**Q1.** Outline potential impacts of farming practices upon the water cycle.

**[3 marks]**

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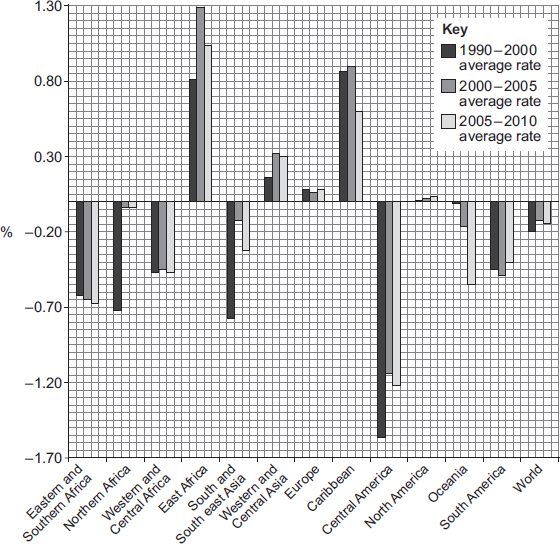
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**Q2. Regional changes in forest cover between 1990 and 2010**

**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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**Q3.** ‘There is always a balance between the inputs and outputs of water in a drainage basin.’

To what extent do you agree with this statement?

**[20 marks]**

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**Q4.**Outline features of a flood hydrograph.

**[3 marks]**

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**Q5.**Which of the following outlines a positive feedback in the water cycle?

**[1 mark]**

|  |  |  |
| --- | --- | --- |
| **A** | Increased CO2 in the atmosphere → warmer temperatures → plants grow quicker removing CO2 from the atmosphere by photosynthesis → levels of atmospheric CO2 reduced. |  |
| **B** | Increased CO2 in the atmosphere acts as a greenhouse gas → atmosphere warms up → methane released as permafrost melts → levels of greenhouse gases increase. |  |
| **C** | Increased greenhouse gases in the atmosphere → atmospheric temperatures rise → increasing evaporation from the surface → water vapour condenses forming clouds → clouds reduce the warming effect. |  |
| **D** | Increased water vapour in the atmosphere acts as a greenhouse gas → atmosphere warms up → more water is evaporated from the oceans → vapour increases in the atmosphere. |  |

**Q6.**Assess the extent to which there are inter-relationships between processes in the water cycle and factors driving change in the carbon cycle.

**[20 marks]**

**Q7.**Which of the following describes the cryospheric store of water?

**[1 mark]**

|  |  |  |
| --- | --- | --- |
| **A** | All water stored as liquid in the atmosphere. |  |
| **B** | All water stored as vapour in the atmosphere. |  |
| **C** | All water stored in its liquid state at the Earth’s surface. |  |
| **D** | All water stored in its solid state in glaciers, ice caps and sea ice. |  |

**Q8.**Using the information below and your own knowledge, assess the natural and human induced causes of the 2005 flood in Carlisle.

**[6 marks]**

|  |
| --- |
| There were two separate aspects within this period of storm which affected the River Eden drainage basin around the city of Carlisle, England. Three rivers converge in the city, which has a population of approximately 72 000. There had been several weeks of above average rainfall for January. The January 2005 flood was a major event. Rainfall was very high for the period 6 to 8 January, during which two months’ worth of rainfall was released in 24 hours. Some areas within the catchment received rainfall of up to 150 mm.  The upper parts of the catchment are dominated by the mountains of Skiddaw and the surrounding fells. The rocks here are hard and volcanic, soils are thin and the gradients of many tributaries are steep. In the lower reaches rivers flow through wide, shallow valleys.  The Eden channel itself has a steep gradient. The head of the catchment is around 690 m, falling rapidly to 160 m. The Eden’s glaciated valley opens out and the channel gradient reflects this change: the River Eden steadily loses height at around 1.8 m per km on its journey to Carlisle. The valley floor is over 2.5 km wide in many places. This forms extensive areas of floodplain.  In terms of land use, the drainage basin has a wide range of agricultural activity, both arable and pastoral farming. There are also golf courses and a small amount of managed forestry. As the River Eden reaches the coast, the area to the south is the heavily developed city of Carlisle. Much of the area is rural apart from this. 67% of the flooding resulted from rivers and watercourses. 25% of flooding was caused by surface water. 8% was due to flooding from sewerage and infrastructure.  In Carlisle, the River Eden peaked at an estimated 1520 cumecs at the Sheepmount Gauging Station at 2.30 pm on 8 January. This flow has a return period in the order of 175–200 years (0.5%). The previous highest recorded flow on the River Eden at Carlisle was 1075 cumecs in 1987. |

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**Q9.**Explain the concept of dynamic equilibrium in relation to the water cycle.

**[4 marks]**

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**Q10.**Evaluate the view that human activity is having a greater impact than natural factors on the water cycle.

**[9 marks]**

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**Q11. SECURE MATERIAL**

**Q12.**Which sentence describes **one** impact of climate change upon global precipitation rates?

**[1 mark]**

|  |  |  |
| --- | --- | --- |
| **A** | Increased cloud cover will mean lower temperatures and less evaporation, leading to less rainfall, falling in shorter bursts. |  |
| **B** | Temperatures will rise leading to increased evaporation and higher amounts of rainfall in many places, with more intense bursts. |  |
| **C** | Temperatures will rise leading to increased evaporation and lower amounts of more intermittent rainfall. |  |
| **D** | The higher temperatures will cause the ice caps to melt putting more water into the oceans. Sea levels will rise and hurricanes will be more likely. |  |

**Q13.**“Human activity has caused irreversible damage to the fragile inter-relationship between the water cycle and the carbon cycle.”

To what extent do you agree with this view?

**[20 marks]**

**Q14.**Which **one** of the following could be a natural cause of variation in the water cycle?

**[1 mark]**

|  |  |  |
| --- | --- | --- |
| **A** | The rate of transfer of water from lithosphere stores to hydrosphere stores can be increased by urbanisation. |  |
| **B** | Hydrosphere stores of water can be reduced by abstraction of water for agriculture. |  |
| **C** | The amount of water stored in the biosphere could be reduced by deforestation. |  |
| **D** | Storm events transfer significant amounts of water from the atmosphere store to the hydrosphere and lithosphere stores. |  |

**Q15. SECURE MATERIAL**

**Q16. SECURE MATERIAL**

**Q17. SECURE MATERIAL**

**Q18.**With reference to a river catchment that you have studied, assess the potential impact of human activity upon the drainage basin.

**[20 marks]**

**Q19.**Which of these factors does **not** affect the rate of overland flow?

**[1 mark]**

|  |  |  |
| --- | --- | --- |
| **A** | The size of the catchment and the amount of rain which has fallen. |  |
| **B** | The level of human activity in the area and the type of rock on which the catchment sits. |  |
| **C** | The amount of soil compaction and coverage by trees within the catchment. |  |
| **D** | The size of the river and its capacity, efficiency and competence. |  |

**Q20.** Where are the typical stores of water within the lithosphere?

**[1 mark]**

|  |  |  |
| --- | --- | --- |
| **A** | Groundwater, lakes and marshland |  |
| **B** | Throughflow, rivers and percolation |  |
| **C** | Groundwater flow, infiltration and stemflow |  |
| **D** | Evaporation, transpiration and soil moisture budget |  |

**Q21.** Assess the potential causes and impacts of changes to the water balance within a tropical rainforest that you have studied.

**[20 marks]**

**Q22.** Outline an example of positive feedback in the water cycle.

**[3 marks]**

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**Q23.** Explain the role of cryospheric change in the water cycle.

**[4 marks]**

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**Q24.** ‘The size of major stores of water change over time more because of human activity than natural variation.’

To what extent do you agree with this statement?

