N21/4/ENVSO/SP2/ENG/TZ0/XX/M

Markscheme

November 2021

Environmental systems and societies

Standard level

Paper 2

21 pages

Subject details: Environmental systems and societies SLP2 Markscheme

Mark allocation

Candidates are required to answer:

- **ALL** questions in Section A **[25]** and **TWO** questions in Section B **[40]**.
- The maximum total = **[65]**.

1. Environmental systems and societies uses marking points and markbands to determine the achievement of candidates

When using marking points (All of this paper except Section B, part (c) questions):

i. A markscheme often has more marking points than the total allows. This is intentional
ii. Each marking point has a separate line and the end is shown by means of a semi-colon (;)
iii. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded**
iv. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

When using markbands (Only for Section B, part (c) questions):

i. Read the response and determine which band the response fits into
ii. Then re-read the response to determine where the response fits within the band
iii. Annotate the response to indicate your reasoning behind the awarding of the mark **Do not use ticks at this point**
iv. Decide on a mark for the response
v. At the end of the response place the required number of ticks to enable RM Assessor to input the correct number of marks for the response.

2. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.

3. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

4. Words that are underlined are essential for the mark.

5. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by **OWTTE** (or words to that effect).

6. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

7. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script.

8. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

Section A

1. (a) (i) State the trophic level of the zebra. **[1 max]**

primary consumer/herbivore/second trophic level;

(ii) State how you could determine gross secondary productivity of the zebra. **[1 max]**

measure the mass of food that the zebra eats and measure the mass of the fecal loss;
GSP is the difference between food consumed & fecal loss/GSP = food eaten – fecal loss;

(iii) Explain how the second law of thermodynamics applies to this food chain. **[2 max]**

i. second law of thermodynamics states that the entropy/disorder of a system increases over time / conversions/transformations in energy aren't 100% efficient;
ii. available energy is lost to environment between trophic levels;
iii. energy is lost as heat from cell respiration;
iv. often only 10% of available energy is passed on / 90% lost between trophic levels / ecological efficiency is limited;
v. not all parts of the grass/zebra are consumed/absorbed;

(b) State the type of relationship that exists between biting flies and the zebra. **[1]**

parasitism / predation / carnivory / disease vector;

(c) Zebra stripes may reduce the ability of the biting flies to land on the zebra. Describe how natural selection may have led to the evolution of zebra stripes in response to biting flies. **[3 max]**

i. there was variation in the population / more or less stripes;
ii. that variation arose randomly/through mutation;
iii. biting flies are an environmental pressure / cause disease / natural selection;
iv. having more stripes is advantageous where flies are present / zebras with stripes are less prone to disease / are better adapted to survive (survival of fittest);
v. striped individuals have a reproductive advantage;
vi. their offspring inherited the advantageous traits / stripes;

***Note**: Award **[2 max]** if not related to biting flies.*

2. (a) Referring to the data in **Table 1**, calculate the Simpson's diversity index (D) of the late successional stage. (Show your working). **[2]**

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

$$\frac{(360 \times 359)}{(70 \times 69) + (60 \times 59) + (90 \times 89) + (90 \times 89) + (40 \times 39) + (10 \times 9)} = \frac{129\,240}{26\,040} = 4.96;$$

***Note**: Award **[1]** for correct answer; **[1 max]** if no working shown;*
Accept 4.96, 5.0 or 5.
Accept any valid working.

