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Programme du diplôme
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Markscheme

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Environmental systems and societies

Standard level

Paper 2

17 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 (<u>All of this paper except</u> 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 **<u>precise point</u>** where it becomes clear that the candidate deserves the mark. **<u>One tick to be shown for each mark awarded</u>**
iv. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

When using markbands (<u>Only</u> 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 <u>underlined</u> 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) State the trophic level of zooplankton. **[1]**

Primary consumer / second trophic level/2nd;

(b) State the relationship between POPs concentration and the trophic level**.** **[1]**

POP concentration increases/is higher moving up to higher/at increasing trophic levels / positive/direct correlation / as one increases the other increases;

Note: *Do not credit biomagnification or bioconcentration in response to this question.*

(c) Explain the relationship between POPs concentration and trophic level. **[2]**

a. POPs bioaccumulate/bioconcentrate within organisms/tissues, as they are taken up from surrounding environment/polluted ocean water/food;
b. … because POPs are non-biodegradable/don't break down…;
c. …and result in biomagnification, as they pass from one trophic level to the next (across levels)...;
d. ...due to the decrease of biomass/energy (respiratory losses) up the food chain;

Note: *Do not award marks if similar statements are given in 2(b) and 2(c)*

(d) Calculate, as a percentage, the efficiency of energy transfer between zooplankton and herring. **[1]**

(25/500) x 100 = 5 (%);

(e) Outline **one** strength **and one** weakness of a pyramid of productivity as a model to represent energy in an ecosystem. **[2]**

Strength: ***[1 max]***
a. shows the flow/production rate of energy/biomass through a food chain (rather than the standing stock) / never inverted;
b. tracks change over time (rather than "snapshot" in time);
c. more efficient comparison of different ecosystems;
d. Visual representation / simplification of complex system/ easy to communicate information to non-specialist;
e. can be used to make predictions;

Weakness: ***[1 max]***
f. difficult to place organisms that occupy more than one trophic level;
g. hard to get accurate data because collection is difficult / inevitably some values are approximate;
h. (estimating in field) may involve killing of organisms;
i. oversimplification and loss of detail/complexities of interacting factors;

2. (a) Using **Figure 2(a)**, identify the month in which NO_x emissions in Asia and Middle East has the greatest reduction. **[1]**

June;

(b) Outline **one** reason for the NO_x emission reductions during Covid lockdowns, shown in **Figure 2(a).** **[1]**

reduced burning/combustion of fossil fuels, a source of NO_x, due to reduced traffic/factory closures;

(c) Explain the relationship between the NO_x emissions shown in **Figure 2(a)** and tropospheric ozone concentrations shown in **Figure 2(b)**. **[2]**

a. the two have a positive correlation/as NO_x decreases so does tropospheric ozone;
b. …because NO_x (is a primary pollutant) that can lead to tropospheric ozone formation (secondary pollutant);
c. …because NO_x interacts with sunlight/UV (and sometimes VOCs) to produce tropospheric ozone;
d. tropospheric ozone continues to increase in some regions after NO_x levels off / possibly because other factors (e.g. weather, other pollutants) influence tropospheric ozone production;

(d) Outline two pollution management strategies to reduce tropospheric ozone. **[2]**

a. education campaigns to consume less fossil fuel/using energy efficient technologies/alternative energy sources/electric vehicles/public transportation/walking or cycling
b. regulate and reduce burning of fossil fuels with government regulation or taxation / limits of when/which cars can be on the road (ex. Mexico city every other day driving / carpool lanes);
c. use of catalytic converters/higher fuel quality to reduce NOx from car exhaust;

Note: *Credit any valid strategy that could reduce the use of fossil fuels*

(e) NO_x also contributes to acid deposition. Outline **two** impacts of acid deposition on living systems. **[2]**

a. damages the leaves of plants / the ability for plants photosynthesize / reduces agricultural productivity;
b. nutrient leaching of soils;
c. toxic effect from leached metals on aquatic organisms/plant roots;
d. changes of soil or water pH kill organisms/push out of tolerance ranges;
e. particles of sulphates/nitrates penetrate lungs and can lead to asthma/bronchitis/respiratory issues;