**[20 marks]**

**Q25.** Outline the relationship between the water cycle and the carbon cycle in the atmosphere.

**[4 marks]**

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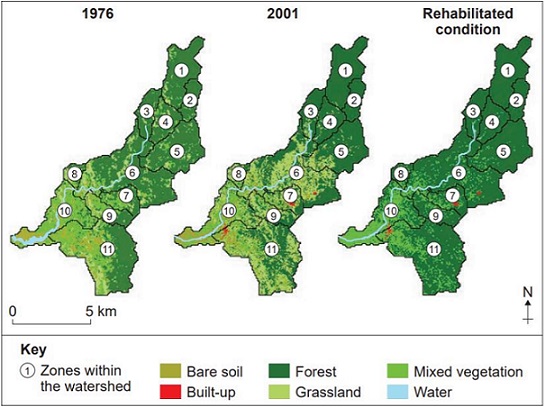
**Q26.** Which of the following are **all** stores of water in a drainage basin?

**[1 mark]**

|  |  |  |
| --- | --- | --- |
| **A** | Channel flow, infiltration, runoff |  |
| **B** | Evaporation, interception, soil water |  |
| **C** | Ground water, soil water, surface water |  |
| **D** | Precipitation, runoff, soil water |  |

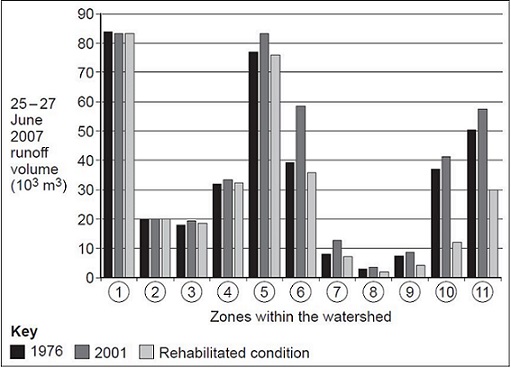
**Q27. Figure 1** shows two maps indicating the changing vegetation cover in the Taguibo Watershed in Agusan del Norte province, north-eastern Mindanao Island, Philippines, from 1976 and 2001. The third map shows how the area could be rehabilitated with natural vegetation.

**Figure 1**

****

**Figure 2** shows the possible impact of a storm in 2007 upon the runoff volume in the Taguibo Watershed for each of the situations shown in **Figure 1**.

**Figure 2**

****

Using **Figure 1**, **Figure 2** and your own knowledge, assess the potential impact of changing vegetation cover upon the runoff in this area.

**[6 marks]**

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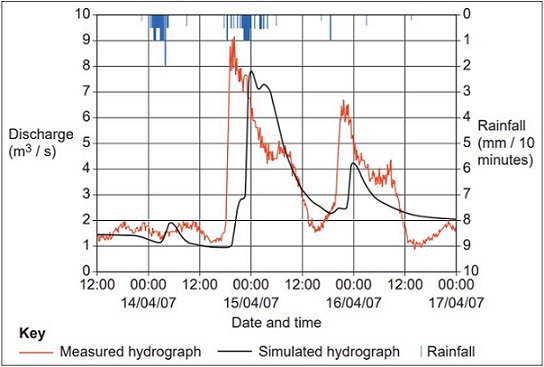
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**Q28.** The graph below shows rainfall data, a measured hydrograph and a simulated hydrograph for Taguibo Watershed in Mindanao Island, southern Philippines. The data were collected from 13 to 17 April 2007. The simulated hydrograph is a computer-generated prediction of discharge.



Analyse the data shown in the graph above.

**[6 marks]**

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**Q29.** Outline flows within the water cycle operating on a hill slope.

**[4 marks]**

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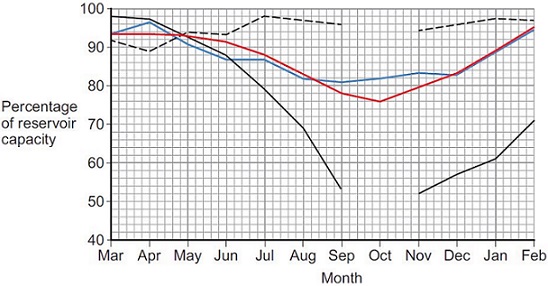
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**Q30.** ‘Human activity has a significant impact on flows of water in tropical rainforests.’

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

**[20 marks]**

**Q31.** The graph below shows data about water stored in reservoirs in England and Wales in box recent years.





Complete the graph above by adding the data shown below, and then analyse the data shown in the completed graph.

**[6 marks]**

|  |  |
| --- | --- |
| **Month** | **Percentage of reservoir capacity** |
| October 1995 | 48 |
| October 2012 | 95 |

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**Q32.** Outline the process of infiltration as a flow of water within a drainage basin system.

**[3 marks]**

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**Q33.** In the water cycle, what is condensation?

**[1 mark]**

|  |  |  |
| --- | --- | --- |
| **A** | Water transfers from a solid state as ice to water vapour in the atmosphere without first melting. |  |
| **B** | Water transfers directly from water vapour in the atmosphere to solid ice without becoming liquid. |  |
| **C** | Water vapour in the atmosphere is changed into liquid water. |  |
| **D** | Where water moves down from the surface store into the soil. |  |

**Q34.** With reference to a river catchment that you have studied, assess the potential factors which can impact upon the flood hydrograph.

**[20 marks]**

**Q35.** Assess the possible impact of changing land use on the shape of a flood hydrograph.

**[9 marks]**

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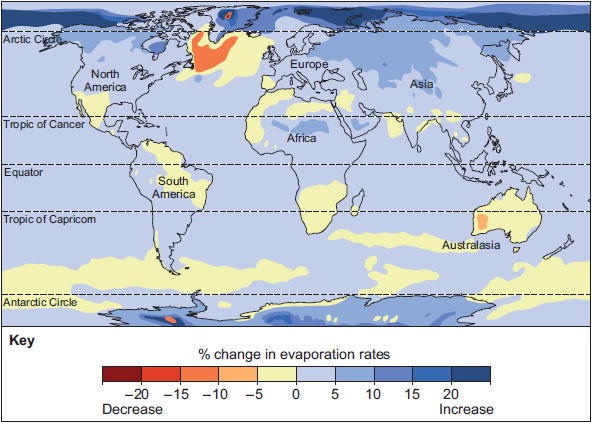
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**Q36.**

The map shows information about predicted changes to the annual rate of evaporation from the surface of the Earth between 2016 and 2035.



Analyse the information shown on the map.

**[6 marks]**

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Mark schemes

**Q1.** Allow 1 mark for each valid point with additional marks for developed points.

A variety of farming practices can affect / interrupt the natural water cycle, e.g.:

•   Irrigation techniques can divert water from rivers, lowering the local river levels (1).

•   Soil compaction by farming practices increases surface runoff upsetting the dynamic equilibrium of the river system (1).

•   Deforestation for farming purposes created a variety of issues including: less interception; lower consumption of rainfall by tree roots. This all exacerbates the flood risk by increasing water entering the river system. (1+1 for developed point).

**AO1 = 3**

**[Total 3 marks]**

**Q2. 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]**

**Q3.**

**AO1** – Knowledge and understanding of the drainage basin as an open system. Knowledge and understanding of the concept of water balance.

**AO2** – Application of knowledge and understanding to assess nature of the drainage basin water cycle and water balance.

Notes for answers

**AO1**

•   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.

•   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.

•   Case study of a river catchment(s) at a local scale to illustrate and analyse the key themes above, engage with field data and consider the impact of precipitation upon drainage basin stores and transfers and implications for sustainable water supply and/or flooding.

**AO2**

•   It is likely that the direction taken will depend upon a chosen local scale river catchment, however the question does not dictate that the response refers to a case study.

•   Assessment of the scale and nature of natural inputs –precipitation.

