

ENVIRONMENTAL MANAGEMENT

Paper 8291/11 Principles of Environmental Management

Key messages

In **Section A**, candidates should note the number of marks available for each part question and write answers accordingly. This will give them an indication of the amount of content and detail expected.

In **Section B**, candidates should indicate clearly which question they are answering, i.e. **Question 5** or **Question 6**.

It is important that instructions are followed carefully. Candidates should make sure that they understand the difference in meaning of the command words such as state, suggest, predict, justify, describe, explain, compare and evaluate.

Candidates should avoid repeating the question in their answers to make best use of examination time.

General comments

There was generally a good response to all questions across the paper. Most candidates found **Question 2** (geospatial maps, big data, and comparison of the effect of photosynthesis and respiration in trees on the carbon cycle) and **Question 3** (wetlands ecosystem) more demanding than the other questions in **Section A**.

Topics which proved more challenging were understanding the difference between renewability and sustainability of energy resources, geospatial maps and big data, sampling methods to estimate number of trees in a forest, photosynthesis and respiration in trees and the effect on the carbon cycle, the role of atmospheric methane in climate change, calculation of percentage increase, and benefits and limitations of dams for managing water security.

Many answers showed a good understanding of terms and attention to detail with effective use of exemplar material.

The most successful answers included effective use of appropriate examples to illustrate key points, along with supporting details using appropriate terminology.

Comments on specific questions

Section A

Question 1

- (a) (i) Many candidates found this question challenging and were not able to access the credit available. A common misconception was that natural gas is a renewable energy resource and that geothermal is a non-renewable energy resource.
- (ii) This question was more challenging and generally less well answered. Few candidates fully understood the difference between the definition of a renewable energy resource and a sustainable energy resource and were therefore unable to explain how an energy resource can be renewable but not sustainable. The most common correct response referred to renewable energy 'not being used up'. Very few candidates were able to explain how a renewable energy source may not be sustainable and did not show understanding that sustainability is about the energy resource not being available for future needs or generations.

- (b) (i) Most candidates were able to compare the percentage of electricity generated from different energy resources in China and the USA for full credit.
- (ii) Most candidates identified at least two reasons why South Africa is likely to face energy insecurity in the future. The most common correct responses included the country's reliance on coal, which is a non-renewable resource that will eventually be depleted.
- (iii) This question was generally answered well with most candidates able to state one or two impacts of energy insecurity. The most common correct responses included loss of jobs, disrupted electricity supply to homes, poverty and conflict.

Question 2

- (a) (i) Candidates generally found this question challenging and many simply repeated information in the stem of the question. Those who were able to demonstrate some understanding of the term geospatial explained that a geospatial map referred to a geographical location. Very few candidates were able to develop their response to include reference to data collection using technology for full credit.
 - (ii) This question proved more challenging and was generally less well answered. Candidates with some understanding of big data were often able to earn credit by identifying a benefit, with the most common response being "large amounts of data." However, very few candidates correctly identified a limitation of big data. Responses typically included vague references to inaccuracy. Stronger answers highlighted concerns about the trustworthiness of data or potential biases in its use.
 - (iii) Most candidates were able to correctly draw an **X** on the map to show a region of high surface run-off, and correctly explain their choice of region, e.g. no trees.
 - (iv) Very few candidates were able to demonstrate knowledge and understanding of sampling methods to estimate the number of trees in a forest. A successful response should describe a map with grid of known area, a random method (randomly choose coordinates) and/or systematic method (transect line with regular intervals) described, trees counted, and a mean number calculated, and the idea of scaling up.
- (b) This question proved challenging as it was clear that the processes of photosynthesis and respiration in trees, in the context of the carbon cycle, was poorly understood. Of the two processes, photosynthesis was better understood and successful responses correctly included explanations that photosynthesis converts carbon dioxide into glucose using light energy, and trees act as carbon sinks. With regard to respiration, many candidates did not show understanding that trees also respire and were unable to make the link between respiration and the carbon cycle, i.e. that respiration converts glucose to carbon dioxide, using oxygen, and adds carbon dioxide to the atmosphere.

Question 3

- (a) (i) Few candidates were able to successfully define the term ecosystem to access full credit. Successful responses included reference to living organisms or biotic factors interacting with their environment. Weaker responses were often vague or incorrectly included other key terms such as habitat, biome and food chains.
 - (ii) Candidates found this question challenging, with most providing only superficial descriptions of competition between aquatic plants. For example, they tended to list factors such as light, carbon dioxide, space, nutrients, and oxygen without further elaboration, which limited the credit they could access. Stronger responses, however, described both interspecific and intraspecific competition, in addition to discussing the factors mentioned above in greater detail.
- (b) (i) Many candidates misread the question, focusing their response on impacts of climate change rather than explaining the role of atmospheric methane on climate change. A common misconception was that atmospheric methane causes depletion of the ozone layer and these answers then included the effects of UV radiation on human health. Successful responses recognised that methane is a greenhouse gas which contributes to the enhanced greenhouse effect through absorption of infrared radiation and results in increased global temperatures.