(b) Define *species diversity.* **[1]**

species diversity is the function of the number of species/richness **and** their relative proportions/abundance/evenness (in an area);

(c) Explain why the diversity changes in the different successional stages. **[2 max]**

Species diversity increases toward the later stage...

i. because there is an increase in habitats;
ii. as new species move or are transported into the area;
iii. because primary productivity tends to increase as you move through the stages;
iv. because nutrient cycling becomes more developed;
v. because evenness/richness increases;

(d) (i) State **one** method to determine the population size of the Keen's mouse. **[1]**

*Award **[1]** for stating appropriate method:*
eg. capture–mark–release–recapture / Lincoln index;

***Note**: Do not credit "full count/total census" or methods that would only give data of relative abundance eg. mouse droppings.*

(ii) Identify **two** factors that could impact the accuracy of the method stated in 2(d)(i). **[2 max]**

i. the number of trials carried out;
ii. type of traps/bait used for catching mice;
iii. type of marking used to identify captured mice (may increase predation);
iv. time for mice to reintegrate after first capture;
v. how easily mice become trap happy/trap shy (might skew results);
vi. size of samples trapped;

***Notes**: Allow error carried forward (ECF) if method for 2di is wrong.*
Both positive and negative impacts on accuracy would be acceptable although candidate does not need to specify which for full credit.

3. (a) (i) Using **Figure 3(a)**, identify the year in which the median prediction of the world population will reach 10 billion. **[1]**

2055;

(ii) Outline **one** reason for the uncertainty in predicting the world's population in **Figure 3(a)**. **[1 max]**

i. different models/scenarios/fertility rates might use different figures in their calculations;
ii. difficult to determine how the demographic policies of countries might change;
iii. factors outside our control *eg*. disaster / disease / war;

Note: *Do not credit vague statements about prediction being difficult. They should identify at least one specific factor that makes it difficult. (NB Migration is irrelevant because this is global population.)*

(b) (i) Using **Figure 3(b)**, identify the region that has the most countries with a decrease in the percentage change in population between 2010 and 2019. **[1]**

Europe and Northern America;

(ii) Outline **two** factors that could contribute to a reduction in population in the countries in **Figure 3(b)**. **[2 max]**

i. increasing emigration due to war/natural disaster;
ii. increasing emigration due to few job opportunities;
iii. increasing deaths due to war/natural disaster/aging population;
iv. high number of women in the workforce / high level of education of women decreases fertility;
v. access to contraception/family planning decreases fertility;
vi. advanced healthcare decreases fertility;
vii. a country's anti-natalist population policy decreases fertility;

Note*: Accept any valid factor appropriately linked to low or decreasing fertility/high or increasing mortality/emigration.*

(c) Discuss how a country's stage in the demographic transition model (DTM) might influence its national population policy. **[4]**

General statement: The DTM can...

i. help a country to predict its future population growth based on current demographics / identify whether birth/fertility/mortality rates are increasing/decreasing / suggest appropriate policy to redress unwanted change;

If in stages 1/2 it might implement programmes to improve living standards such as:

ii. improve health care access/facilities;
iii. vaccination policy to reduce child mortality;
iv. invest in campaigns/education informing people on hygienic measures;
v. fight poverty / improve economic development;
vi. ask for international medical/economic aid;

If in stages 2/3 it might implement programmes to slow population growth / achieve population stability such as:

vii. anti-immigration policies;
viii. policies that increase the empowerment/independence of women / raise minimum legal age of marriage;
ix. increase access to contraception/sex education;
x. support family planning programs (governmental or by NGOs);
xi. put a limit in number of children per family (one-child policy);

*If in stages 4/5 it might implement programmes to increase population growth / stop population decline, such a*s:

xii. pro-immigration policy;
xiii. economic incentives for additional children / *eg*. baby bonuses / family allowances / tax deductions;
xiv. social incentives for larger families, / *eg*. maternal and paternal leaves, flexible work schedules, public office for parents of more than 3 children, free schooling/nursing;

Counterargument:

xv. other factors than DTM may be more significant *eg*. cultural/religious/economic/political factors;

***Note**: Responses must be linked to some aspect of the DTM to gain credit (i.e. the stage, or prevailing DR/BR)*

Section B

Part (c) questions in Section B are all to be assessed using the markbands on page 24 with the guidance given below for each question.