•   Assessment of the subsequent scale of the impact of processes and transfers within the drainage basin:

-   Natural - interception, stemflow, infiltration, utilisation by vegetation, overland flow and channel flow. Also the impact of seasonal changes or storm events.

-   Human – farming practices, land use change and water abstraction.

•   Assessment of the subsequent scale and nature of natural outputs – evaporation, transpiration and runoff.

•   To fully address the AO2 element of the question there must be clear assessment of the extent to which there is ever balance between the inputs and outputs of water in a drainage basin. Assessment may focus on a snapshot in time, whilst others may come to the view that the answer depends on a range of factors, including temporal change, which may also be assessed.

Any conclusion is acceptable, though should relate to the preceding content.

**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]**

**Q4.** Point marked

Award 1 mark per valid point with extra mark(s) for developed points (d).

For example:

Notes for answers

**AO1**

•   A graph of discharge of a river over the period of time when the normal flow of the river is affected by a storm event (1).

•   The rising limb illustrates how quickly a river responds to the rainfall event (1).

•   The highest point on the graph indicates the peak discharge following the rainfall event (1).

•   The gap between the peak rainfall and peak discharge is the lag time (1). If the rising limb is very steep and the lag time short, then the rainfall has entered the river very quickly (1d).

•   The receding limb indicates the rate at which the river returns to its normal discharge (1).

•   NB – if a response includes an **accurate** sketch/drawing of a flood hydrograph allow 1 mark for a sketch on its own, however accurate annotations of features identified above can receive (1) per correct feature.

The notes for answers are not exhaustive. Credit any valid points.

**AO1 = 3**

**[Total 3 marks]**

**Q5. D** Increased water vapour in the atmosphere acts as a greenhouse gas → atmosphere warms up → more water is evaporated from the oceans → vapour increases in the atmosphere.

**AO1 = 1**

**[Total 1 mark]**

**Q6. AO1** − Knowledge and understanding of processes in the water cycle and factors driving change in the carbon cycle.

**AO2** − Application of knowledge and understanding to assess the inter-relationships between processes in the water cycle and factors driving change in the carbon cycle. Response should come to a view in relation to extent of inter-relationships.

Notes for answers

**AO1**

•   Processes in the water cycle which directly inter-relate to / with the carbon cycle.

•   Processes in the water cycle which do not relate to the carbon cycle. Evaporation and condensation are processes which are determined by the sun’s energy and the variation in temperature related to this.

•   Factors driving change in the magnitude of stores and transfers in the water cycle. These factors may relate to the sun’s energy as well as vegetation coverage in drainage basins.

•   Global distribution and size of major stores of water − lithosphere, hydrosphere, cryosphere and atmosphere. Some may structure their responses around the four major spheres and the inter-relationships which exist in these distinct zones.

•   The role of transpiration in the carbon cycle may be considered as a specific example where there are clear interactions between the two cycles.

•   Global distribution, and size of major stores of carbon − lithosphere, hydrosphere, cryosphere, biosphere, atmosphere and the interactions with the water cycle which exists in these four major zones.

•   Factors driving change in the magnitude of carbon 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. Knowledge and understanding of the role of the water cycle should be applied here (See AO2).

•   Case study of a tropical rainforest setting to illustrate and analyse key themes in water and carbon cycles and their relationship to environmental change and human activity. This case study may be used to exemplify some of the inter-relationships within the biosphere.

**AO2**

•   Evaluation − Responses may challenge the theme of the question and suggest that the water cycle has many elements which are not inter-related to the carbon cycle. The basic elements of the water cycle involve the transfer of water through the lithosphere, hydrosphere, cryosphere and atmosphere. This is entirely driven by the sun’s energy and gravity and is independent of the carbon cycle.

•   Analysis − Water cycle transfers and stores within drainage basins may also be considered as processes. Infiltration and through flow for example can only occur in the presence of well-formed soils. The formation of soil structures is dependent upon factors driving change in the carbon cycle.

•   Analysis − A number of processes within the carbon cycle directly relate to the water cycle. Photosynthesis for example, converts the sun’s energy into chemical energy. This is completely reliant upon the presence of water for all plant growth. Transpiration may also be considered in this context.

•   Analysis − Decomposition is another important process in the carbon cycle. This activity is undertaken by detritivores which cannot operate without the presence of water in the areas where decomposition occurs. The detritivores themselves respire which is a key carbon process which can only operate in the presence of water, stored in soils and groundwater. It is important to note that some carbon is lost to the system due to detritivore respiration which can only take place in the presence of water, provided via precipitation. Some may use the tropical rainforest case studies to exemplify and support the analysis.

•   Analysis − Some may refer to the fact the carbon can be dissolved directly into large water bodies such as oceans, seas and lakes. Furthermore, carbon can be dissolved in precipitation as rain falls to the earth’s surface. When dissolved in water, carbon dioxide reacts with water molecules and forms carbonic acid, which contributes to ocean acidity.

•   Analysis and evaluation − Responses may also explore the inter-relationships between processes in the water cycle and factors driving change in the carbon cycle in a range of human activities and human life processes. This is a legitimate approach.

•   Analysis − Some may make further links e.g. to decomposition in periglacial areas (cryosphere) which is currently being exacerbated by climate change. The melting ice in the active layer is leading to rapid decomposition and a release of carbon dioxide and methane.

•   Analysis and evaluation − Natural fires may also be considered act as process within the carbon cycle where there are inter-relationships with processes in the water cycle. Pyriscence for example has maturation and release of seeds which is triggered, in whole or in part, by fire or smoke; fire is a critical ingredient in the renewal of some ecosystems (biosphere). This is an example of where a factor driving change in the carbon cycle might impact processes in the water cycle.

•   Analysis and evaluation − Weathering is another process which releases carbon back to the atmosphere (lithosphere and hydrosphere). This requires the presence of water, usually through precipitation or under sea water weathering. This potentially reveals another link between precipitation and the carbon cycle. This potentially reveals another link between processes in the water cycle and the factors driving change in the carbon cycle.

•   Overall evaluation − More sophisticated responses should note that the carbon cycle is entirely dependent upon the water cycle for its existence. Without the cycling of water through the lithosphere, hydrosphere, cryosphere and atmosphere, there could be no carbon cycle.

**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 (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]**

**Q7.**

**D** All water stored in its solid state in glaciers, ice caps and sea ice.

**AO1 = 1**

**[Total 1 mark]**

**Q8.**

**AO1** − Knowledge and understanding of the causes of floods in drainage basins.

**AO2** − Application of knowledge to the conditions in this drainage basin. Suggested causes should show an understanding of the conditions within this location and how these human and physical conditions affect the flooding.

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 analysis and evaluation 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 basic analysis and evaluation drawn from the context provided. Connections and relationships between different aspects of study are basic with limited relevance.

Notes for answers

**AO1**

•   Natural processes operating at hill slope level and in drainage basins.

•   Inputs and outputs, to include precipitation, 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.

•   Human impact upon drainage basins to include farming practices and land use changes.

•   Runoff variation and the flood hydrograph.

**AO2**

•   Responses should note that prolonged periods of heavy rainfall prior to a storm appear to have contributed to the impact of antecedent rainfall. This antecedent rainfall referred to in the resource lead to full storage in groundwater and in the soil. Saturated ground prior to this event has exacerbated the impact of the subsequent storm. This almost certainly sped up overland flow / surface runoff during the storm which contributed to the 2005 Carlisle flood. Some may refer to full storage in groundwater and soil due to the antecedent rainfall.

•   Expect to see connections made between drainage basin characteristics alluded to in the resource and the impact of the flooding − rock type and gradient have clearly contributed to the flashy nature of the storm hydrograph. Significant urbanisation and arable or grazing land may also feature as examples of human activity and land use change. This would suggest that any rain which did fall in the storm, was quickly channelled to the river through the urban drainage systems and through farmland drainage. Limited forestry in this area also suggests that there will be little interception further contributing to the flood.