- (ii) Candidates also found this question challenging. The most common correct sources of atmospheric methane other than wetlands stated were landfills and livestock. Common incorrect responses included naming other types of biome such as tundra, rainforest and deserts, and sources such as vehicle emissions and aerosols.
- (c) (i) Very few candidates were able to calculate the percentage increase in the mean concentration of atmospheric methane between 1990 and 2020 to provide the correct answer of 7.04 to three significant figures. Most candidates were credited for correctly reading off data from **Fig. 3.2**, i.e. the value of 1825 for mean concentration of methane (ppb) for 2020 and the value of 1705 for mean concentration of methane (ppb) for 1990. Few candidates were able to develop their answer further and carry out the subtraction, $1825 - 1705 = 120$ to give the increase in mean atmospheric methane, and then complete the calculation to give the percentage increase, dividing 120 by 1705 and multiplying the answer by 100 to give 7.038. For full credit, this answer then needed to be rounded to three significant figures. Credit was available for correct working even if the final answer was incorrect.
- (ii) Most candidates gave a vague response or simply repeated information in the stem of the question. The most common correct answer was that the values in **Fig. 3.2** are averages. Some candidates made reference to the concentration of atmospheric methane fluctuating. Very few understood that the measurements represented a small sample of the atmosphere which are then scaled up to represent the whole atmosphere.

Question 4

- (a) Candidates, in general, were often unfamiliar with the definition of water security and most limited their answer to a correct reference to the ability to access sufficient quantities of clean water. Successful responses went further and included the maintenance of adequate standards of food and manufacturing of goods, adequate sanitation and sustainable healthcare for full credit.
- (b) This question was generally answered well with most candidates correctly identifying strategy 1 as a reservoir or dam and strategy 2 as rain water catchment or water butt.
- (c) Most candidates were able to suggest at least one way in which strategy 2 can be improved to increase water security. The most common improvements suggested were to cover the barrels with a lid, increase the number of barrels or make the barrels larger, and add a filter to ensure the water is clean.
- (d) This question was generally well answered where the candidates understood the meaning of the term subsistence agriculture. The most common correct impact explained was that of reduced crop yield or crop failure. Some candidates were then able to develop their response to explain that this can lead to food shortages and then malnutrition, famine or starvation for full credit.
- (e) Candidates found this question more challenging as their response depended on correctly identifying strategy 1 as a reservoir or dam in **Question 4(b)**. Most were able to describe one benefit, large volume of water, and a very few candidates went on to consider other benefits such as recreational opportunities, creating jobs or benefiting the local economy, and use as a potential source of food (fish). Some responses described one or two limitations of strategy 1, such as a high set-up cost, flooding or disrupting habitats as the most common limitations. More successful responses would include limitations such as people being forced to move and historic sites or family homes being lost.

Section B

Significantly more candidates chose to answer **Question 5** rather than **Question 6**. Most candidates clearly indicated whether they were answering **Question 5** or **6**.

In general, the majority of candidates were awarded Level 2 for both AO2 and AO3 with a total mark between 8/20 and 12/20. Some candidates were able to achieve Level 3 for AO3 as they discussed both sides of the argument. A small number of candidates were unable to achieve more than Level 1 for AO2 as they did not provide any examples to support their answer, and Level 1 for AO3 as their response was largely descriptive and they did not make any judgements. There were a few candidates who did not answer either question in **Section B**.

Question 5

Some candidates were aware of a range of impacts on ecosystems of both plastics and other pollutants, but their responses lacked development, thus limiting the level awarded. Weaker responses simply focused on the impact of plastics with limited examples such as entrapping or harming marine organisms, e.g. sea turtles, marine organisms ingesting plastics due to mistaking plastic for food, and microplastics entering the food chain. Some suggested that plastics have a greater impact on ecosystems than other pollutants, without named examples or descriptions of any other pollutants. Very few candidates used specific case study examples in their response.

A few candidates had a good command of technical terminology to describe the impacts of pollutants such as greenhouse gases, enhanced greenhouse effect, acid deposition, bioaccumulation and biomagnification.

Higher-level responses made good use of specific case study examples, e.g. the Great Pacific Garbage Patch, microplastic flux in the Southern Ocean, and acid deposition in Scandinavia and Canada to support their answers.

Most candidates only described one side of the argument with the majority concluding that plastics have a greater impact on ecosystems than other pollutants, thus limiting their response to Level 2 for AO3. A minority of responses gave good evaluations and judgements, for and against, to achieve Level 3 or 4 for AO3.

Question 6

Many candidates who opted for this question had good knowledge of global warming and the enhanced greenhouse effect and showed some understanding of the impacts of climate change. Some candidates were able to use specific case study examples of both successful and unsuccessful national and international agreements, e.g. the Paris Agreement, Kyoto Agreement, Clean Air Act and reduction or banning of deforestation in the Rain Forest. Most candidates achieved Level 2 for AO2.

Stronger responses showed good knowledge of directly relevant national and international agreements related to climate change and were able to discuss a range of examples for managing climate change.

Few candidates were able to achieve more than Level 2 for AO3 as evaluations were often one-sided, stating that national or international agreements were either successful or not successful for managing climate change. Many candidates chose specific case study examples that were not directly relevant to managing climate change such as the Montreal Protocol and the Antarctic Treaty of 1959.