(f) State **one** method that could be used to restore an ecosystem damaged by acid deposition. **[1]**

liming / reforestation / restocking fish / extracting toxic metals from water/soils / adding nutrients/fertilisers to soils / adding woodash / planting acid resistant plants to bind soil;

3. (a) With reference to **Figure 3**, identify the stage that represents the greatest food loss and waste in North America. **[1]**

use / stage 5;

(b) Outline **two** strategies to reduce food waste at the 'distribution and retail' stage in North America. **[2]**

a. ensure proper temperature/packaging for transport/storage to reduce spoilage;
b. use of proper storage/pesticides to avoid pest infestation in stores;
c. buy/sell "ugly" fruits and vegetables;
d. buy/sell products/GMOs that have a more durable shelf life;
e. donate unsold food/discount food near expiry to avoid waste at retail;
f. reduce distribution losses by feeding locally;

Note: *Accept other valid points relevant to stage 4.*

(c) With reference to a stage in **Figure 3**, describe **one** reason for a difference between food loss and waste in a less economically developed country (LEDC). **[2]**

LEDCs might have more waste in stage 1/2/3/4/5…; **[1max]**
…due to… **[1max]**
a. …more pest infestation due to lack of pesticides (stage 1);
b. …poor storing conditions/ higher ambient temperatures increasing spoilage during handling/transportation (stage 2 or 4);
c. ...less efficient facilities/machinery may lead to increased waste during harvest/handling/packaging (stage 2 or 3);

LEDCs might have less waste in stage 1/2/3/4/5…; **[1max]**
…due to… **[1max]**
d. …subsistence farming reduced productivity (stage 1);
e. …local consumption of grown food reducing need for handling and processing (stages 2 or 3);
f. …buying/eating the cheaper "ugly" food (stages 4 or 5);
g. …consuming less food due to less income (stages 4 or 5);
h. ...consuming lower on food chain/less meat (stages 4 or 5);
i.

Note: *Accept any point of equal significance*
Only award credit for reasons that are correctly linked with "less" or "more" waste

(d) Discuss the sustainability of **two** solid domestic waste disposal strategies that can be used to manage food waste. **[4]**

a. Composting is turning food waste into natural fertilizer / reduces waste to landfill / emits less methane (aerobic composting)…;
b. …but does not apply to meat/dairy/liquids / may associate with pests/disease;
c. Methane collection from landfills would contribute to sustainable/low-impact energy production / sustainably designed landfills (e.g. liner, collecting & treating leachate) is an efficient method of dealing with huge amounts of waste…;
d. …but landfills are notorious for emitting various pollutants contaminating ground/water/air / prevent any possibility of re-using food waste / require large amount of land;
e. Incineration would efficiently reduce volume of food waste / require less land…;
f. …but would release harmful air pollutants / would require a lot of energy/initial investment;
g. anaerobic digestion/fermentation may turn food waste into biogas/fuel...;
h. ...but requires facilities (digesters)/expertise not available in LEDCs;

*Allow **[1 max]** for a conclusion, like "landfill/incineration overall increase EF / composting overall contributes to lower EF" or comparing the sustainability of the SDWs discussed "compost is a less expensive SDW than incineration / compost is less efficient for management of large quantities of food waste"*

*Award **[2 max]** for each SDW strategy (i.e. one mark for positive, one for negative)*

***Note:** only award mark once for same point for different strategies*
***Note:** recycling is not a valid method*

Section B

4. (a) Outline the difficulties in determining the carrying capacity of the human population. **[4]**

carrying capacity for humans difficult to determine because:
a. human ingenuity, meaning that humans are able to substitute one material for another;
b. variations in lifestyles;
c. technological developments that give rise to continual changes in the resources required and that are available for consumption;
d. wide range of resources used;
e. importation of resources;
f. climate change may cause significant/rapid changes in resource availability;

