

Markscheme

May 2025

Environmental systems and societies

Standard level

Paper 2

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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) Identify the category with the highest global harvest weight from aquaculture in **Figure 1**. [1]

Freshwater fish;

- (b) (i) Using **Figure 1**, calculate the projected increase in the harvest of crustaceans between 2019 and 2050. [1]

(30 million – 17 million) 13 000 000 / 13 million (T) (accept 10 – 16 million);

Note to examiners: Units (T) are not required.

- (ii) Outline **one** reason for the increase referred to in **1.(b)(i)**. [1]

- a. Increased demand for food / due to rising population / increased affluence / shifting diet preferences (toward high-protein aquatic food or eating at lower trophic levels);
- b. Improved technology and techniques for harvesting/raising crustaceans;
- c. Increased incentives (financial, legal, political) for crustacean aquaculture/wild capturing / reduced limitations/increased quotas for crustacean fishing;
- d. Increased wild crustacean populations due to efficient conservation;
- e. Fishing more crustaceans due to dwindling fish populations;

(c) Describe **two** possible reasons for the difference in global aquaculture harvest between marine fish and crustaceans in **Figure 1**.

[2]

- a. Easier/more efficient to raise crustaceans in confinements due to their smaller size / lower (niche) requirements (higher stocking densities possible);
- b. Crustaceans are less susceptible to stress/water quality fluctuations (relative to marine fish);
- c. More efficient feed conversion lowers production cost / e.g. shrimp require less feed to gain same body mass;
- d. More (financial, legal, political) incentives provided for crustacean aquaculture (relative to marine fish);
- e. Higher (actual or potential) revenue from crustacean aquaculture (relative to marine fish);
- f. Higher demand for crustaceans due to diet/cultural preferences;
- g. It's not economically viable to farm large marine species like tuna with aquaculture;
- h. Knowledge of raising crustaceans in aquaculture is more common/popular in many societies, e.g. East Asia;
- i. No need of aquaculture/pisciculture, if certain marine fish species are abundant in wild populations/easier to catch than farm;
- j. Opposition to fish farming (pisciculture) for ethical reasons/concerns for pollution/conflicting water uses/impact on wild fish populations;

Note to examiners: Credit other valid points explaining the higher aquaculture harvest of crustaceans relative to marine fish or, conversely, reasons for less pisciculture.

Do not credit general arguments favoring aquaculture over wild fisheries or other food production systems; e.g. "increased demand for seafood / rising population" is not enough for MPf.

No credit for reference to wild capture, unless clearly linked to a valid impact on aquaculture, as in MPI.

- (d) Evaluate the use of aquaculture in meeting the projected harvest of global seafood, as shown in **Figure 1**.

[4]

Pros [3max]:

- a. Seafood demand is expected to rise significantly by 2050, so it can provide new/more sources of food;
- b. aquaculture harvest would reduce stress on wild fisheries/farming land;
- c. Provides economic opportunities for coastal nations, particularly developing nations;
- d. Waste and nutrients can be cycled, making it more sustainable / usually reduces food miles;
- e. More than one species can be harvested in Integrated multi-trophic aquaculture (IMTA);
- f. Many forms of seafood have a high protein value;
- g. Aquaculture, usually, is more efficient (economically, ecologically) than capture;

Cons [3max]:

- a. May lead to loss of habitat in certain ecosystems;
- b. Greater localized aquatic pollution (antibiotics, medicines, nutrient pollution, etc.);
- c. Spread of diseases and escaped species (some involving genetically modified organisms);
- d. Ethical concerns towards mass fish farming or genetically modified organisms (GMOs);
- e. It is not economically viable to farm large marine species like tuna with aquaculture;
- f. May raise local water conflicts;
- g. Difficult to certify for sustainability/social responsibility;
- h. Current frameworks suit better, in most case, large-scale industrial aquaculture (rather than small-scale farmers);
- i. Current share of marine fish coming from aquaculture suggests it is unpopular;
- j. Aquaculture has high set-up/maintenance costs / requires a lot of resources i.e. fish feed/antibiotics;

Note to examiners: Credit any valid advantage or disadvantage. Do not credit simplistic arguments, like more costly, more sustainable, more efficient, etc.

Credit other valid responses

2. (a) Identify the altitude with the highest concentration of ozone shown in **Figure 2(a)**. [1]
22–24 km;

Note to examiners: Do not credit if units are omitted.

