The question expected students to make links between two areas within the water and carbon cycles specification. Students had to make an evidenced assessment of any impacts to life on Earth resulting from natural changes to the carbon cycle. Many limited the credit available to them by making human impacts on the greenhouse effect and enhanced global warming the focus of their argument, rather than natural changes. A number of the better responses explored long-term change in the carbon cycle and the role of natural processes in controlling concentrations of carbon the atmosphere, which impacts on life on Earth by controlling temperatures. Others explored shorter-term impacts, for instance the impact on vegetation as carbon is transferred from biosphere stores to the atmosphere via wildfires.

The average mark for the question was 3.9 suggesting that students need more preparation in the application of knowledge to questions which require them to make links between different elements of the specification.

**Q9.**

A quarter of students engaged well with this question, providing clear responses achieving marks in Level 3 or higher. These students generally scored well with respect to AO1 with clear and detailed knowledge of specific human activity in specific named rainforest locations that affected flows of water. The key to scoring well with respect to AO2 was the quality of the judgements made about the extent to which impacts on flows of water were significant. Many made the impacts of deforestation on flows such as overland flow the focus of their response. This was credit worthy and gained more credit for the level of detail given regarding specific areas of deforestation and the sophistication of the assessment.

The less effective responses tended to be quite vague. Many lacked clear focus on specific human activities in specific named tropical rainforest settings, giving a generic response. Others showed some confusion between flows and other elements of the water cycle by making inputs, outputs or stores the focus of their response. Others did not substantially address the question by focusing their response on the carbon cycle.