(b) Evaluate the potential value of aquaculture for providing food for future generations. **[7]**

Aquaculture pros:
a. Provides fish for consumption without overfishing;
b. Producing more seafood can alleviate food insecurity;
c. Aquaculture creates economic opportunities;
d. Advances in technology are increasing efficiency/potential of aquaculture;
Provides additional/healthy source of protein / seafood becoming more popular;

Aquaculture cons:
e. loss of habitats;
f. pollution from feed/feces;
g. pollution from antifouling agents/antibiotics;
h. spread of diseases;
i. escaped species that are not native could become invasive;
j. if escaped species are GMOs they could alter the wild gene pool/outcompete;

Note: [1 mark] for supported conclusion

(c) Human population dynamics are influenced more by social, cultural, political and economic factors than by resource availability.

Discuss the validity of this statement. **[9]**

The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria 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** of population dynamics; carrying capacity; ecological footprint; limits to growth; Malthus v Boserup; population policies; pro-natal & anti-natal; contraception; tax incentives; abortion policies; marital age; female emancipation; literacy; religions/ideologies; migrations; wars; child labour; importation of resources; density dependent factors; resource exploitation; sustainable yields; demographic transition; renewability of resources; recycling; etc
- **breadth in addressing and linking** population dynamics (growth and decline) with a wide range of factors including social (e.g. role of women), cultural (e.g. religious imperatives), political (e.g. population policies), economic (e.g. tax incentives), resource availability (e.g. food production, energy, water, pollution management) etc
- **examples** of named social, cultural, political, economic factors that influence population growth in a range of different named countries and societies (MEDCs and LEDCs, Western and Eastern, tropical and temperate) along with examples of different resources that may limit population growth, and different management strategies addressing the availability of resources.
- **balanced analysis** of the extent to which sociopolitical factors are more or less influential than resource availability on the growth and/or decline of human populations considering both the pros and cons for the argument selected.
- **a conclusion that is consistent with and supported by analysis and examples given, e.g.** Human populations in the latter stages of demographic transition are largely regulated by sociopolitical factors and generally it is only the populations at earlier stages of the DTM that are literally limited by resource factors such as famine and water scarcity.

Please see markbands on page 17.

5. (a) Outline the differences between anthropocentric and technocentric value systems. **[4]**

*Anthropocentric **[2 max]***
a. Sustainable management is a duty of human societies / environmental manager;
b. Population control given equal weight to resource use;
c. Strong legal regulation by authorities / imposing environmental taxes, fees, compensations;
d. It is moral for human societies to benefit from natural capital;
e. Encourages debate to reach a consensual, pragmatic approach to solving environmental problems;

*Technocentric **[2 max]***
f. believes technological developments can provide solutions to environmental problems;
g. provides an optimistic view of the role humans can play in improving the lot of humanity;
h. encourages scientific research in order to form policies and to understand how systems can be controlled, manipulated or changed to solve resource depletion;
i. sees a pro-growth agenda as necessary for society's improvement / believes that economic growth can be sustained without environmental harm;

***Note:** any valid and exclusive characteristic of the given value system can be credited.*

(b) Evaluate the use of ecological footprint in assessing the sustainability of a society. **[7]**

*definition of Ecological Footprint **[1 max]***
a. an ecological footprint represents the hypothetical area of land required by a society/group/individual to fulfill all their resource needs

*Strengths/advantages: **[4 max]***
b. a useful snapshot of the sustainability of a population's lifestyle;
c. a tangible tool for individuals/governments/countries to measure/quantify their environmental impact/to identify necessary changes in lifestyle;
d. iconic symbol/image for raising awareness of environmental issues;
e. the footprint size considers both resource needs and waste assimilation;
f. as a model for monitoring environmental impact the ecological footprint can allow for direct comparisons between groups and individuals, e.g. MEDCs and LEDCs;
g. can provide a (quantitative) estimate of human carrying capacity;

*Limitations/disadvantages: **[4 max]***
h. does not include all information on the environmental impacts of human activities;
i. only a model so simplified/not precise;
j. approximation of actual figures which cannot be accurately calculated;
k. does not show types of resources used / shows only total resources;
l. negative in approach so could be perceived as de-motivating;

*Conclusion **[1 max]***

(c) Urbanization has had a greater effect on the quality and availability of freshwater resources than agricultural activities.