- (b) With reference to **Figure 2(a)**, describe the importance of higher ozone concentration between 20 and 30 kilometers for living organisms. [2]
- a. Ozone in the stratosphere absorbs ultraviolet radiation from the sun / less ozone means more ultraviolet radiation reaching the earth's surface;
 - b. Ultraviolet radiation is harmful for living tissues / increasing the incidence of cataracts / mutation during cell division / skin cancer/melanoma / immune deficiency;
 - c. Increased ultraviolet radiation may reduce biological productivity / damage photosynthesising organisms including phytoplankton...;
 - d. ...disrupting food chains/ecological equilibria / e.g. reduction of krill population around Antarctica;

Note to examiners: Do not credit simplistic statements, like “protects life on Earth”, “absorbs sun’s rays”.

- (c) State **one** possible impact of increased ground-level ozone concentration on human health. [1]

Damages lungs/lung tissue / irritates respiratory tissue/bronchitis/emphysema / eye irritation / lung cancer / cardiovascular issues;

Note to examiners: Do not credit conditions relating to UV radiation or global warming i.e. cataracts, skin cancer etc.

- (d) Outline two possible reasons for the change in ozone exposure for India shown in **Figure 2(b)**. [2]

- a. Increased release of primary pollutants / VOCs & NOx...;
- b. ...due to increased population...;
- c. ...due to increased living standards...;
- d. ...leading to increased vehicular traffic/industrial production/fossil fuel burning/air-conditioning use;
- e. Global warming increasing air-conditioning/energy use / perhaps leading to a localized increase in rate of photochemical reactions / increased urban heat island effect;
- f. Increase in high rise buildings traps pollutants.

Note to examiners: No credit for “defects in data collection”, “release of GHGs/CFCs”.

- (e) Outline **two** possible ways countries can reduce their ozone exposure, as shown in **Figure 2(b)**. [2]
- a. Increased investment into renewable technology/energy sources;
 - b. Stricter laws/taxes for vehicle/industry emissions of NO_x & VOCs / Set/enforce stricter ozone air concentration standards;
 - c. Public policy initiative (e.g. don't drive days/vehicle bans/improved public transportation/promote biking etc.);
 - d. Technological improvements (e.g. catalytic convertors/scrubbers/electric vehicles);
 - e. Improve energy efficiency in buildings/appliances;
 - f. Promote sustainable agricultural practices that do not emit methane (a VOC);
 - g. Promote sustainable behaviour, like carpooling, reduced use of solvents/paints;
 - h. Planting trees/greening in cities reduces ozone levels;

3. (a) Identify the household waste category with the lowest carbon impact from production in **Figure 3**. [1]

Wood;

- (b) Describe **one** possible reason why paper/cardboard waste has double the overall carbon impact of that of metal waste in **Figure 3**. [1]
- a. Metal waste is recycled while paper is not/is recycled less (in Scotland, not in general) / metal recycling is easier/more effective than recycling paper;
 - b. More paper waste is put into landfill than metal waste / landfill increases the overall carbon impact due to decomposition/methane release;

Note to examiners: Do not credit reference to production of paper vs. metal waste, as these values are equal.

- (c) Outline **two** disadvantages of using landfill to dispose of paper/cardboard, as shown in **Figure 3(b)**. [2]
- a. Paper waste overall increases the amount of land required for landfills / reduces space useful for farming/habitats/other uses;
 - b. Reduces potential to be recycled / thus more paper must be produced from raw material / leading to forestry loss/clearcutting/more energy/water spent/increased carbon impact;
 - c. Causes littering due to being blown by wind;
 - d. Decomposition of paper releases GHG (methane) / is slower than in soil;
 - e. Significantly adds up to trash volume / increases toxic leachate polluting soil/water;
 - f. Increased chance of self-ignition/fire releasing GHGs/air pollutants;

Note to examiners: Do not credit general disadvantages of landfills not clearly linked to paper waste.