ENVIRONMENTAL MANAGEMENT

Paper 8291/12 Principles of Environmental Management

Key messages

A wide disparity was seen in knowledge surrounding the formation and impacts of photochemical smog.

Many candidates needed more practice in describing sampling techniques in a logical way.

Candidates should always show their working in calculations so that an error carried forward can be applied where appropriate.

Candidates demonstrated a limited knowledge of biomagnification.

General comments

Whilst there were some very strong responses surrounding interpretations of graphs and descriptions of trends and relationships, overall candidates would benefit from further learning and support in this area. Descriptions often needed to include data, and when a description of distribution in terms of a global geographical image was required, responses often included terms such as 'to the right' or 'to the left' or in response to the equator, 'above' or 'below' the equator which are far too general for any credit to be awarded.

Answers to **Section B** questions provided a variable range of response levels, from very strong through to more limited. Where the question requires evaluation, it is important that candidates provide a balanced response with a conclusion of the key points in order to evidence a secure approach and understanding of the topic area.

Comments on specific questions

Section A

Question 1

- (a) (i) Most candidates were able to describe the distribution of ozone globally, either by reference to data or in terms of high, medium and low. Strong responses named continents. Candidates needed to take care to refer to the northern hemisphere or high latitudes with regard to the Equator or Tropic of Cancer, as citing above or below could not be credited.
- (ii) Many responses described the formation of photochemical smog. At times there were misunderstandings of the formation of smog where candidates instead described wet and dry deposition.
- (iii) Reduction in photosynthesis impacting crop production and reduced visibility were common correct responses to this question about the impacts of photochemical smog. A significant number of candidates provided other impacts related to human health, which was already given in the question and so could not be credited.
- (b) The majority of candidates showed good knowledge of ways to reduce methane, including reduction in conventional rice crops, reduction in livestock being farmed as well as a reduction in landfill.

- (c) (i) The question required candidates to provide the range in mean global temperature in 2100: whilst many candidates were able to interpret the graph and identify correct data, some obtained data from 2030, thereby providing an incorrect response. Candidates should ensure they read and interpret the question carefully.
- (ii) Reasons why it is difficult to predict climate change by different climate models was not well understood.

Candidates often provided correct reference to limited historical data. The notion of different models using different variables and a lack of understanding of different climate feedback mechanisms was not described in responses.

Question 2

- (a) (i) Whilst there were correct points given in terms of the capture-mark-recapture method, such as use of sweep nets and marking dragonflies, the concept of the method was not generally understood. Candidates should regard descriptions of fieldwork as a set of instructions that must be logical and coherent enough that another learner could follow the method provided to obtain an estimate of a population.
- (ii) Most responses were able to correctly describe limitations of the capture-mark-recapture method, which often included difficulty in catching dragonflies and migration to other habitats, as well as issues surrounding harming of the dragonflies through methods of capture.
- (b) (i) A significant number of candidates were able to correctly calculate the number of dragonfly species that were at risk of extinction as a whole number.
- (ii) This was well answered by many candidates, with correct responses including increased predation, lack of prey, climate change or loss of habitat to name a few.
- (c) (i) Most candidates were able to construct a food chain containing four trophic levels; common errors included not providing a producer at the start of the food chain and incorrect direction arrows or none at all between trophic levels.
- (ii) Candidates were generally not secure in the interpretation of a food web and providing an organism that feeds both at the secondary and tertiary levels.
- (iii) Many candidates correctly identified pyramid **A** and were able to explain the concept of energy lost between trophic levels as well as citing examples of why, such as respiration or movement. Some candidates provided muddled answers and described the relationship of consumers preying on consumers, rather than discussing energy transfer.

Question 3

- (a) (i) Many candidates were able to gain some credit for referring to the use of renewable energy sources or capturing carbon dioxide from the atmosphere and not returning it afterwards. Most had difficulty in using the diagram to give full reasoning as to why the production of an electrofuel was carbon neutral. Candidates would benefit from further use of diagrams in learning to be able to apply knowledge correctly.
- (ii) Candidates generally were able to provide reasons for the differences as to why low-income economies had lower production of electrofuels compared to high-income economies. Affordability and reliance on fossil fuels were commonly cited.
- (b) (i) Most candidates were able to give a good definition of energy security. Some weaker responses discussed food security aspects which were incorrect.
- (ii) An evaluation of rationing as a strategy to manage energy security was less well understood by candidates. Many candidates were able to demonstrate knowledge of conserving energy through rationing, the negatives such as low industrial output or reduction in economic aspects were less well known. Many responses also recognised the potential for conflict as a negative of rationing.
- (iii) Two other strategies for energy security were commonly given by most candidates.

Question 4

- (a) Candidates were required to describe the trends in the mass of waste by disposal method from **Fig. 4.1**, a stacked bar chart. There were many strong responses that interpreted the three disposal method trends correctly. Common errors included discussion of data from specific years only, rather than from 2005 to 2020. A significant number of candidates only discussed the general trend of mass of waste disposal over that period rather than by method as required by the question, so missed out on credit. Candidates would benefit from further study surrounding graphs and interpretation in general.
- (b) (i) Candidates generally provided a secure understanding of the benefits of waste incineration.
- (ii) Aside from plastic waste being unsuitable for waste incineration, candidates were not generally familiar with other limitations of waste incineration; whilst strong responses made reference to toxic gases and provided clear examples, credit was not given to just stating the production of 'greenhouse gases'.
- (iii) Secure knowledge was shown by candidates surrounding limiting the impacts of plastic waste disposal; recycling and reusing were often stated.
- (c) Very few candidates demonstrated secure knowledge when explaining the process of biomagnification.