•   As the storm progressed there was clearly a significant impact upon the river as a result of the conditions outlined above. Lag time to peak discharge was almost certainly very low. Expect to see reference to a ‘flashy’ storm hydrograph. There was likely to be significant flooding as a result of a combination of these factors.

•   There should be some explicit assessment, most likely to attribute the flood to a combination of atmospheric, local geological and human induced causes which led to the floods in 2005.

**AO1 = 2, AO2 = 4**

**[Total 6 marks]**

**Q9.**

Allow 1 mark per valid point with extra mark(s) for developed points (d).

**AO1**

•   Dynamic equilibrium refers to the tendency towards a natural state of balance within the hydrological cycle (1).

•   The cycle is a closed system as no water enters or leaves the system; it is simply recycled around the system (d)(1).

•   The drainage basin element of the hydrological cycle is an open system where the inputs and outputs can change (d)(1).

•   The dynamic equilibrium is easily upset by extreme events such as storms or droughts (1).

•   Human activity can also cause disruption to the dynamic equilibrium, e.g. by modifying the drainage basin (1).

•   This causes disruption or interference to the dynamic equilibrium and is evidenced through flooding for example (1).

•   Such events and processes cause sudden changes in the state of the system and disrupt or interfere with dynamic equilibrium as is the case with flooding (1).

**AO1 = 4**

**[Total 4 marks]**

**Q10.**

**AO1** − Knowledge and understanding of a range of human activities impacting upon the water cycle. Knowledge and understanding of natural factors which affect the dynamic equilibrium.

**AO2** − Application of knowledge and understanding to evaluate the relative impact of both human factors and natural variation, where they inter-relate, and where one influences / exacerbates the other.

Mark scheme

**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. Evaluation 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. Evaluation 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. Evaluation is basic and supported with limited appropriate evidence.

Notes for answers

**AO1**

•   Systems concepts and their application to the water cycle inputs − outputs, energy, stores / components, flows / transfers, positive / negative feedback, dynamic equilibrium. This basic understanding of stores and transfers should underpin the response.

•   Global distribution and size of major stores of water − lithosphere, hydrosphere, cryosphere and atmosphere. These are the four global stores of water. Expect to see reference to human activity and natural processes impacting upon some or all of these stores.

•   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. These are the natural flows and transfers impacting upon the size of the major stores.

•   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. This element provides the basis of the evaluation.

•   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. This element of the specification applies where the students reference global warming as a major impact of human activity impacting upon the water cycle.

**AO2**

•   Evaluation − The water cycle is a natural cycle of water between land, ice, oceans and the atmosphere. The cycle is affected by natural events such as droughts and periods of heavy rainfall leading to floods. It is also affected by human activities. The best responses will note that it is the combination of natural variation and human activity which causes the greatest impacts upon dynamic equilibrium.

•   Evaluation − There are any number of storms events to which students can refer. They may consider diverse and / or connected issues such as el Niño, tropical storms or droughts in the intertropical convergence zone. Whatever the approach it should be acknowledged that it is the natural variation which upsets the dynamic equilibrium. Some may / will go further and consider the impact of the natural variation upon the water cycle, particularly where there is a comparison between human activity and natural variation.

•   Evaluation − Human factors are potentially wide and varied. Consideration of industrial, agricultural, forestry and construction processes are likely to dominate. Some may make the link between human activity, global warming and resultant changes to the water cycle. This is a legitimate connection between human activity and natural variation.

•   Evaluation − The best responses will see the connection between human activity and how this can work in conjunction with natural variation to have exacerbated impacts upon the dynamic equilibrium. For example, a storm in a drainage basin will have much greater impacts where deforestation has occurred, or where substantial development exits. These combine to cause significant flooding in drainage basins.

**AO1 = 4, AO2 = 5**

**[Total 9 marks]**

**Q11.**

**AO3** − There should be detailed analysis of the overarching pattern in the climatic water balance but also the extent to which there is variation over the period involved, using the three years’ data.

**Level 2 (4−6 marks)**

**AO3** − Clear analysis of the quantitative evidence provided, which makes appropriate use of data in support. Clear connection(s) between different aspects of the data and evidence.

**Level 1 (1−3 marks)**

**AO3** − Basic analysis of the quantitative evidence provided, which makes limited use of data and evidence in support. Basic connection(s) between different aspects of the data and evidence.

Notes for answers

**AO3**

•   The typical pattern (using the 1961-1990) average shows that from January to July (approximately), the area has a surplus balance. That maximum surplus is around 80-90 mm in May. In July this falls to 0 mm. The peak deficit is reached mid-October and this is around 90-95 mm before returning to 0 mm late December.

•   Some may suggest that the 30-year average shows an overall annual balance of 0, i.e. despite the seasonal peaks and troughs, there is an overall balance between precipitation and evapotranspiration and the area is becoming neither wetter or drier.

•   When considering annual variation against the 30-year average there is considerable difference between the three years but also variance against the 30-year average.

•   Two of the years are significantly drier than the 30-year average. These are 2003 and 2008. In 2003, the deficit started 2 months earlier in May and the year ended close to 300 mm in deficit. Analysis may suggest that this was either an extremely dry or hot year.

•   In 2008, there was a peak balance of around 130 mm in May. This was well above the mean line of approximately 80 mm. However, the deficit still occurred earlier (mid-June) than the mean line. This year ended with an overall deficit of around 95 mm which would almost certainly have been lower had it not been for the peak in May.

•   The significant anomaly year was 2007. Despite a trough in May, the area experienced a year of surplus climatic water balance with cumulative precipitation exceeding potential evapotranspiration for the entire year. The year ended on a surplus of approximately 140 mm.

•   Some may go a little further and make the point that this balance is a cyclical phenomenon and a new 30-year average might better indicate any localised climate change phenomena.

**AO3 = 6**

**[Total 6 marks]**

**Q12.**

B

**AO1 = 1**

**[Total 1 mark]**

**Q13.**

**AO1** − Knowledge and understanding of the inter-relationships which exist between the water cycle and the carbon cycle.

**AO2** − Application of knowledge and understanding to assess the extent to which there is a fragile relationship between the two cycles and whether human activity has caused irreversible damage to this relationship.

Notes for answers

**AO1**

•   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.

•   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.

•   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).

•   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.

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

**AO2**

•   Expect to see a variety of scales in response to this question.

•   Some will consider inter-relationships at the level of the small-scale ecosystem whilst others will consider regional scale inter-relationships in biomes. Another alternative relates to the global inter-relationships including atmospheric CO2 and precipitation.

•   At the scale of a local ecosystem, expect to see concepts of fragility explored in relation to the impact of human activity upon inter-relationships within the ecosystem. For example, both the carbon cycle and water cycle can be disrupted by a range of human activity including farming, vegetation clearing, establishment of plagio-climax vegetation communities and work on local rivers and the associated catchments.

•   At the local scale, some may consider positive actions to support the balance between the two cycles. Afforestation and peat bog development could be referenced as long as it is clear how these activities impact upon the inter-relationships between the cycles.

•   At the regional scale, some may consider the impact of atmospheric changes at the regional scale. For instance, in tropical forests, wide scale removal of vegetation is known to disrupt the cycling of water through convection rainfall. The lack of transpiration causes a reduction in precipitation rates. This in turn can cause a devastating impact upon rainforest vegetation, especially tree growth. Where this occurs, the carbon cycle is effectively broken.

•   Wide scale removal of vegetation can also impact upon the soil carbon stores. The carbon stores are removed through rain splash impact and surface runoff. Rivers carry away soil which contained an important store of carbon.

•   Some may consider drylands as another place where there is a potentially damaging impact of human activity upon the carbon and water cycles. This is particularly the case where precipitation is reduced or where irrigation channels water away from certain locations.

•   Some may make the link between large scale vegetation removal and an increase in weathering. This can trigger slow carbon release through the weathering processes of rocks containing carbon.