- (d) Outline **two** disadvantages with recycling metal as an approach to decreasing carbon impacts, as shown in **Figure 3**. [2]
- a. Some metals cannot be recycled;
 - b. Metal waste is a minor/relatively small contributor to carbon impacts compared to other categories;
 - c. Recycling of metals has low carbon reduction impact in proportion to production of metal;
 - d. Many metal objects can be reused, which is more efficient than recycling;
 - e. Difficult/time-consuming to separate different metals/remove paint/oil/dirt/ clean metal before recycling;
 - f. The recycling process, usually, needs high energy inputs from fossil fuels;

Note to examiners: No credit for “lower quality of recycled metal” or being costly and inefficient.

- (e) Suggest **two** pollution management strategies that could be used to decrease the carbon impacts from animal/food waste in Scotland. [2]
- a. Municipalities can invest in community compost collection / local composting;
 - b. Incentives for more/improved food storage appliances/freezers/refrigerators/ technologies;
 - c. Implementation of/legislation towards more efficient farming practices reducing food waste / e.g. precision harvesting technique/train workers for selective harvesting/ promote efficient crop residue management systems to reduce food waste going to landfills;
 - d. Sell sub-optimal farming products to juice makers/soup producers/sauce manufacturers / encourage supermarket groups to sell ‘slightly imperfect fruit and vegetables / people eating slightly misshapen fruit rather than wasting them;
 - e. Feeding properly treated food scraps to farmed animals;
 - f. Citizens/families preparing food with less waste / efficiently plan meals / restaurants efficiently managing portion size/donating leftovers;
 - g. Promote vegetarianism, as meat industry, in general, produces more food waste / leads to more methane release;
 - h. Promote/invest/apply modern technologies reducing food waste / e.g. single-cell protein food production (minimizes food waste) / genetically modified crops that spoil later;
 - i. Using food waste for biomass energy production (is considered carbon neutral);

Notes to examiners: Credit any other valid strategy that produces less food waste or reduces release of food waste to the environment or removes it from the environment without increasing carbon impact; e.g. no credit to “incinerating food waste”.

Allow credit for “food recycling”, but consider sim to MPs a, e & i.

Do not credit “consume/produce less food” on their own.

Section B

4. (a) Identify **four** characteristic features of the tropical rainforest biome **[4]**

Tropical rainforest has:

- a. High species/habitat/niche diversity / high biodiversity / hotspots / many endemic species;
- b. High primary productivity / high photosynthetic rate / serve as major carbon sinks / produce a lot of oxygen;
- c. High nutrient turnover / high decomposition rate;
- d. High rates of insolation;
- e. High mean temperatures;
- f. Abundant precipitation / high humidity;
- g. Nutrient-poor/acidic soils;
- h. Thin topsoil layer / rich in organic matter / very deep overall / red colored (rich in iron);
- i. Dominated by tall straight trees;
- j. Complex/highly branched food webs;
- k. Stratified ecosystem / tree buttresses in ground level, dense broad-leaved canopy, emergent trees;
- l. Found around the Equator / between Tropics of Cancer & Capricorn;
- m. Low/no seasonality/annual fluctuation in climate (precipitation and temperature);

Note to examiners: Do not credit “found in the Tropics”; see MPI.

(b) Explain how a community of decomposers contributes to the stability of the whole ecosystem

[7]

- a. Decomposers will feed on dead organic matter/detritus (like dead leaves, wood, carcasses, feces)...;
- b. ... reducing their accumulation / cleaning up Earth;
- c. They will break down organic matter into inorganic matter...;
- d. ...enhancing soil fertility / increasing nutrient availability;
- e. The inorganic minerals (nitrates, phosphates, metals) will then feed plant communities / will be absorbed by plant roots...;
- f. ...supporting high vegetation/plant abundance;
- g. ...and may support high habitat/niche diversity;
- h. Decomposers are responsible for nutrient cycling / e.g. nitrogen cycling (nitrogen fixation/ammonification/nitrification/denitrification / phosphorus cycling / carbon cycle;
- i. ...high flow of matter may support complex food webs;
- j. Decomposers are the basis of a detritus-based food web / important part of ecosystem flow of energy / may be eaten/pass biomass on to carnivore community...;
- k. ...supporting/stabilizing carnivore abundance;
- l. As decomposer numbers decrease due to predation, so do carnivores;
- m. ... thereby contribute to regulation of the carnivore community / which is an example of negative feedback (leading to stability);
- n. Decomposer will release organic matter through their own death/defecation...;
- o. ... which would provide food for other decomposers;
- p. Decomposers participate in humus formation...;
- q. ...increasing water holding capacity of soil (and soil fertility = MPd);
- r. Decomposers may compete with one another regulating their populations (another example of negative feedback = MPm);
- s. Decomposers, like earthworms, loosen soil / disperse nutrients / create space for air and water circulation...;
- t. ...helping root growth / improving soil structure;
- u. Fragmentation: larger invertebrates initially fragment larger chunks of organic matter (then bacteria and fungi complete decomposition into nutrients = MPC);
- v. After a disturbance, decomposers will increase their metabolic/respiration rate/feeding on detritus...;
- w. ...contributing to a faster return to original state (resilience entailing stability);