4. (a) Identify **four** factors that make the use of the insecticide DDT controversial. **[4 max]**

DDT…

i. is a very effective/affordable insecticide;
ii. can help in the management of insect borne diseases/malaria/zika;
iii. can help in the control of agricultural pests, improving harvests;
iv. is a persistent (organic) pollutant / causes soil degradation/aquatic pollution;
v. has negative effects on human health;
vi. bioaccumulates in the bodies of organisms;
vii. biomagnifies in food chains;
viii. causes impact on non-target species/death of birds of prey/top carnivores;
ix. reduces biodiversity;

(b) Explain how human activities continue to affect stratospheric ozone. **[7 max]**

Introductory explanations:

i. ozone depleting substances (ODSs)/CFCs disrupt (the dynamic equilibrium of) ozone formation;
ii. ODSs are halogenated organic gases such as chlorofluorocarbons (CFCs) / halons;
iii. ...used as cooling agents (old refrigerators, air-conditioning units) / aerosol propellants (spray cans) / blowing agents (insulating foams) / fire-extinguishers / cleaning solvents (electronic equipment) / pesticides;

Activities that lead to increase/restoration of ozone:

iv. pollution management may be achieved by reducing the manufacture and release of ozone-depleting substances;
v. methods for this reduction include recycling refrigerants/developing alternatives to gas-blown plastics/ halogenated pesticides/propellants and aerosols/developing non-propellant alternatives;
vi. the Montreal Protocol (on Substances that Deplete the Ozone Layer (1987)) (and subsequent updates) is an international agreement for the reduction of use of ODSs;
vii. this is considered to be a very successful international agreement;
viii. national governments complying with the agreement made national laws and regulations to decrease the consumption/production of ODSs;

Mechanisms that lead to reduction/destruction of ozone:

ix. UV light breaks apart the ODSs/CFCs and releases a halogen atom;
x. … halogen atom breaks an ozone molecule apart and combines with an oxygen atom;
xi. oxygen atoms combine with the oxygen from the halogen and release the halogen to start the process again;
xii. … the halogen is considered a catalyst / why the reaction is cyclical;

Explanations of "continuing" effect on ozone:

xiii. ODSs/CFCs have a very long lifetime in the atmosphere / there is a time lag from removal of ODSs to the end of ozone destruction;
xiv. halogen atoms are removed very slowly from stratosphere; (*Cl by a chemical reaction with methane forming hydrochloric acid*)
xv. an illegal market for ozone-depleting substances persists and requires consistent monitoring;
xvi. some countries are still not complying with international agreements on bans;
xvii. HCFCs may have lower ozone depleting potential, but still destroy ozone (not phased out before 2020);
xviii. increasing GCC/GHGs affect polar weather conditions (increasing temperature difference between troposphere and cooler stratosphere), thus affecting the distribution of ozone (positively in 2019, negatively in 2020); (***Note** that this should be the only link with GCC accepted)*

***Notes**: Award **[5 max]** if there are no explanations of "continuing" effect on ozone.*
Accept CFCs as alternative to ODSs.

(c) To what extent is the use of solid domestic waste (SDW) as an energy source beneficial to a society? **[9 max]**

The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria given in each of the markbands (although "ESS terminology" has been conflated with "Understanding concepts"). This guide simply provides some ***possible*** *inclusions and should not be seen as requisite or comprehensive. It outlines the kind of elements to look for when deciding on the appropriate markband and the specific mark within that band.*

Answers may include:

- **understanding concepts and terminology** types and sources of SDW; increasing trend (overpopulation); consumerism; methods of SDW disposal (landfill, incineration, recycling, composting); strategies for managing SDW including zero-waste programmes; energy production, *eg.* trash to energy systems; environmental indicators; sustainability; pollution – air, atmosphere, water;
- **breadth in addressing and linking** disposal of SDW to climate change and pollution; impact on resource use and exploitation; perspectives from EVSs; range of perspectives from a societal and cultural angle; differences due to development level; energy security;
- **examples** could include different countries' strategies; examples of sustainability plans for cities; examples of impact of incineration or landfills; examples of climate change goals and integration;
- **balanced analysis** could include a range of societies challenges; a variety of perspectives from an EVS angle; contradiction of energy production needs and reduction of resource use; contrast of MEDCs to LEDCs;
- **a conclusion that is consistent with, and supported by, analysis and examples given** *eg.* the use of SDW as an energy source can be very beneficial for a city in reducing its waste disposal needs and greenhouse gas emissions however it can lead to a reduction in impetus to reduce waste production and therefore resource use as the society becomes dependent on the waste as an energy source;