•   At the global scale, increased carbon emissions are likely to feature. These must clearly be linked to the inter-relationship between water and carbon in order to access credit for AO2.

•   Mitigation strategies to reduce CO2 may feature but these must be clearly linked to the inter-relationships between water and carbon for AO2 credit.

•   Expect to see some overarching evaluation as to the extent to which the inter-relationships are fragile but also how the extent to which any damage is irreversible.

**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]**

**Q14.**

D

**AO1 = 1**

**[Total 1 mark]**

**Q15 -17 SECURE MATERIAL**

years old compared to other stores. With over 60 times older groundwater than modern groundwater.

Responses will note the significance of the surface water store compared to the other smaller non-groundwater stores, with over 6 times the next biggest store, soil water.

Responses will note that, as groundwater stores below 100 years old become younger, the size of the store increases slightly.

**[Total 6 marks]**

**Q18.**

**AO1** − Knowledge and understanding of the impact of human activity in drainage basins.

**AO2** − Application of knowledge and understanding to analyse and evaluate the impact of this human activity.

Notes for answers

**AO1**

•   Case study of a river catchment at a local scale to illustrate and analyse key themes, engage with field data and consider the impact of precipitation upon drainage basin stores and transfers and implications for sustainable water supply and / or flooding.

•   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 which are reasonably derived from the chosen human activities within a drainage basin.

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

•   Farming is likely to feature strongly in many responses. Forest clearance for arable and pastoral farming reduces interception. There is likely to be more water in the drainage basin as a result of a lack of vegetation coverage. This may increase surface run off and heighten the ‘flashiness’ of the storm hydrograph. Infiltration may be lower where soil compaction has occurred which will again increase the amount of surface run-off. Named locations within drainage basin should be a feature of stronger responses.

•   Land use changes may also be considered as valid human activities − building of settlements in particular will have an adverse impact upon the drainage basin hydrology, decreasing lag time to peak discharge as a result of urban drainage and a lack of infiltration. Expect similar references to flooding risk increasing. There should be some direct reference to the candidate's own case study in this regard.

•   Some may consider water abstraction as a valid human activity. This lowers the water table and reduces the discharge in rivers. Responses may consider some negative impacts of this.

•   Responses may include the use of field data in support.

**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).

**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 he 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).

**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).

**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). Interpretation is basic.

•   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).

**Level 0 (0 marks)**

•   Nothing worthy of credit.

**AO1 = 10, AO2 = 10**

**[Total 20 marks]**

**Q19.**

D

**AO1 = 1**

**[Total 1 mark]**

**Q20.**

A

**AO1 = 1**

**[Total 1 mark]**

**Q21.**

**AO1** − An awareness of factors leading to change in the water cycle over time. Knowledge and understanding of the chosen tropical rainforest case study.

**AO2** − Application of knowledge and understanding to assess the human and physical causes and impacts of changes to the water cycle in tropical rainforests.

Notes for answers.

**AO1**

•   Processes driving change in the magnitude of water storage over time and space, including flows and transfers: evaporation, condensation, cloud formation, causes of precipitation, 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.

•   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.

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

**AO2**

•   In terms of causes, most are likely to refer to changes in the water cycle as an indirect consequence of human activity. Expect to see reference to a range of human activities such as:

-   Agricultural practices which lead to soil compaction increasing surface runoff.

-   Deforestation which reduces evapotranspiration, removes top soil thus infiltration and throughflow.

-   Mining which leads to large scale vegetation clearance which again reduces evapotranspiration and convection rainfall.

•   Some may consider the potential role of climate change and its impact upon the water balance in tropical rainforests.

•   Impacts may be considered in the local and regional contexts:

•   Locally the removal of vegetation and soil compaction combine to lead to increased likelihood of flood. Rivers have reduced capacity due to the effect of sediment transfer to the river bed. There is also increased runoff and a lack of uptake of water through vegetation.

•   Regionally some may refer to the risk of reduced convectional rainfall as a result of the loss of water in the system and the breakdown of the convection cycle. Some may refer to a reduction in the regional precipitation rates causing increased temperatures, rates of evaporation and a disruption to the regional weather systems in the affected area. There may be a link to changes in the carbon cycle at this point. This is acceptable as long as it does not lead to drift away from the theme of the question.

•   Regionally some may argue that there is expected to be an overall decrease in the discharge of rivers in tropical rainforests as a result of the fall in overall precipitation levels.

•   Support should be offered through a named tropical rainforest. Expect Amazonia, central Africa and south-east Asia to feature.

•   Some sense of the nature / character of the place concerned may be conveyed.

There should be some explicit overarching assessment based upon preceding content.

**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).

**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).

**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).

**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).

**Level 0 (0 marks)**

•   Nothing worthy of credit.

**AO1 = 10, AO2 = 10**

**[Total 20 marks]**

**Q22.**

Point marked

Allow 1 mark for each valid point with additional marks for developed points.

Notes for answers

•   Higher temperatures increase the melting of snow and ice (1) leading to a reduction of surface albedo (1) so more sunlight absorbed by land and sea (d). Temperatures increase further, which leads to further melting (d).

•   A response that outlines one example of positive feedback can achieve full marks.

•   Allow max (1)(d) for support with data regarding positive ice albedo effect.

•   Makes clear the nature of positive feedback, for example, a system where the effects of an action are increased or amplified by its subsequent knock-on effects (1) - accept any valid definition.

Allow any valid example of positive feedback in the water cycle. Others may outline the feedback of warming, leading to evaporation, leading to enhanced warming due to water vapour as a greenhouse gas. For full marks response must show understanding of positive feedback, then have a sequence clearly showing how one action leads to a further action that increases / amplifies the initial action.

**AO1 = 3**

**[Total 3 marks]**

**Q23.**

Allow 1 mark per valid point with extra mark(s) for developed points (d).

**AO1**

•   Cryospheric change has a regulatory role in sea levels (1).

•   The cryosphere is a major store of water (1).

•   In a period of cooling (glacial period) the cryosphere will grow in size (1). This is because the water cycle is slowed considerably as the ice restricts the return of the water to the sea and ocean (d).

•   In a period of warming the cryosphere will add water to the cycle (1). As the water cycle restarts more of the ice melts and returns water to the sea (d).

•   This increased the size of ocean store causing sea levels to rise through increased volumes of water (1) and thermal expansion (d).

•   Consideration of changes in permafrost is also valid (1).

No additional credit for straight reversals.

**AO1 = 4**

**[Total 4 marks]**

**Q24.**

**AO1** − Knowledge and understanding of the global distribution and size of major stores of water. Knowledge and understanding of the human and natural factors controlling the size of major stores of water.

**AO2** − Application of knowledge and understanding to analyse and evaluate the role of human activity and natural variation on the size of major stores of water and that human activity is the more important factor. Should come to a view on ‘extent’.

Notes for answers

**AO1**

•   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 major stores of water over time and space, including flows and transfers: evaporation, condensation, cloud formation, causes of precipitation and cryospheric processes, at global scales with reference to varying timescales involved.

•   Human activities are likely to include farming practices, land use change and water abstraction.

•   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**

•   Evaluation − The human activity and natural variation is not the focus of the question. It is the impact each set of factors has on major stores of water and the extent to which human activity is more important.

•   Evaluation of the impact of human activities on major stores may address different temporal scales, from short term and temporary to longer term and permanent. Some will also assess the impact of human activities contributing to the enhanced greenhouse effect and climate change and global warming and its impact on stores of water − at present and in the future.

•   Evaluation of impacts of natural variation operating at different temporal scales, including evaporation, condensation, cloud formation, causes of precipitation and cryospheric processes.