Discuss the validity of this statement. **[9]**

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Answers may include:

- **understanding concepts and terminology** of urbanization, waste-water treatment; leaching of heavy metals; sedimentation; suspended solids; landscape changes; well-drilling; aquifers; urban growth; grey water cycling; acid precipitation; reverse osmosis; pesticide pollution; bioaccumulation; biomagnification; irrigation; flooding; drip irrigation; leaching of fertilisers; eutrophication;
- **breadth in addressing and linking** urbanisation and agricultural activities with a range of associated impacts on quality and availability of freshwater including pollution; waste disposal; sustainable management; overexploitation; development of irrigation/drinking systems/dams etc
- **examples** of named pollutants from urban and agricultural sources; named strategies for sustainable management of water in urban and agricultural contexts; named countries/societies in which issues arise;
- **balanced analysis** evaluating the relative impact (negative or positive) of both urbanisation and agriculture on water quality and availability and the extent to which these may be mitigated through sustainable management
- **a conclusion that is consistent with and supported by analysis and examples given,** e.g. although urbanization creates a broader range of negative effects on freshwater quality than agriculture it also provides methods for the production of freshwater from sewage and sea water.

Please see markbands on page 17.

6. (a) Outline how the abundance of a motile species in an ecosystem can be measured. **[4]**

a. abundance of motile organisms can be measured using direct and/or indirect methods;
b. numbers can be counted from aerial images/ satellite images/trigger cameras over a representative area
c. overall population numbers can be calculated from extrapolation to whole area;
d. mark recapture techniques can be used to sample populations / description of Lincoln Index method/equation;
e. method of capture e.g. pitfall trap/live trap/collection of species
f. method of marking with appropriate tag that doesn't affect survival;
g. appropriate time interval between release and recapture

(b) Explain **one** natural and **one** human-caused factor that influences changes in biodiversity. **[7]**

*Natural factor **[4 max]**:*
(Extinction)

a. mass extinctions of the past/local extinctions caused by various natural factors, have (temporarily) reduced biodiversity;
b. e.g. tectonic plate activity / super-volcanic eruption;
c. e.g. climatic changes (including drought and ice ages);
d. e.g. meteorite impacts;

(Evolution)

e. Evolution is a natural factor that has led to increased biodiversity;
f. Mutation leads to increases in genetic diversity;
g. Natural selection may lead to some reduction in genetic diversity;
h. Speciation has led to increased species diversity;
i. Adaptive radiation has led to increased speciation/genetic diversity;

*Human caused factor **[4 max]**:*
(Extinction)

j. human activity is considered to be causing a sixth mass extinction;
k. e.g. habitat destruction/deforestation/urbanisation;
l. e.g. pollution of freshwater water bodies/oceans/soils/atmosphere/leading to climate change/associated environmental hazards;
m. e.g. over-exploitation of resources/overfishing/hunting/intensive agriculture;

(Conservation)

n. conservation/restoration of ecosystems has led to increased biodiversity;
o. e.g. establishment of national parks/nature reserves etc.;
p. e.g. ex situ conservation/zoos/plantations/seed banks reduce loss of biodiversity;
q. e.g. legislation/trade agreements protecting species e.g. CITES/fishing quotas/endangered species act;

(c) Discuss the effectiveness of habitat-based conservation in relation to the impacts of climate change. **[9]**