Please see markbands on page 21.

5. (a) Outline **one** method for measuring the impact of a build-up of dead organic matter in an aquatic ecosystem. **[4 max]**

i. use of a biotic index/indicator species;
ii. take samples from water source using kick samples/drag nets;
iii. sort/identify species and count number of individuals;
iv. calculate diversity index for samples;
v. presence of indicator species that are particularly sensitive to pollution will indicate water is clean/unpolluted;
vi. a biotic index is based on species tolerance, diversity and relative abundance;
vii. impact judged by changes in diversity over a range of time or space;

OR

viii. measuring Biological Oxygen Demand (BOD) / the amount of dissolved oxygen required to break down the organic material in a given volume of water through aerobic biological activity;
ix. collect samples from the water source upstream, at source, downstream following a standard procedure;
x. measure dissolved oxygen in collected samples;
xi. place sealed samples in dark for five days and re-measure dissolved oxygen in samples / BOD calculated by the change in the dissolved O_2 measurements over 5 days (mg L^{-1});
xii. repeat dissolved oxygen measurements after a suitable time frame (*eg.* 1 month);
xiii. impact judged by changes in BOD over a range of time or space;

***Notes**: Credit can be similarly awarded for impacts on other valid components of ecosystem* eg. *turbidity / dissolved O_2.*
If candidate addresses more than one method then only give credit for most high scoring.

(b) Explain how models of ecosystems might be used in species conservation. **[7 max]**

Notes*: Award* ***[2 max]*** *for valid named examples of ecosystem models* eg*. food chains / webs / pyramids / systems diagrams / flow charts / aquaria / zoos / microcosms / biodiversity indices / computer programmes / mathematical models.*
Credit can be given for any of the following ways in which models may assist conservation:

i. models of ecosystems can give holistic perspective on conservation;
ii. flows of energy and matter / box-and-arrow models can be used to identify key storages/processes for conservation;
iii. modelling may consider biodiversity measures to help in evaluating conservation;
iv. measures of genetic diversity help to determine breeding plans for species conservation;
v. physical models can help in studying abiotic needs of a species;
vi. modelling feeding interactions / predator-prey interactions allows conservationists to determine the needs of species;
vii. modelling feeding interactions can demonstrate possible trophic cascades and provide information about benefits of conservation;
viii. modelling biotic interactions can help identify potential threats/essential interactions to the conservation of a species;
ix. modelling energy/matter flows helps determine habitat needs/area for a species;
x. modelling is likely to be used in combination with field observations/community needs;
xi. modelling may miss emergent properties of a system and therefore not help in species conservation;
xii. modelling may not take account of human activities / unpredictable events;
xiii. modelling may not take account of rare events, such as natural disasters;
xiv. mathematical modelling may quantify population dynamics;
xv. ...thus allow predictions on probability of extinction/recovery;
xvi. microcosm may study effects of disturbance on species;
xvii. single species models may be too simplistic and fail to predict actual behaviour of ecosystem
xviii. zoos can be designed to reflect the specific features of an endangered species niche;

(c) Discuss how the introduction and re-introduction of a species can affect an ecosystem. **[9 max]**

The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria given in each of the markbands (although "ESS terminology" has been conflated with "Understanding concepts"). This guide simply provides some ***possible*** *inclusions and should not be seen as requisite or comprehensive. It outlines the kind of elements to look for when deciding on the appropriate markband and the specific mark within that band.*