Section B

Question 5

The concept of reducing food waste as an effective strategy for managing food security produced a broad range of responses.

Strong responses demonstrated an understanding of what food security involved as well as the potential threats underpinning food security, such as population growth, agricultural disease, price setting, land degradation and climate change to name a few. These areas often provided a secure introduction to the topic and response in general.

In addition, strong responses provided a range of other strategies for managing food security, such as food stockpiling, increased food production methods, e.g. aquaculture and hydroponics as well as selective breeding and genetic modification. These were commonly appraised in comparison to reducing food waste as a strategy and candidates often concluded that there was not necessarily one strategy that was effective overall but a common perspective that all strategies have a role to play. These illustrations provided context and an opportunity for candidates to provide reasoning and address the extent these strategies contributed to food security in comparison to a reduction in food waste methods.

The weaker responses tended to focus disproportionately on reducing food waste when addressing the appraisal of managing food security. While this focus was not incorrect, these responses often lacked balance. It is crucial for candidates to recognise that a well-rounded and balanced response, combined with a thorough evaluation of the various strategies for managing food security, is essential for producing a robust and comprehensive answer.

Question 6

Candidates were required to evaluate geo-engineering as a strategy to counteract climate change. Overall, there were few candidates who opted for this question, suggesting that knowledge and understanding of this concept was not fully secure.

The question required candidates to demonstrate an understanding of climate change as well as knowledge of the impacts of climate change, such as temperature and precipitation, ocean and wind circulation, sea levels or melting of glaciers and permafrost.

The majority of the few candidates who answered this question used the knowledge and impacts of climate change as an introduction. However, whilst there were appropriate examples of geo-engineering strategies given, including albedo management, the use of space reflectors or the use of stratospheric aerosols, candidates often provided only one of these examples, therefore giving a limited breadth of topic area. The

principles and benefits of an appropriate example were generally secure, though the limitations of the strategies were generally not discussed.

Candidates also included strategies such as the reduction in the use of fossil fuels or the use of catalytic converters that are not geo-engineering techniques, showing a confused understanding of this topic.

Case studies were not used in candidates' illustrations; these would have significantly supported the candidates' discussion and evaluation.

ENVIRONMENTAL MANAGEMENT

Paper 8291/13
Principles of Environmental
Management

There were too few candidates for a meaningful report to be produced.

ENVIRONMENTAL MANAGEMENT

Paper 8291/21 Management in Context
--

Key messages

Candidates should note the number of marks available for each part question and write answers accordingly. This will give them an indication of the amount of content and detail expected.

It is important that instructions are followed carefully. Candidates must make sure that they understand the difference in meaning of the command words such as state, suggest, predict, justify, describe, explain, compare and evaluate.

Candidates should avoid repeating the question in their answers to make best use of examination time.

Candidates should show all working out in calculation questions as credit may be available for the correct calculation method even if the final answer is incorrect.

General comments

There was generally a good response to all questions across the paper. Most candidates found some parts of **Question 1** (carbon capture and storage) and parts of **Question 3** (investigation of insect pests on soybean plants) more difficult.

Topics which proved more challenging were the disadvantages of storing captured carbon, the use of CO₂ntainers to reduce negative impacts on the environment, the process of carbonation, combustion of chicken litter, random sampling methods, biological control, hydroponics in the context of food security, calculation of range, vegetation associated with a hot desert biome and the ACFOR scale.

Many answers showed a good understanding of terms and attention to detail with effective use of exemplar material.

The strongest answers included effective use of appropriate examples to illustrate key points, along with supporting details using appropriate terminology.

Comments on specific questions

Question 1

- (a) Candidates found the unfamiliar context of this question on carbon capture and storage challenging. Some candidates misread the question and described the process of carbon capture and storage rather than considering the disadvantages of storing captured carbon compared to using captured carbon. Successful responses considered the cost of carbon storage, not enough storage facilities or space being available to store carbon, and that the stored carbon might leak, for full credit.
- (b)(i) The majority of candidates were able to correctly calculate the maximum mass of industrial waste the four CO₂ntainers can treat in five years as 240 000. Credit was available for showing the working out, i.e. $12\,000 \times 4 = 48\,000$ and then $48\,000 \times 5$, as well as for the answer of 240 000.
- (ii) Candidates found this question challenging. The most common responses included reduction in the need to quarry or mine, the process being sustainable or reducing greenhouse gas emission. Some candidates made vague references to climate change, incorrect references to ozone depletion and CFCs, or made reference to use in the construction industry which was given in the stem of the question.

- (iii) Candidates also found this question challenging and it was generally poorly answered. Candidates were not able to apply their knowledge of the process of carbonation to seashells and explain how the carbon dioxide is naturally stored for millions of years. Those who answered this question well included reference to organisms with shells dying, being covered in layers of sediments and then being compacted or pressurised for full credit.
- (c) Most candidates were able to correctly state two other limiting factors of photosynthesis (other than carbon dioxide) as sunlight and water.