The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria 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** of habitat-based conservation; species-based conservation; reserves; national parks; size; shape; edge effects; corridors; buffer zones; ecotourism; climate change; precipitation patterns; global warming; biome shifts; migrations; extinctions; salinity change; melting glaciers; hazardous weather events; droughts; rising sea levels; salt intrusion etc
- **breadth in addressing and linking** a good range of features of habitat-based conservation including design and management of reserves and their relevance in addressing a range of impacts from climate change including those leading to loss of biodiversity and changing distribution patterns.
- **examples** of named conservation areas from a variety of named regions/countries and examples of named species impacted by climate change along with relevant named organisations currently addressing habitat conservation (e.g. World Wildlife Fund for Nature, Greenpeace, Friends of the Earth International and Earth First!)
- **balanced analysis** evaluating the degree to which the various aspects of conservation areas can or cannot effectively address the threats of climate change including both strengths and limitations of habitat-based conservation.
- **A conclusion that is consistent with and supported by analysis and examples given**, *e.g.* habitat-based conservation strategies are effective, especially when contrasted to species approach, but cannot compensate for climate change impacts on their own; there needs to be international cooperation and political will toward mitigating climate change altogether.

Please see markbands on page 17.

7. (a) Outline **two** transfers and **two** transformations within a soil system. **[4]**

*Transfers **[2 max]**:*
a. biological mixing of nutrients and inorganic material;
b. movement of water due to percolation/infiltration;
c. minerals dissolved in water moving through soil/leaching;
d. feeding/ingesting of organic matter;
e. uptake of nutrients by plants;
f. soil erosion by wind/water.
g. sediment deposition;

*Transformations **[2 max]:***
h. decomposition of organic matter/detritus/by decomposers;
i. weathering of parent material resulting in increase of inorganic matter,
j. nutrient cycling example e.g. carbon/nitrogen/phosphorus;
k. respiration by living organisms;

(b) Compare and contrast the pathways of energy through the atmosphere and the pathways of energy through an ecosystem. **[7]**

*In both (compare) **[4 max]:***
a. energy is not created or destroyed.
b. the source of energy is the sun.
c. energy is transformed from one form to another.
d. energy is lost as radiated heat.
e. sunlight energy is reflected, absorbed, radiated.

*Contrast **[4 max]:***
f. energy from the sun is reflected by clouds in the atmosphere
g. …and by light surfaces/ice in ecosystems.
h. energy from the sun is absorbed by clouds/GHG in the atmosphere
i. ...and by the earth's surface/organisms/soil/water in ecosystems;
j. the energy from the sun is used in photosynthesis by plants only in ecosystems (not in atmosphere);
k. energy is lost as the radiation of heat through respiration in ecosystems as it is passed through food chains
l. ...whereas in the atmosphere it is lost through radiation from resonating GHGs;
m. transfers/transformations of energy in ecosystems often go through living organisms, but not in the atmosphere;

(c) To what extent are food production systems impacted by anthropogenic (human-caused) changes to the atmosphere. **[9]**

The following guide for using the mark bands suggests certain features that may be offered in responses. The five headings coincide with the criteria in each of the mark bands (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 mark band and the specific mark within that band.

Answers may include:

- **understanding concepts and terminology** of food production systems; subsistence; commercial; intensive; extensive; terrestrial; aquatic; acid rain; global warming; climate change; precipitation patterns; hazardous weather events; inundation; ocean acidification; ozone depletion; tropospheric ozone; photochemical smog;
- **breadth in addressing and linking** a wide range of anthropogenic impacts on the atmosphere's composition and temperature with their associated impacts (both positive and negative) on a wide range of food production systems in different environments/regions.
- **examples** of named impacts on named food production systems in named locations and societies due to named anthropogenic influences on the atmosphere.
- **balanced analysis** evaluating the extent to which anthropogenic impacts on the atmosphere do or do not influence food production systems either positively or negatively.
- **a conclusion that is consistent with and supported by analysis and examples given,** *e.g.* There are a wide range of anthropogenic influences on the atmosphere that impact both terrestrial and aquatic food production systems and although some impacts may positively affect productivity, the great majority tend to reduce it.

Please see markbands on page 17.

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.