- (c) To what extent is a technocentric value system more appropriate than other value systems in addressing issues of sustainability.

[9]

Answers may demonstrate:

- **understanding concepts & terminology** of technocentrism; anthropocentrism; ecocentrism; valuing components of biosphere & natural capital; social/economic/environmental sustainability; environmental indicators; ecological footprint; EIA; pollution management strategies; biodiversity conservation; access to clean fresh water; access to food; aquaculture; sustainable development goals; industrialization; commercial high-input food production systems; soil degradation; soil conservation; urbanization; catalytic converters; scrubbers; carbon capture technology; mitigation/adaptation strategies; GMOs; drought-resistant crops; coastal defences; CFC alternatives; shifting to renewable resources; hydropower/nuclear/wind/solar; electric vehicles; vertical farming; increasing carrying capacity; environmental degradation; resource depletion;
- **breadth in addressing** range of technocentric values/strategies/developmental projects/policies **and linking** them with responsible use and sustainable management of resources & different aspects of sustainability.
- **examples** of technocentric values, strategies, developments, policies addressing issues of sustainability, like pollution, environmental degradation, economic inequalities, social conflicts.
- **balanced analysis evaluating** extent to which technocentric strategies manage to effectively address issues of sustainability AND comparing them with corresponding strategies based on different EVSs.
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. Technocentrism emphasizes economic development, scientific progress and technological solutions rather than self-restrain, respect to tradition and changes in behavior, which are usually considered the safer road toward sustainability. However, commitment by technocentrists to sustainable development has led to impressive technological developments and innovations that allow responsible and sustainable use of resources.

Please see markbands on page 23.

5. (a) Outline **four** important functions of water in natural ecosystems. [4]
- a. It is used in photosynthesis to produce glucose/biomass/oxygen;
 - b. It dissolves minerals in soils so they can be absorbed by plants;
 - c. It provides a medium/habitat for aquatic organisms / covers two-thirds of Earth's surface;
 - d. It dissolves chemicals so that biochemical reactions/metabolism can take place in individuals;
 - e. It generates a pressure (turgor) within plants that provides them with support;
 - f. It transfers heat polewards from the equator to higher latitude ecosystems / from lower to higher altitudes (evaporation/condensation);
 - g. It can be an effective coolant through evaporation;
 - h. Its high heat capacity helps in regulating temperatures;
 - i. clouds in the atmosphere/ice sheets with high albedo reflect incoming solar radiation / cool Earth's temperature / ocean has lower albedo than land, thus absorbing heat;
 - j. All organisms need to water to survive / water comprises ca.70% of organisms/95% of cells;
 - k. Water (rain/rivers/currents) is responsible for many transfer processes in biosphere / moving organisms/nutrients/sediment/pollutants / erosion/leaching / help pollination/seed dispersal;
 - l. Rain/moving water/ice may cause weathering;
 - m. Oceans dissolve carbon dioxide/major carbon sinks;

Note to examiners: Do not credit social or economic benefits of water.
Do not credit water chemical properties, like cohesion, adhesion, capillary action, surface tension, hydrogen bonds, unless linked to above MPs.

- (b) Describe methods that could be used to measure the population of water snails in a pond.