Question 2

- (a) (i) Most candidates were able to plot the data in **Table 2.1** as a bar chart to gain some of the credit available. Graph skills were generally good although bars touching and not of equal width were common errors.
- (ii) Candidates found this question challenging as using computer models for climate change was poorly understood. The most common correct answers included providing reliable data, predicting emissions where data is not available or increasing awareness. Responses that did not access any of the credit available generally repeated information given in the stem of the question.
- (b) (i) Few candidates were able to correctly calculate the percentage change in carbon dioxide emissions for the transport sector from 2015 to 2020, to three significant figures. Some candidates were able to give correct readings from the graph. Few candidates were able to access the credit available for correct manipulation of 2015 and 2020 data.
- (ii) Candidates were generally able to access some credit by suggesting that carbon dioxide emissions for the transport sector decreased due to a decreased use of vehicles or an increase in use of public transport or electric vehicles.
- (c) This question was generally well answered with most candidates able to access some of the credit available. The most common methods of waste disposal on land stated were landfill sites, incineration or burning of waste and recycling.
- (d) (i) This question was poorly answered as candidates were unable to apply the information given in the stem of the question to explain why combusting chicken litter does not increase the overall net concentration of carbon dioxide in the atmosphere. A successful response would include reference to chicken litter being plant based, the plants have taken in carbon dioxide through photosynthesis and this carbon dioxide is returned to the atmosphere.
- (ii) Candidates generally were not able to state the name of the type of renewable fuel, from chicken litter, as biomass or biofuel.
- (iii) Candidates found this question on the negative impacts of growing eucalyptus trees challenging. Few candidates achieved full credit. The most common correct answers included: could become invasive, require a lot of water or reduces biodiversity.

Question 3

- (a) (i) Candidates found this question challenging and few were able to correctly circle the plants at 32, 60 and 53 on **Fig. 3.3**.
- (ii) Most candidates were able to correctly state one benefit of using a random number generator to select the soybean plants as avoids bias or gives equal chance of selection.
- (b) (i) This question was not well answered with candidates generally gaining limited credit. A successful response would include reference to the method, e.g. tap or hit the plant gently with a stick, collect falling insects on the beating tray and count the insects, reference to processing, e.g. repeat method and take a mean, and the idea of scaling up, e.g. multiply the mean number of insects in the sampled area by the total number of plants for full credit.

- (ii) Candidates were generally able to describe one limitation of the beating tray method for investigating insect population on soybean plants. The most common correct response was that beating can damage the plant.
- (c) (i) This question was not well answered, with very few candidates able to correctly name the type of method of controlling the aphid population using a predator, as biological control.
- (ii) Most candidates were able to correctly suggest that the predator was not added to field 1 as it was a control or to be able to compare results.
- (iii) Most candidates correctly suggested that the aphid population was measured before the predator was added to field 2 to ensure that the two fields had comparable numbers of aphids or to see if the predator had an effect.
- (iv) Most candidates were able to conclude that the predator reduces the aphid population. More successful responses concluded that the predator takes 8–12 days to make an impact and were able to quote comparative data in support of their conclusion.
- (v) Most responses correctly suggested that the farmer covered the soybean plants after the predator is added to prevent the predator flying away. A few candidates were able to suggest a second reason for full credit.
- (d) Most candidates were able to correctly suggest that climate change could benefit the harlequin beetle as increased temperatures mean it will not become inactive.
- (e) (i) Hydroponics as a strategy to improve food security was poorly understood and very few candidates accessed credit. Responses most often described hydroponics rather than how using hydroponics can manage food security. A successful response would include reference to plants grown at high density without soil so they can be grown in areas with soil erosion or poor-quality soil, and that yields are not dependent on weather conditions.
- (ii) Most candidates were able to attain some credit and correctly describe one limitation of large-scale food stockpiling. The most common correct response was that food could rot if not stored properly. Few candidates were able to develop their answer to achieve full credit.
- (iii) This question was generally well answered with most candidates able to access some of the credit available. The most common impacts of food insecurity suggested were food scarcity, malnutrition, famine and poverty.

Question 4

- (a) (i) Most candidates either described the distribution as mainly north and south of the equator (in the tropics) or named a continent, e.g. Africa. Very few candidates achieved full credit and some described a hot desert biome rather than the distribution of hot desert biomes.
- (ii) Most candidates were able to correctly draw an **X** on the map in **Fig. 4.1** to indicate the location of a cold desert. The most common response was an **X** drawn on Antarctica.
- (b) (i) Most candidates were able to correctly complete **Fig. 4.2** by drawing a line between the plotted points.
- (ii) This question was challenging, and few candidates were able to correctly calculate the range for precipitation in the desert biome in **Fig. 4.2** as 49. Most candidates who gave an incorrect answer incorrectly read the values off the y-axis for temperature / °C.
- (iii) Some candidates were able to correctly calculate the simplest whole number ratio for precipitation in the desert biome compared to the rainforest biome as 3:20. It was clear that candidates who gave incorrect answers did not have a good understanding of ratios.
- (iv) This question was poorly answered and it was evident that most candidates did not have a good understanding of types of vegetation associated with a hot desert biome. Most responses correctly identified cactus as being associated with a hot desert biome but very few candidates gained credit by also identifying grass as being associated with a hot desert biome.