•   Evaluation − The importance of different impacts may address different stores over a range of time scales. For example, over geological time scales natural factors controlling cycles of glacials and interglacials during the Pleistocene were the main factor in controlling the size of global stores of water. i.e. at the most simple level during glacials the cryospheric store increased at the expense of the ocean store. More sophisticated responses may elaborate on how other stores such as soil and atmospheric stores also change during these cycles.

•   Evaluation − Assessment may conclude that natural variation has been the main driver of change in major stores of water over past geological time scales, but that impacts associated with human activity have gained in importance over recent decades and may dominate in the future. Responses may give the view that in future human timescales, human activity may be the most important as it not only directly impacts the size of stores, but creates, possibly permanent, changes to processes of natural variation.

•   Evaluation − Responses must make a judgement on which factors are more important. Either view is valid as long as the response assesses the relative importance of the different factors and there is clear rationale based upon preceding content.

**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]**

**Q25.**

Point marked

Allow 1 mark per valid point with extra mark(s) for developed points (d). For example:

Notes for answers

•   Increasing concentrations of carbon (and Methane) in the atmosphere has a warming effect on the planet and leads to increased evaporation (1). This can increase rates of precipitation or equally higher rates of evaporation can further exacerbate aridity (1) (d).

•   Volcanic eruptions release both carbon dioxide and water vapour into the atmosphere (1).

•   Photosynthesis requires both precipitation and carbon dioxide (1).

•   Decomposition releases carbon dioxide and requires the presence of water (1). Some may link this to the melting of permafrost, which is a significant contributor to CO2 release (1) (d).

•   Some may consider the acid rain as an outcome of the relationship between water and carbon on the atmosphere (1). This may be further linked to ocean acidification (1) (d).

The notes for answers are not exhaustive. Credit any valid points.

**AO1 = 4**

**[Total 4 marks]**

**Q26.**

C

**AO1 = 1**

**[Total 1 mark]**

**Q27.**

**AO1** – Knowledge and understanding of 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** – Application of knowledge to show an understanding of impact of changing the natural vegetation in an area and the impact that this might have upon the novel situation.

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**

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

**AO2**

•   Variation in runoff volume is a product of a number of factors. These include antecedent rainfall, vegetation cover, underlying bedrock and relief. Human activity is also a significant factor.

•   The resource provides only limited information about the area. It is clear that where forest is replaced by mixed vegetation, grassland, built up areas or bare soil, runoff is likely to increase. In 2001, for most areas within the watershed, the run off has increased compared to 1976. This is best exemplified with areas 5, 6 and 11.

•   The removal of forest is likely to lead to decreased canopy, less interception, reduced transpiration and possibly soil compaction depending upon how the land is subsequently used. Area 6 is a good example of this.

•   However, there is no information provided about precipitation levels or relief. For example, in areas 1 and 2 there is little variation between the periods or the rehabilitated condition.

•   There are only two or three areas where the removal of vegetation appears to have had a significantly detrimental impact upon runoff.

•   In the rehabilitated area, runoff is lower suggesting increased interception and evapotranspiration. In area 10, the mixed vegetation appears to have reduced the runoff substantially. Similarly area 6 has appeared to have undergone significant rehabilitation and this has reduced runoff to below the rates seen in 2007.

**Credit any other valid assessment.**

**AO1 = 2**

**AO2 = 4**

**[Total 6 marks]**

**Q28.**

**AO3** – There should be clear analysis of the relationships between rainfall in the drainage basin and its impact upon the simulated hydrograph. There should also be data manipulation to support the analysis. The relationship between the simulation and actual hydrograph should also be analysed.

Mark scheme

**Level 2 (4–6 marks)**

**AO3** – Clear analysis of the quantitative evidence provided, which makes appropriate use of data in support. Clear connection(s) between different aspects of the data and evidence.

**Level 1 (1–3 marks)**

**AO3** – Basic analysis of the quantitative evidence provided, which makes limited use of data and evidence in support. Basic connection(s) between different aspects of the data and evidence.

Notes for answers

**AO3**

Level 1 responses are likely to simply describe the data without clear attempt to analyse, for instance by manipulating data, identifying relationships and / or spotting trends.

•   The first round of rainfall appears to make little impact on either the measured or simulated discharge. Rainfall peaks at 2mm and the event appears to last around 4–5 hours. Discharge remains at between 1–2 m3 / sec. The simulated discharge appears to show some response to the event with a sharp rise and quick return to below normal baseflow within 4–5 hours. It is the measured flow which shows very little response to the event.

•   However, by around 6pm on 14.04.07 there is a very strong and almost immediate increase in discharge. Discharge increases by almost 7m3 / sec with virtually no build up prior to this. The simulated data shows more of a lag – around 3–4 hours, a sharp increase but a lower peak perhaps up to 1m3 / sec less. Some may question the reliability of the simulation in predicting the impact of the first event.

•   The second event appears to start around 6pm on 14.04.07 and last around 10 hours. The lag time is longer for both the measured and simulated discharge. The peak is also lower at around 6.6 m3 / sec. The simulation is even less accurate following the second event. The peak is lower than the measured flow by over 2m3 / sec and the return to base flow is less pronounced.

**Credit any other valid analysis.**

**AO3 = 6**

**[Total 6 marks]**

**Q29.**

Point marked

Allow 1 mark per valid point with extra mark(s) for developed points (d). For example:

Notes for answers

•   Surface runoff occurs when water runs directly over the ground (1) This may occur if the soil is saturated (or flow over impermeable surfaces). (1)(d).

•   Infiltration occurs when the water moves from the surface and then down through the soil horizons (1) until it reaches the groundwater or an impermeable layer in the soil (1)(d).

•   Throughflow occurs when, under the force of gravity, water moves downslope through the soil until it reaches a water body (1). This movement is usually very slow due to the frictional effect of the soil particles (1)(d).

•   Groundwater flow is the movement of water through permeable rock under the force of gravity (1). This is the slowest flow of water on a hillslope (1)(d).

Other types of flow may also be considered e.g. percolation, stemflow Allow 1+1 if appropriately defined and elaborated.

Must offer more than one flow for full marks.

Allow 1 mark for a list of two or more processes.

**The Notes for answers are not exhaustive. Credit any valid points.**

**AO1 = 4**

**[Total 4 marks]**

**Q30.**

**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)**

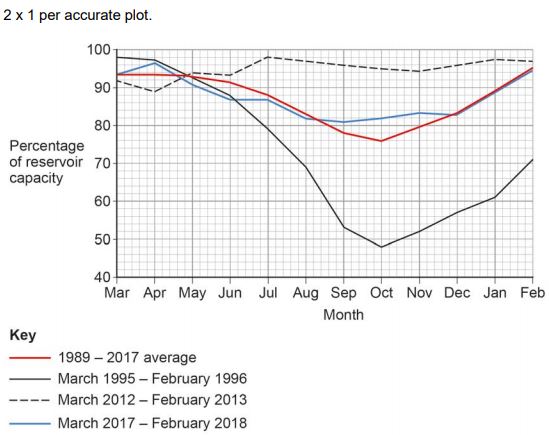
Nothing worthy of credit.

**AO1 = 10**

**AO2 = 10**

**[Total 20 marks]**

**Q31.**

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Notes for answers

Allow 1 mark for each valid point with additional marks for developed points.

•   Across all time periods the amount of water stored in England and Wales’ reservoirs has fluctuated (1).

•   In all but the 2012 to 2013 time period, reservoirs begin the period above 90% full in March, April and May then drop to their lowest levels in September or October, with water levels rising again to February the following year (1).

•   The level of water stored in reservoirs in 2017 to 2018 most closely follows the average levels for the whole period (1989–2017) (1). Both periods begin 94% full only dropping between 13 and 18 percentage points, before both returning to 94% full (1d).

•   In 2012 to 2013 the amount of water stored in reservoirs is generally the highest and most stable, remaining above the other values for all but March and April (1).