[7]

Capture-Mark-Recapture methodology essentials:

- a. Mark snails caught (using standard marking procedure);
- b. Count total marked individuals;
- c. Release individuals into ecosystem;
- d. After a set period of time to allow mixing of marked snails...;
- e. ...repeat sampling procedure for a second time/ can do this multiple times;
- f. Count marked and unmarked individuals in recapture;
- g. Enter data into Lincoln Index to estimate abundance...;
- h. ... originally marked \times total caught in 2nd sample / marked in 2nd sample;
- i. If repeated sampling a 2nd sample, may average the estimates for a final estimate;

Data collection method & limitations: [3max]

- j. Identify random locations within area of pond/use a grid and random number generator / systematically choose the locations/habitats to study;
- k. Sample as large an area/habitat as possible;
- l. Employ standard sampling procedure at each location / e.g. stirring the net/scoop on pond bank/bottom for a specified time, ending with a scooping motion / may kick-sample before the netting / may use palm-leaf traps (or any other appropriate trapping method);
- m. Then pick/count snails by hand;
- n. Use a key to identify the snail species measured;
- o. Marking should be indelible and harmless;
- p. Prefer sampling during the season without births (usually summer/dry) / avoid season with many deaths (usually winter);
- q. Return individuals to habitat at end of investigation;

Note to examiners: *If any other valid method (e.g. quadrat sampling) is described, then again allow [3max] for the collection of data & limitations of methodology, but for full credit, there needs to be a clear description of how abundance of pond snails is calculated.*

Add credit from all methods described.

No mark for just naming a method.

Do not credit biomass/productivity methods.

- (c) With reference to named examples, to what extent might the design and management of conservation areas contribute to their success.

[9]

Answers may demonstrate:

- **understanding concepts & terminology** of habitat/species conservation; biodiversity; national parks; wildlife reserves/refuges; MPAs; zoos; location of conservation area; buffer zones; wildlife corridors; shape, size/number; edge effects; proximity of protected areas to each other; proximity to human influence; surrounding land uses; Man and Biosphere reserves; habitat diversity; ecotourism; funding; flagship/keystone/umbrella species, reintroduction; niche/habitat requirements; fragmentation; monitoring/estimating diversity/abundance; threats: habitat degradation/loss; introduction of invasive species, pollution, overharvesting; hunting/poaching; NGOs; governmental intervention; community support; conflicting land uses;
- **breadth in addressing** a range of design aspects AND management strategies applied in various conservation areas **and linking** these to how they effectively address issues of habitat and/or species preservation.
- **examples** of conservation areas, outlining design principles, management strategies, cases of successful protection of named species & habitats.
- **balanced analysis evaluating** extent to which the layout and management of various named examples of conservation areas located in different countries and biomes, involving a range of stakeholders (government, NGOs, local communities, investors, industries), addressing diverse threats to biodiversity contributed positively or negatively to the aims of conservation.
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. Even if a conservation area is perfectly designed -large, continuous, round, including diverse niches, interconnected though protected corridors with other similar areas, spread over a large geographical area- eventually it is the commitment and collaboration of governments, NGOs and local communities that may guarantee its long-term success.

Please see markbands on page 23.

6. (a) Outline **four** advantages for a country changing from fossil fuels to renewable sources of energy. [4]
- a. Reduces greenhouse gas emission from combustion of fossil fuels;
 - b. Reduces NO_x and SO_x emissions causing acid rain;
 - c. Reduces photochemical smog (also secondary formation of tropospheric ozone) due to emissions from burning fossil fuels;
 - d. Reduces environmental impacts (e.g. groundwater pollution, oil spills) from extraction/transportation of fossil fuels;
 - e. May reduce economic dependence on imports from other countries / on fluctuating prices of fossil fuel/energy crises;
 - f. May reduce territorial claims over fossil fuel resources/causing conflicts between neighboring countries / may alleviate political/economic tensions/instability;
 - g. Ensures greater energy security/self-sufficiency / e.g. if power grid is diversified, then increases reliability of a country's energy supply / prepares countries for eventual depletion/scarcity of fossil fuels;
 - h. Contributes to meeting internationally agreed targets of sustainable development (Paris protocol) / would reduce carbon footprint / would make country more sustainable;
 - i. Economic/social benefits of using/developing new technologies/ new/more jobs/ novel business prospects/empower people in poor areas / selling more tradable carbon permits;
 - j. May improve health of people (by decreasing air/water pollution) / economic benefit from less health issues;
 - k. Use of biomass energy reduces landfills;
 - l. Less pollution may allow habitat/species recover;

Note to examiners: Do not credit "increased reliability", unless properly explained (see MPg), as renewable energy sources are notorious for their "intermittency"; even geothermal is not more reliable than fossil fuel.

- (b) Evaluate **two** strategies for preventing eutrophication.