- (c) (i) This question was also poorly answered and it was evident that candidates did not have good knowledge of the ACFOR scale. Few candidates were able to correctly complete **Table 4.2** and name the categories F O R on the ACFOR scale as frequent, occasional and rare. There were a significant number of candidates who did not attempt to answer this question.
- (ii) This question was generally well answered with most candidates able to correctly complete **Table 4.3** and determine the ACFOR scale for each of the plant species, with CRFCF for full credit.
- (iii) Very few candidates were able to state any correct limitations of the ACFOR scale and were unable to access the credit available. There were a significant number of candidates who did not attempt to answer this question. Successful responses should include reference to the ACFOR scale being qualitative and biased or subjective for full credit.
- (d) (i) Most candidates were able to correctly plot the data in **Table 4.4** on the grid in **Fig. 4.3** with 25, 9 plotted. There were a significant number of candidates who did not attempt to answer this question.
- (ii) Most candidates correctly recognised that the results in **Fig. 4.3** showed that the current number of bird species (at every location) is less than the historic number of bird species.
- (iii) Most candidates were able to correctly describe that a probability of 0.003 meant there is a low chance of a bird species colonising a new location within a desert biome.

ENVIRONMENTAL MANAGEMENT

Paper 8291/22 Management in Context
--

Key messages

Care should always be taken to read questions carefully and note the number of marks available for each question part, before responding. This will indicate the amount of content and detail expected, and is particularly important where just one mark is available, but two commands are given. Under time restraints, bulleted answers for structured questions are often the clearest way to demonstrate knowledge.

It is important that instructions are followed carefully. The difference in meaning of question command words needs to be understood. The command words in this paper are: suggest, describe, state, conclude, explain, define, complete, plot, calculate and circle.

Candidates should not use the white space on the examination paper to continue their answers. Similarly, long answers squeezed into short answer spaces in small handwriting risk not being credited if they are not fully legible. If extra space is required, then an additional answer booklet should always be used. In these cases, care should be taken to label responses accurately. This is particularly important when there are several parts to one question.

Repeating the question in an answer is not necessary and takes up valuable examination time. If an answer needs to be re-written, then a single line through the incorrect passage is appropriate.

Candidates should show all working out in calculation questions as credit may be available for the correct method even if the final answer is incorrect. Where just one mark is available for a written answer, only the first response will be considered. Correct answers written after a wrong answer will not be credited. This applied to several questions across the paper where candidates lost out on credit for stating more than the required number of answers and giving incorrect responses along with correct ones.

Vague terms such as: resources, pollution, environmentally-friendly, harms, affects, impacts etc., should be avoided as much as possible without qualification. For example, resources could be qualified as food, water, energy etc. Pollution could be qualified as atmospheric pollution, water pollution etc. Credit is most often not given for vague, unqualified terms.

Candidates must avoid using alternative words to describe compass points on a map. In particular, for **Question 4(a)**, answers attempting to describe the area north of the Tropic of Cancer using non-geographical terms, such as 'above', 'over' or 'on top of' the Tropic of Cancer, were not credited. Compass points must always be in terms of north, south, east, west, or descriptive such as western, north-easterly, etc.

General comments

Many candidates misread a question or more than one question, which negatively impacted their score. The most commonly misread questions were **Question 1(a)(i)** (aquaculture as an alternative to land-based crop farming), **Question 1(a)(iii)** (benefits of vertical aquaculture farming other than reducing the impacts of climate change) and **Question 4(c)(iii)** (limitations of the method of investigating plant biodiversity in the tundra biome).

Candidates could improve by making more effective use of given resources to help their answers. In **Question 3(a)**, explaining pathways that gaseous mercury takes to enter the environment during extraction of gold proved demanding, despite candidates being invited to use **Fig. 3.1** to help them. Some responses used correct syllabus terminology, such as precipitation or rain; many others described rain in vague terms such as 'water droplets falling from the sky'.

Most candidates found **Question 3(d)(i)**, the polluter pays principle and **Question 3(e)(ii)**, strategies for managing gold as a resource, particularly challenging. Types of vegetation associated with the tundra biome in **Question 4(b)(iv)** were also not well known.

There were some good responses to most other questions across the paper. Many answers showed clear understanding of syllabus terms and topics. Where asked for, the strongest responses made effective use of the information given in tables, charts and figures.

The most successful answers made good use of correct terminology and appropriate examples to support and illustrate key points.