Answers may include:

- **understanding concepts and terminology i**ntroduction of species as alien species; introduction of species that become invasive species; re-introduction of species that were previously removed from an ecosystem; restoration; competition; biodiversity; food chain interactions; resource partitioning and evolution of niche (fundamental *vs* realised); limiting factors/carrying capacity; extinction; trophic cascades and keystone species;
- **breadth in addressing and linking** explains difference between introduction and re-introduction of a species; considers both positive and negative effects; impact on biodiversity; addresses cultural / societal perspectives; considers role of community / government / NGOs in success;
- **examples** include both alien species and re-introduced species in a variety of habitats;
- **balanced analysis** needs to consider value of both introduction and re-introduction and the benefits and challenges in the local communities and ecosystems; accidental or deliberate;
- **a conclusion that is consistent with, and supported by, analysis and examples given** *eg.* the introduction of a species can result in a range of impacts, including only minor changes in competition for indigenous species and realignments of realised niches through resource partitioning, to very large impacts through competition, loss of biodiversity and ultimately extinction of native species, *eg*. after the introduction of brown snakes into Guam or the American crayfish into UK freshwater systems. The re-introduction of a species, *eg.* wolves to Yellowstone National Park, also leads to increased competition and changes in distribution and population size of native species but can also lead to positive trophic cascades and an increase in biodiversity;

Please see markbands on page 21.

6. (a) Outline the albedo effect and its role in regulating the Earth's global temperature. **[4 max]**

i. albedo is a measure of the reflectiveness of a surface / is greater from lighter-coloured/smoother surfaces;
ii. high albedo means that solar radiation is reflected away from a surface/reducing temperature / low albedo means that solar radiation is absorbed by a surface/increasing temperature;
iii. oceans/ice/clouds contribute significantly to Earth's albedo;
iv. the balance between the albedo of the Earth's surfaces involves feedback loops;
v. negative feedback loops reduce change (retain the balance in ratio of albedo) and maintain the global temperature;
vi. *eg.* rise of global temperature ➔ increased evaporation ➔ increased cloud cover ➔ increased albedo and reflection of solar radiation ➔ decrease in global temperature;
vii. a change in the balance can result in a positive feedback loop which amplifies changes and results in a rise in the Earth's global temperature;
viii. *eg.* rise in global temperature ➔ increase melting in ice caps ➔ decrease in albedo ➔ increase in solar radiation absorption ➔ rise in global temperature;

***Note**: Accept alternative feedback loops.*

(b) Compare and contrast the adaptation strategies to climate change for **two** societies. **[7 max]**

The following adaptation strategies can be credited ***provided*** *it is clear whether they are common to both societies (compare) or are a point of difference (contrast).*

weather readiness…

i. flood defences;
ii. increase resilience of ecosystems, *eg.* flood retention in mangroves/marshes;
iii. support water saving/reduction schemes (for droughts);
iv. planting of crops in previously unsuitable climates;
v. tree plantings, shady areas, reflective construction materials, green roofs, and the ecological management of rainwater;
vi. produce plans for heatwaves;
vii. develop rapid response teams;

health…

viii. vaccination programmes;
ix. reduce water and air borne diseases;

education…

x. include climate change in educational curriculum;
xi. provide information to citizens about risks;
xii. capture indigenous knowledge for benefit of all;
xiii. invest/support scientific research into climate change monitoring and adaptation;

infrastructure and economy…

xiv. desalinization plants;
xv. diversification away from climate sensitive industries;
xvi. increase resilience of communities through economic development;
xvii. increased resilience of buildings and infrastructure (to heat waves, flooding);
xviii. legislation and planning to consider climate impacts;
xix. monitoring, forecasting and early alert systems;

Notes*: Award* ***[5 max]*** *if only compare or only contrast used.*
Award ***[3 max]*** *if strategies are simply described but not clearly compared or contrasted between two named societies.*
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(c) Discuss whether biodiversity loss or climate change is a greater threat to human societies **[9 max]**