[7]

Strategy: [1max]

- a. Avoid use of inorganic fertilisers by education / switch to organic fertilisers via taxes/laws;

Pros: [2max]

- b. Eliminates origin of problem;
c. Organic fertilisers may be gained cheaply from natural waste;
d. Organic fertilisers provide slow release of nitrates/phosphates;
e. Education should have long-term impacts, especially if addressed to young generations;
f. Reduces GHG emissions/energy use during manufacturing of synthetic fertilizers;

Cons: [2max]

- g. May reduce productivity;
h. Involves a change of farming practice that may not be popular;
i. Leads to inflation/passing higher prices to consumers;
j. Educational programs/laws/taxes need to be enforced effectively;
k. Taxes/laws may be unpopular/considered coercive;

Strategy: [1max]

- l. Plant buffer zones to prevent agricultural run off;

Pros: [2max]

- m. Prevents nitrates/phosphates from entering nearby water bodies;
n. Increases biodiversity of farmlands;
o. Low cost solution;
p. Reduces soil erosion;

Cons: [2max]

- q. Requires considerable labour in short term;
r. Takes up space that could be used for more crops;
s. Heavy rainfall may overwhelm the buffer zone;
t. Does not eliminate origin of pollution;

Strategy: [1max]

- u. Phosphate stripping/nitrate removal at sewage/domestic wastewater treatment facilities;

Pros: [2max]

- v. Prevents phosphates/nitrates from reaching water bodies / completely removes from water;
w. Biological removal decreases sludge production;
x. Physical removal recovers phosphorus for re-use;
y. Some methods of phosphate stripping are considered cost-effective / fit for LEDCs, too;

Cons: [2max]

- z. Chemical precipitation/removal results in more toxic sludge;
aa. Usually require high initial investment / high operational costs / large-scale facilities;
bb. Require continuous monitoring / high expertise;

Note to examiners: Credit any valid advantage or disadvantage of **up to two** valid strategies. If more than two strategies are evaluated, credit the two that gain the more marks and ignore the other strategies.

Do **not** credit similar evaluative KSs for both strategies (e.g MPm & MPv will get mark once, but allow both MPb & MPt).

Do **not** credit restoration strategies.

To get the strategy mark, there should be a little more than just naming; especially for strategies like “construction of a dam” or “scrubbers reducing NOx” there should be outline of how these strategies would prevent eutrophication. Still allow ECF.

- (c) ‘Steady state equilibrium’ is a concept relevant to many systems. Justify its usefulness in understanding the sustainability of named systems.

[9]

Answers may demonstrate:

- **understanding concepts & terminology** of steady state equilibrium; short-term oscillations; long-term stability; systems approach; holistic view; open/closed systems; storages; flows; balanced inputs & outputs; balanced processes (transfers & transformations); laws of thermodynamics; tipping points; stable equilibrium; negative & positive feedback; ecosystem resilience; sustainable development definition; life-supporting services; food webs; population dynamics; S curve; carrying capacity; cycles of matter; flow of energy; mean global temperature; natural income; natural capital; MSY (maximum sustainable yield); environmental/social/economic sustainability;
- **breadth in addressing** the concept of steady state equilibrium (SSE) as applied to a range of natural and/or anthropogenic systems **and linking** to how this concept contributes to understanding sustainability as the quest of human societies to achieve long-term stability (meeting the need of future generations), despite inevitable short-term fluctuations in the process of meeting present needs.
- **examples** of different steady state equilibria occurring in a range of natural & anthropogenic systems, e.g. predator-prey cycles, fluctuation around carrying capacity, disturbance-prone ecosystems, nutrient cycling, timber harvesting, fisheries, crop/meat production, energy use, water extraction, etc. or unsustainable examples deviating from SSE; e.g. deforestation, overfishing, global climate change, pollution, habitat loss, overconsumption etc..
- **balanced analysis providing evidence supporting** the idea that the concept of ‘steady state equilibrium’ is useful in understanding how various aspects of sustainability may be achieved in a range of systems. [**Note to examiners:** *not how equilibrium is achieved in sustainable systems or how unsustainable systems deviate from equilibrium/balance. Still, such examples are implicitly linked to the context of the question*].
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. Steady state equilibrium is inherent in the sustainable management and responsible use of natural capital. Short-term fluctuations are inevitable, as, for example, catching fish at a rate observing MSY, reduces temporarily the population, but soon it will regenerate through reproduction. Understanding that the important issue is to maintain the long-term stability of natural capital would help achieving sustainability of a system like wild fisheries.