Comments on specific questions

Question 1

- (a) (i) Stronger responses gave clear suggestions for how climate change affects land-based crops, such as extreme weather, or rising sea levels leading to loss of land and crop failure. Most answers were either too vague for credit or reflected misinterpretation of the question. For example, many indicated less space is used or less deforestation is needed. Some other incorrect responses suggested aquaculture did not cause climate change. Some candidates could have benefitted from taking a moment longer to re-read the question before answering.
- (ii) There were some good answers with the most popular being that seaweed absorbs carbon dioxide during photosynthesis. Some went on to gain further credit for correctly suggesting seaweed and shellfish are carbon stores or sinks. Some candidates confused photosynthesis with respiration, or described both within the same process and therefore gained no credit. A very few made good use of the given information, noted the number of marks available, and achieved full credit.
- (iii) The majority of answers were too vague for any credit or indicated misinterpretation of the question. The most common creditworthy answer was improved food security. Some candidates missed out on the credit by giving more than one answer and contradicting themselves.
- (b) (i) Candidates generally performed well on this question with some clear answers describing the main sections of the trend. The strongest responses made use of the data and included the relevant years to demonstrate the overall trends. Weaker answers described unnecessary detail between successive years, particularly for the period 1978 to 1987. Others had misread the x-axis and provided an incorrect year to describe a trend.
- (ii) This question proved difficult for a proportion of candidates. However, some creditworthy suggestions were given with the most popular answers being climate change or a description of extreme weather such as storms or hurricanes.
- (c) Candidates were invited to analyse and interpret a line graph showing three percentage growth rate predictions for the global yield of annual seaweed between 2020 and 2050. They were also given a table showing the area of ocean required for each prediction. Suggestions as to why there is concern about the impact of a 20% growth rate were mixed, with many giving responses too vague for any mark point. Others correctly interpreted the table to identify that a large area of ocean would be needed.
- (d) Strategies for reducing the impact of overfishing were well understood by most, with many good answers given. Most candidates appreciated that fishing quotas are important and that changes to net size or fishing method are effective. The majority identified that legislation is an important part of international agreement.
- (e) (i) This question was well answered with most responses offering at least one creditworthy answer and many giving two or three. The most popular answers were rivers and lakes. 'Dams' was a very common incorrect answer.
- (ii) The majority of candidates successfully demonstrated knowledge of atmospheric composition to access credit. Many gave two or three correct answers. The less successful responses stated gases found in polluted air such as carbon monoxide.

- (f) This question drew mixed responses with many unable to name three abiotic components of an ecosystem. Some correctly named at least one abiotic component, whereas others were able to state at least two or three. Some of the most popular correct answers were temperature, sunlight, pH and salinity. Incorrect answers included organic components and vague terms such as 'air'.

Question 2

- (a) (i) Responses were mixed; some clearly understood that the second detector was used as a control with which to compare data sets or to identify anomalies, and others were too vague for credit.
- (ii) Most candidates were able to interpret both line graphs in **Fig. 2.2** to conclude that the data does not support the hypothesis and to correctly describe trends to support this. A notable proportion did not access the credit because they only provided a description of the trends without indicating if this supported the hypothesis or not. Candidates should take care to read each question carefully to understand what is required of them. In this case, 'conclude' and 'give a reason' were both required for the credit to be awarded.
- (iii) Many were able to suggest creditworthy answers such as the same bat may have been counted more than once, or some not at all. Others correctly stated that the data shows only bat activity, not the number of bats.
- (b) The most common good suggestion was indicating that a tracking device could be fitted to the bats. Some were able to access full credit by expanding this answer to include monitoring by either GPS or radio tracking. Many others gave answers too vague to access credit.
- (c) This question was not well answered, with many responses indicating a lack of detailed knowledge of the role of CITES. The most popular creditworthy responses were that CITES raises awareness, whereas others explained its role in preventing illegal trade. However, there were many vague or incorrect answers. A large proportion suggested that bats are captured and placed in zoos or protected zones and are encouraged to breed there. The use of case studies when reviewing the role of CITES would be of help to candidates.
- (d) Candidates performed well and there were some very good suggestions with the most common creditworthy answer being that the device is quick and easy to use compared to other methods. Many developed their ideas for the limitations section, correctly suggesting that insects could be harmed or killed by the suction action. Some scored full credit by also indicating that the equipment is expensive or that it is heavy to use.

Question 3

- (a) **Fig. 3.1** illustrates how gaseous mercury is deposited onto land after it is used to extract gold during small-scale mining. In general there were some good answers with some able to identify that mercury dissolves in water in the atmosphere and falls with rain or as wet deposition. Most candidates understood that rain, dust or gas is intercepted by leaves on the tree and is subsequently deposited onto the soil during autumn leaf fall. Some of the terminology used was too vague for any credit, for example, it is incorrect to express mercury as 'reacting' with water, dust or gas. Candidates should clearly know the definitions of both wet deposition and dry deposition.
- (b) The majority of candidates scored well here. The strongest responses showed a neat graph with vertical bars of equal width drawn with a ruler and not touching, both axes fully labelled including the units on the y-axis, and all five countries correctly plotted. Bars not drawn with a ruler resulted in reduction of credit where the plot was not clear and a further reduction where bar widths were unequal. Bars touching each other were not credited as this depicts a histogram, which is incorrect for discrete variables. Candidates should always label both axes including any units, which in this case for the y-axis was mercury concentration in μg of mercury per g of soil.
- (c) There were some good answers with most candidates able to interpret the photographic image to access credit. Some of the most popular answers described deforestation and loss of habitat, leading to loss of biodiversity. Most were able to describe specific pollution impacts such as water or soil pollution. The more developed answers described fragmentation as a consequence of deforestation or that leaching from toxic waste in the ponds leads to groundwater or soil pollution. Weaker responses gave suggestions too vague for any credit, for example, it is not enough to state

the environment is polluted without qualification of which type of pollution it is, or what is polluted. Some others had misidentified the toxic ponds as drinking water sources.