The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria given in each of the markbands (although "ESS terminology" has been conflated with "Understanding concepts"). This guide simply provides some ***possible*** *inclusions and should not be seen as requisite or comprehensive. It outlines the kind of elements to look for when deciding on the appropriate markband and the specific mark within that band.*

Answers may include:

- **understanding concepts and terminology** biodiversity (habitat, species, genetic); climate change; threats to ecosystems from biodiversity loss; threats to ecosystems from climate change; impact of these on human societies; threats to food production from both; extinction; hotspots; sustainable development goals;
- **breadth in addressing and linking** tipping points; positive and negative feedback loops; regime shifts/alternative stable states; possible use of solutions to address challenges of each threat (mitigation, adaptation, conservation strategies); benefits of biodiversity; ecosystem resilience; ecosystem stability; biome shift; loss of keystone species; conservation, EVSs; uncertainty of GCC impacts/modelling;
- **examples** of scale of biodiversity loss; impacts to food webs/productivity/ecosystems; examples of climate change impacts on ecosystems/society/economics/energy production (at both global and local scale); examples of causes of biodiversity loss and of climate change;
- **balanced analysis** two-way (bidirectional) interaction of climate change and biodiversity loss; contrast efficiency/difficulty of conservation/management strategies to mitigation/adaptation strategies (in the context of different EVSs); political implications (national & international agreements, role of NGOs); compare present rate and scale to past events; contrast local to global scale;
- **a conclusion that is consistent with, and supported by, analysis and examples given** *eg.* I believe climate change is a bigger threat to human societies as it will result in biodiversity loss in more systems than areas which could gain in biodiversity and result in multiple impacts on human health, human populations from severe weather, however without building ecosystem resilience through preserving biodiversity, climate change will be even more of a threat to human societies;

Please see markbands on page 21.

7. (a) Identify **four** strategies that can be used in the sustainable management of wild fisheries. **[4 max]**

i. use of quotas / international regulations against overfishing/by-catch/fishing endangered species;
ii. designation of marine protected areas (exclusion zones) / restriction of fishing zones;
iii. restrictions/bans on types and size of fishing gear (including mesh size / bottom trawling / drift nets/ cyanide/dynamite fishing);
iv. restrictions on time/season/size/age allowed to fish;
v. monitoring illegal fishing through technology/permits/licenses;
vi. research and support of calculation of maximum sustainable yield;
vii. labelling schemes to provide consumers with information on sustainability of fish;
viii. campaigns to reduce consumption of wild caught fish / promotion of aquaculture;

(b) Evaluate the sustainability of **two** water management strategies to improve access to freshwater resources in a society. **[7 max]**

Examples of strategies ***[2 max]***:

i. reservoirs; dams; rainwater harvesting; water diversion projects; international sale of water resources; desalination; artificial glaciers; cloud seeding; water conservation/grey water reuse; restoration of wetlands; prevention of water pollution; pumping of aquifers;

Evaluation may include factors such as…

ii. impact of cost on economic sustainability of population;
iii. demand placed on human / physical resources;
iv. climate impact – carbon negative/neutral/positive;
v. impact on ecosystem resilience;
vi. impact on biodiversity;
vii. interference with natural cycles;
viii. limiting geographical/climatic factors;

The following examples of water management strategies and their evaluation show how credit can be given for any appropriate strategy.