Please see markbands on page 23.

7. (a) Outline the similarities and differences between “crude birth rate” and “natural increase rate”.

[4]

Differences:

- a. Crude birth rate (CBR) is the number of (live) births per 1000 individuals / CBR focuses only on births;
- b. Natural increase rate (NIR) is the CBR – CDR divided by 10 / NIR is expressed as a percentage / NIR takes both births and deaths into account;
- c. NIR can be negative / CBR may assume only a positive value;
- d. Can estimate doubling time, if divide 70 by NIR;
- e. NIR is a more accurate/direct indicator of population growth;

Similarities:

- f. Both involve number of births in their calculation;
- g. Both refer to mean values;
- h. Both give some indication of potential for growth;
- i. Both are (usually) annual values;
- j. Same data sources/data collection methods for both (census, civil registration, household surveys);
- k. Both are required for assigning a country into a specific stage of the Demographic Transition Model;
- l. Both exclude immigration and emigration.

Note to examiners: Allow [3max] if only differences or only similarities.

- (b) Evaluate water taxation and grey-water recycling as a means of sustainably managing water supply.

[7]

Water taxation (4 max):

Pros: [3max]

- a. Aims to reduce water consumption;
- b. Attaches more realistic cost/value to water supply / internalizes environmental cost;
- c. Distributes cost of water supply according to use;
- d. Provides funding for sustainable management projects / improving water infrastructure/water conservation technologies;
- e. Can be adjusted according to supply/demand;

Cons: [3max]

- f. Maybe unpopular with consumers/stakeholders / consider unethical to tax a basic need;
- g. Requires continuous policing/management;
- h. May increase social inequality / poor individuals may resort to unsafe water for drinking in order to avoid taxation / while wealthy parties might become wasteful in use of water;
- i. Dependent on accurate water metering / may be expensive to construct measuring and billing infrastructure (especially in LEDCs and/or rural areas);

Grey-water recycling (4 max):

Pros: [3max]

- j. Reduces demand for fresh inputs of water;
- k. Maintains healthy/safe water supply;
- l. Reduces water bill;
- m. Less water wasted into septic tanks/wastewater treatment;

Cons: [3max]

- n. Requires appropriate technological development / professional guidance from experts;
- o. Costly to install and maintain;
- p. Errors in treatment may render water non potable / impose health risks / lead to smelly water / thus some people may oppose its use;
- q. May increase water consumption / lead to wasting mentality;

Note to examiners: Credit other valid points.

(c) To what extent can population policies lead to a stable human population?

[9]

Answers may demonstrate:

- **understanding concepts & terminology** of population policies; development policies; anti-natalist/pro-natalist; China's one child policy; female emancipation; gender equality; contraception; child benefit/child tax; population pyramids; population momentum; demographic transition; sustainable development; limiting factors; carrying capacity; S-J curves; DTM; demographic tools (CBR, CDR, TFR, DT, NIR);
- **breadth in addressing** a range of population and development policies **and linking** them to their impact on the stability of various human populations and comparing their success.
- **examples** of relevant national & international population policies and their degree of success in stabilising the population;
- **balanced analysis** comparing various population policies from a range of countries and **evaluating** the extent to which these policies managed to effectively stabilise the population on which they were implemented.
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. Economic incentives and disincentives can be effective in curbing the growth of human populations, but, generally, the most effective means of stabilising growth seems to come naturally with the development of populations, as evidenced by the relatively stable MEDC populations.

Note to examiners: *There is a definition in literature of stable population having stable (=constant) demographics, i.e. CBR, CDR, age structure, but also NIR! Thus it contradicts the definition of a stable population as one with a constant population size (CBR = CDR). Do not penalize the former, although, most probably will lead to convoluted analysis. A response should not earn the higher MBs, unless addressing the latter definition.*

Please see markbands on page 23.

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	<p>The response contains:</p> <ul style="list-style-type: none"> • 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	<p>The response contains:</p> <ul style="list-style-type: none"> • 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	<p>The response contains:</p> <ul style="list-style-type: none"> • 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.