- (d) (i) This question attracted mixed responses, with many unsure of the meaning of the polluter pays principle or how it is used to manage the impacts of pollution. Others were able to develop good answers by describing the strategy as a financial incentive not to pollute. Very few scored full credit here.
- (ii) This question was challenging for most and it was clear that the polluter pays principle was not well known. Consideration of real case studies would be useful for candidates in preparation for this topic. The focus of this particular question was missed by the majority of candidates. The question refers back to **Fig. 3.2**, which shows an illegal gold mine. Being illegal means the mine may refuse to pay or there may be difficulty in monitoring the pollution, particularly if the mine is hidden within the Amazon rainforest.
- (e) (i) Most candidates were able to correctly define the term sustainability and access full credit. Some struggled to give a clear answer for any credit.
- (ii) Candidates found this question challenging with many answers too vague for any credit. The most common correct answers were either to recycle gold or place quotas on its extraction.

Question 4

- (a) The strongest answers described the distribution of tundra biome as being in the Northern Hemisphere (or North of the Tropic of Cancer) and gave two correctly named locations such as northern Europe and northern Russia. Many responses were not specific enough to gain credit. The majority of candidates attempted to describe locations without compass point descriptors. For example, no credit was given for describing tundra as 'above the Tropic of Cancer', or 'on top of North America'. Many others gained no credit for specifying 'North America' without indicating northern or north North America.
- (b) (i) The majority who responded were able to carefully join the twelve data points for temperature giving a smooth curve, or with straight lines drawn between successive data points. A notable proportion gave no response. Candidates should be aware that not every question requires a written response within an answer line space and to always make sure every question part has been attempted.
- (ii) Most were able to identify the highest and lowest precipitation data points and correctly calculate the range. Some incorrect answers indicated candidates had either read from the wrong y-axis, or had given the range for temperature instead.
- (iii) The majority were able to calculate 250 mm (tundra precipitation per year) compared to 2000 mm (rainforest precipitation per year) as a ratio of 1 : 8.
- (iv) Vegetation associated with the tundra was not well known. Many responses were either incorrect or had made a contradiction by circling both lichen and moss with a third (incorrect) vegetation type. Candidates would benefit from revising the differences in vegetation types between desert, forest, grassland and tundra biomes.
- (v) There were some good answers with the strongest responses making use of given information in **Question 4(b)(i) to (b)(iv)**. Candidates demonstrated knowledge of the optimum conditions for crop growth or photosynthesis including water and temperature requirements and suggested that the tundra would not meet those needs. Others described the permafrost and limited sunlight or a short growing season. Some attempted to describe 'poor soil conditions' without qualification that the soil layer is thin.
- (c) (i) Responses were mixed with many unable to suggest how the location is selected at random. Others accessed credit for indicating a random number generator could pick a location and needed to go on to describe a method of assigning locations a number or name for full credit. Where a large geographical area is under investigation, assigning coordinates or dividing the area into grids is appropriate.

- (ii) Many responses gained full credit for 5 neat crosses positioned on or just either side of the line, an equal distance apart and which covered at least half of the line's length. Any other number of crosses, or symbols other than crosses were not awarded. Sample positions at clearly unequal distances apart were not awarded since this does not show a systematic sampling strategy. Candidates must read each question carefully before responding, particularly where information is given. A notable proportion of candidates did not attempt this question.
- (iii) Responses were poor with most having misread this question, which asked for limitations of the method, many gave limitations of choosing the tundra biome to carry out the investigation. Descriptions of a barren, cold or remote location where the investigation would be difficult were not credited. Others stated that the scientist may miss plants if the plants were covered in snow. A few candidates understood that only one location sampled on only one day and with only five sample positions is not representative of the whole biome. A very small number described lack of repeats (and therefore any method for calculating a mean) or information on climatic conditions. Candidates would benefit from working through case studies of this type of investigation including correct methodology and limitations.
- (d)(i) Many worked through the four steps to correctly calculate D , scoring full credit. Those who missed out, generally incorrectly calculated the second step for each plant type U-Z. The most common mistake made here was quoting plants W and Z as 3.9, rather than 0.0039. Calculators can display answers in standard form, so it is important that candidates understand this and know how to indicate this in answers. In this case, an answer of 3.9×10^{-3} for plants W and Z was acceptable. Another common mistake was rounding an answer too far, e.g., for plant U, an answer of 0.02 rather than 0.015 was not accepted.
- (ii) This question was poorly answered with only the minority able to suggest that the value for D would be higher for the rainforest than that for the tundra, as well as give the correct reason, which is that there is higher plant diversity in the rainforest. The difference between the plant population (number of plants) and plant diversity (number of species) was not clearly understood. The command words 'suggest' and 'give a reason' both needed to be followed for credit to be awarded.

ENVIRONMENTAL MANAGEMENT

Paper 8291/23
Management in Context

There were too few candidates for a meaningful report to be produced.