Example 1: Rainwater harvesting;
Positive:
does not impact natural water cycle / replenishment rate / impossible to reduce natural income;
free natural capital;
useful for watering plants/irrigation / washing / fire protection / (thus) reduces consumption of groundwater/other freshwater resources;

Negative:
availability restricted temporally and spatially (unequal distribution of rain / unpredictable supply);
usually not safe for drinking;
can’t satisfy needs of irrigation of commercial agriculture;

Example 2: Desalinization;
Positive:
sustainable if energy required produced by photovoltaic cells;
sea water is more available than freshwater;
provides accessible/safe drinking/irrigation water;
salt may be used for producing useful chemical products (sodium hydroxide, hydrochloric acid);
reduces pressure on freshwater reserves that need protection;

Negative:
requires huge amounts of energy / increase GCC if fossil fuel used;
not available in landlocked countries;
building of facilities result in environmental damage/pollution;
disposing of salt (brine) poses environmental hazards/pollutes ocean / salt is contaminated so can’t be eaten;
high cost to build and operate that may be economically unsustainable;

Notes: *Award* ***[1 mark]*** *for each appropriately identified strategy for improving access to freshwater up to* ***[2 max]****.*
Do not accept simplistic statements not clearly linked to sustainability, eg. cheap / efficient / doesn’t need elaborate equipment/scientific expertise.
Accept statements such as “its cost is too great to be economically sustainable / its cost may divert economic resources away from habitat/species protection / resource requirement maybe unsustainable for LEDCs”.
Award ***[5 max]*** *if only positive OR only negative evaluation OR only one strategy evaluated.*
Award ***[1 max]*** *for each clear negative or positive evaluation of each factor.*

(c) To what extent can the different environmental value systems improve the sustainability of food production. **[9 max]**

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Answers may include:

- **understanding concepts and terminology** environmental value systems; ecocentric/anthropocentric/technocentric; sustainability; sustainable development; environmental indicators; ecological footprint; natural capital & income; aquatic and terrestrial food production; soil; biodiversity; eutrophication;
- **breadth in addressing and linking** inclusion of both aquatic and terrestrial systems; variety of systems in different climates; variety of factors affecting sustainability (sub-topic 5.2);
- **examples** of food production systems in terrestrial systems and aquatic systems;
- **balanced analysis** includes ecocentric, anthropocentric and technocentric solutions and a mix of terrestrial and aquatic systems; and evaluation of their relative impact on sustainability;
- **a conclusion that is consistent with, and supported by, analysis and examples given** *eg.* an ecocentric approach to food production may be the most sustainable with minimal input of pesticides, fertilizers and small-scale production but the addition of some low technological solutions such as monitoring of climate and drip irrigation with an anthropocentric addition of setting limits to the use of pesticides and fertilizers and incentives to reduce climate change will be the most successful approach;

Note: *IB considers anthropocentrism as "humans sustainably managing global system" (through regulations/policies/incentives etc) rather than the common dictionary definition that it means simply "humans are the central/most significant entities in the world" leading to an understanding of the EVS as cornucopian (which it isn't necessarily). Responses addressing anthropocentrism should be evaluated in this light.*

Please see markbands on page 21.

Section B, part (c) markbands

Marks	Level descriptor
0	The response does not reach a standard described by the descriptors below and is not relevant to the question.
1–3	The response contains: • minimal evidence of knowledge and understanding of ESS issues or concepts • fragmented knowledge statements poorly linked to the context of the question • some appropriate use of ESS terminology • no examples where required, or examples with insufficient explanation/relevance • superficial analysis that amounts to no more than a list of facts/ideas • judgments/conclusions that are vague or not supported by evidence/argument.
4–6	The response contains: • some evidence of sound knowledge and understanding of ESS issues and concepts • knowledge statements effectively linked to the context of the question • largely appropriate use of ESS terminology • some use of relevant examples where required, but with limited explanation • clear analysis that shows a degree of balance • some clear judgments/conclusions, supported by limited evidence/arguments.
7–9	The response contains: • substantial evidence of sound knowledge and understanding of ESS issues and concepts • a wide breadth of knowledge statements effectively linked with each other, and to the context of the question • consistently appropriate and precise use of ESS terminology • effective use of pertinent, well-explained examples, where required, showing some originality • thorough, well-balanced, insightful analysis • explicit judgments/conclusions that are well-supported by evidence/arguments and that include some critical reflection.