•   During 2012 to 2013 the level of water only varies by about 9 percentage points (1), whilst 1995 to 1996 has the greatest range in water levels of 50 percentage points (1).

•   1995 to 1996 is also the year where water levels differ most to the average (1). The range in the 1989 to 2017 period is 3 times smaller than the range in water levels for 1995 to 1996 (1d).

•   In February 1996 reservoirs are almost a quarter less full than in all the other time periods (1).

**The Notes for answers are not exhaustive. Credit any valid points**.

**AO3 = 6**

**[Total 6 marks]**

**Q32.**

Point marked

Award one mark for each relevant point with extra mark(s) for developed points (d). For example:

Notes for answers

•   This is a downwards movement of water from the ground surface into the soil (1).

•   The rate of this flow is affected by soil characteristics and level of soil saturation (1).

•   Soil porosity is a main factor controlling this flow (1). Coarse grained, sandy soils have greater porosity and allow greater flows of water (1d), flows of water (1d).

•   Saturated soils will limit the flow of water (1d).

•   Burrowing animals and plant roots create macro- and micro-channels in the soil increasing rates of this flow (1).

**The Notes for answers are not exhaustive. Credit any valid points**.

**AO1 = 3**

**[Total 3 marks]**

**Q33.**

C

**AO1 = 1**

**[Total 1 mark]**

**Q34.**

**AO1** – Knowledge and understanding of the flood hydrograph and factors affecting the shape of it. K/U of a chosen case study of a river catchment.

**AO2** – Application of knowledge and understanding assess the impact of environmental factors, development and / or conservation on the hydrograph.

Notes for answers

**AO1**

•   Drainage basins as open systems – inputs and outputs, to include precipitation, evapo-transpiration 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, seasonal changes and human impact including farming practices, land use change and water abstraction.

•   Case study of a river catchment(s) at a local scale to illustrate and analyse the key themes above, engage with field data and consider the impact of precipitation upon drainage basin stores and transfers and implications for flooding.

**AO2**

•   Responses are expected to apply their knowledge of factors affecting the flood hydrograph to their chosen case study of a river catchment.

•   Land use and other human activities influence the peak discharge of floods by modifying how rainfall is stored on and run off the land surface into streams. In undeveloped areas such as forests and grasslands, rainfall and snowmelt collect and are stored on vegetation, in the soil, or in surface depressions. When this storage capacity is filled, runoff flows slowly through soil, this reducing the flashiness of the hydrograph.

•   In contrast, urban areas, where much of the land surface is covered by roads and buildings, have less capacity to store rainfall and snowmelt. Construction of roads and buildings often involves removing vegetation, soil, and depressions from the land surface. The permeable soil is replaced by impermeable surfaces such as roads, roofs, concrete and tarmac surfaces, store little water, reduce infiltration of water into the ground, and accelerate runoff to ditches and streams. Even in suburban areas, where lawns and other permeable landscaping may be common, rainfall and snowmelt can saturate thin soils and produce overland flow, which runs off quickly. Once water enters a drainage network, it flows faster than either overland or subsurface flow.

•   Expect to see reference to specific case study detail eg Streamflow in Mercer Creek, an urban stream in western Washington, increases more quickly, reaches a higher peak discharge, and has a larger volume during a one-day storm on 1 February 2000, than streamflow in Newaukum Creek, a nearby rural stream. Streamflow during the following week, however, was greater in Newaukum Creek. Lag time was shorter and the peak was significantly higher Mercer Creak. The return to normal base flow was longer on Newaukum Creek. With less storage capacity for water in urban basins and more rapid runoff, urban streams rise more quickly during storms and have higher peak discharge rates than do rural streams. In addition, the total volume of water discharged during a flood tends to be larger for urban streams than for rural streams. For example, streamflow in Mercer Creek, an urban stream in western Washington, increases earlier and more rapidly, has a higher peak discharge and volume during the storm on 1 February 2000, and decreases more rapidly than in Newaukum Creek, a nearby rural stream.

•   As with any comparison between streams, the differences in streamflow cannot be attributed solely to land use, but may also reflect differences in geology, topography, basin size and shape, and storm patterns. Expect to see responses that consider natural factors such as these when considering impacts on the storm hydrograph.

•   Other responses may consider the impact of conservation on the storm hydrograph. In simple terms, expect to see the opposite impact ie that conservation flattens the peak and lengthens the lag to peak discharge. In other words, one of the key benefits of afforestation on the drainage basin is that it can dramatically reduce the likelihood of flooding downstream.

•   For example, the Pickering Project in North Yorkshire was one of three natural flood management trials set up after the severe floods of 2007. Another was at Holnicote in Somerset and a report by the Moors for the Future Partnership for the Environment Agency in February estimated this could reduce peak river flow by 25%. The third project, in Derbyshire, was estimated to be able to reduce peak flows by 4%.

•   Tree planting can make a big contribution to reducing flood risk and should be part of a wider flood risk management approach, including conventional flood defences.

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).

•   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).

**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]**

**Q35.**

**AO1** – Knowledge and understanding of a flood hydrograph. Knowledge and understanding of land use change in a drainage basin.

**AO2** – Application of knowledge and understanding to assess the impact of land use change in a drainage basin on the shape of a flood hydrograph.

**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**

•   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, seasonal changes and human impact including farming practices, land use change and water abstraction.

•   Case study of a river catchment(s) at a local scale to illustrate and analyse the key themes above, engage with field data and consider the impact of precipitation upon drainage basin stores and transfers and implications for sustainable water supply and/or flooding.

**AO2** (assessment)

•   Responses are likely to conclude that changes in land use in a drainage basin could have a significant impact on the shape of a flood hydrograph.

•   Although the question does not require reference to a specific example drainage basin, it is likely that many responses will refer to the local scale river catchment prescribed in the specification, assessment of the impact of land use change upon a flood hydrograph in this context is valid.

•   Candidates are directed to make reference to changes in the shape of a flood hydrograph, therefore responses should include reference to different elements of the hydrograph, including: base flow, rising limb, falling/recession limb, peak discharge, lag time. Evaluation should relate to impacts on the steepness, height, duration etc. of the elements of the hydrograph.

•   Although the expectation is that answers are written in extended prose, some candidates may choose to illustrate their response with diagrams to exemplify the shape of the hydrograph. This is acceptable, but the accompanying text will need to assess the impact of the change in land use on the illustrated changing shape of the hydrograph shown in the diagram/s.

•   Responses are likely to refer to land use changes such as deforestation, urbanisation or agricultural change. To address the AO2 element of the question there should be clear assessment of the impact of a change in land use, not just a description of the impact of current land use on the shape of the hydrograph.

•   Responses may come to the view that a change in land use such as deforestation may lead to a steeper rising limb, shorter lag time, higher peak discharge and steeper recession limb than would have been created following a similar precipitation event previously. Assessment would then conclude that this change in land use has had a significant level of impact on the shape of the hydrograph.

•   As the question requires an assessment of the impact of land use change then some responses may seek to quantify that impact and may support this with case study detail. This approach is valid and creditworthy.

Overall assessment should focus on the impacts of any land use change on the shape of a flood hydrograph. Assessment of the impact of these changes could be addressed in a number of ways – for example, the speed of change in shape, length of impact on shape, scale of impact, level of change in shape from one change in land use compared to another.

Credit any other valid assessment.

**AO1 = 4, AO2 = 5**

**[Total 9 marks]**

**Q36.**

**AO3** – Clear use of the diagram in analysing the predicted changes in the annual rate of evaporation.

**Level 2 (4–6 marks)**

Clear analysis of the quantitative evidence provided, which makes appropriate use of data in support. Clear connection(s) between different aspects of the data and evidence.

**Level 1 (1–3 marks)**

Basic analysis of the quantitative evidence provided, which makes limited use of data and evidence in support. Basic connection(s) between different aspects of the data and evidence.

Notes for answers

•   The map evidence suggests that the majority of the Earth’s land surface is predicted to experience an increase in evaporation rates.

•   The map evidence suggests that exceptions to the above include a limited number of areas with a small predicted decrease of between 0 to 5%, eg most of Mexico and parts of Central America, a strip running from Venezuela southeast through Brazil, Spain and Portugal, a strip running around the west and north coast of Africa into the Middle East, much of southern Africa and small areas of Bangladesh, India and Pakistan, and Southern China.

•   Australia is a significant anomaly as almost the whole country is predicted to see a decrease in evaporation rates and with the largest terrestrial area of predicted rates of decrease of between 5 and 10%.

•   The map evidence suggests that the rates of increase of evaporation are expected to be greatest towards the poles. Almost all of the continent of Antarctica is predicted to have an increase in evaporation.

•   Very significant areas of the Arctic Ocean are predicted to experience the greatest increase in rates of evaporation. Some areas to the north of Russia and Alaska are predicted to have an increase more than 4 times that of much of Antarctica.

•   A very extensive area of northern and central Russia and Central Asia is predicted to experience at least a 5% increase in evaporation. Similar rates of predicted increase do not reach as far south in North America, remaining confined to more northern latitudes.

•   A significant proportion of the North Atlantic Ocean is expected to experience a decrease in rates of evaporation, with the largest area of increased evaporation rates, of greater than –10% being found in the northwest of the ocean.

The notes for answers are not exhaustive. Credit any valid points.

**AO3 = 6**

**[Total 6 marks]**

Examiner reports

**Q2.**

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.

**Q3.**

Over half 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 the water balance and processes within a drainage basin. The key to scoring well with respect to AO2 was the quality and clarity of the judgements made about the extent to which there is a balance between inputs and outputs of water in a drainage basin. Some responses supported their points with reference to their case study river catchment, although this was not a prescribed requirement of the question, it was credit worthy.

Weaker responses tended to either show little understanding of the concepts of the water balance or dynamic equilibrium in natural systems. Many also made flooding the focus of their response which often limited the level of credit awarded. Some of the weakest responses showed very little understanding of drainage basins as open systems.

**Q4.**

Many students performed well on this question. Just over half of responses gained 2 or more marks, but just over 10% scored no marks. The key to achieving full marks was to go beyond just listing features of a flood hydrograph and to give some elaboration of each named feature. Some students appeared to confuse a storm hydrograph with the concept of soil moisture budget.

**Q5.**

This question differentiated well, around half of students identified D as the correct option.

**Q7.**

This proved straightforward with well over 90% of students correctly identifying Option D as the correct answer.

**Q14.**

93% of students identified D as the correct option.

**Q18.**

This question was reasonably well engaged with. Almost 50% of the candidature accessed Level 3, producing clear responses to the question set. The key to a successful answer was in producing a response which was clearly rooted in a chosen place with logical potential human impacts. There is no specification requirement to study human impacts in the chosen catchment and so this constituted the AO2 element. If the impacts were geographically sound and logical, credit was available. Many students referred to dam building, deforestation, the impact of farming practices and urban development. This was all creditworthy and gained more credit if it was rooted in place.

Weaker responses were vague and generalised. Many could only cite basic impacts of human activity in drainage basins e.g. rivers are more likely to flood following storms in urban areas due to increased surface run off compared to rural areas. Whilst creditworthy this was considered as only a partial response.

**Q19.**

84% of students correctly identified option D as the correct answer.

**Q20.**

68% of students scored this mark by shading lozenge A.

**Q21.**

Most students did show understanding that human activity and natural variation can affect the water cycle in tropical rainforests. Many considered Amazonia and the major issues of deforestation and global warming. Links were often strong and processes considered in good detail. As long as the response clearly related back to the water cycle, credit was available. Some drifted into the carbon cycle with limited relevance. Also, whilst many referenced Amazonia, there was often very limited place support. Reference to the damaging impact of dam building or the positive impact of afforestation schemes (designed to restore the water balance) were specific ways that students could have been more place specific.

**Q22.**

Students found this question quite challenging, with 33% scoring no marks, and only 27% achieving full marks. The key to achieving maximum marks was to show clear understanding of the concept of positive feedback. Most achieved credit by making links between elements of the water cycle. For example, many linked higher atmospheric temperatures to melting ice, but failed to ‘close the circle’ of positive feedback and show how this could lead to further warming and then more melting.

**Q23.**

Those who failed to understand the concept of the cryosphere really struggled to get going on this question. Many accessed two marks for defining the concept and showing an understanding that warming will return more water to seas and oceans from stored water in the form of ice. Some went further and considered the role of permafrost in this regard. Others considered the concept of glacial advance and its role in lowering sea levels.

**Q24.**

Students generally engaged with this question well. Over 50% of responses gave clear answers to the question set and accessed Level 3. Many candidates scored well with respect to AO1 with clear and detailed knowledge of both human and natural factors that affect stores of water over a range of time scales. The key to scoring well with respect to AO2 was the quality of the judgements made about the nature of the impacts on the stores of water, and most importantly the extent to which human activities are more important. Many made the enhanced greenhouse effect resulting from the emissions of carbon dioxide from various human activities the focus of their response. This was creditworthy and gained more credit for the level of detail given regarding impacts on specific stores and the sophistication of the assessment.

The weaker responses tended to be quite vague. Many lacked technical terminology relating to processes affecting changes in stores of water e.g. evaporation, condensation, cloud formation, precipitation and cryospheric processes. Others showed little awareness of impacts over different time scales e.g. how natural processes may have more significance over longer time periods, while human activity may cause quicker changes and may be more important in the future.

**Q26.**

Students found this straight forward with 92% correctly identifying option C as the correct answer.

**Q27.**

This question appeared to offer good opportunities for students to apply their knowledge concerning factors affecting runoff. The data itself was inconclusive; there was some evidence that removing trees increased run-off (e.g. in Zone 6), but equally there was plenty of evidence that run-off did not dramatically increase by reducing tree coverage. This brought in further opportunities to apply knowledge with other factors which might be affecting run-off such as rock type or relief. Those who spent too long trying to analyse the data missed the thrust of the question and accordingly scored less credit.

**Q28.**

This question differentiated between the rather too many responses which drifted into AO2, failing to analyse patterns, and those who analysed pattern and used the three pieces of data to readily access higher marks. Some looked at the peaks and noticed the difference between the measured discharge and the simulated discharge compared to the rainfall event. There was opportunity to manipulate data which many responses took. Those who tried to account for the lag time or the variation between the two discharges scored no credit as this constituted AO2.

**Q29.**

Too many students missed relatively straightforward opportunities for credit here. Those who produced simple definitions of flows (such as groundwater flow, through flow, infiltration, percolation etc) readily accessed credit. Some missed the thrust of the question and failed to notice ‘hillslope’, writing instead about flows within the wider water cycle. There was no credit for this approach.

**Q30.**

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.

**Q31.**

Most students were able to complete the line graphs, although many were inaccurately plotted. There was very little evidence of students using a ruler to connect the points with a straight line, so markers were instructed to award the marks for a ‘clear attempt to connect points with a straight line’. Few responses obtained 4 marks or above, reflecting a strong tendency to describe rather than analyse data and / or manipulate it in a more sophisticated manner. Other responses did not score well as they drifted into explanation such as possible reasons for the changes in water levels which relates to AO2 and therefore is not valid in this AO3 question.

**Q32.**

This proved a challenging question for students. The key to achieving maximum marks was to only focus on infiltration itself and not digress onto what precedes it or what it leads to, which many students did. Many limited their response to outlining surface runoff, through flow or ground water flow. Many confused infiltration with percolation. Many responses were unable to identify infiltration as a flow from the surface into the soil / ground. The most effective responses gave succinct clear responses outlining features of infiltration.

**Q33.**

Almost all of the students identified C as the correct option.