Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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Environmental systems and societies

Standard level

Paper 2

18 pages

Section A

1. (a) Using **Figures 1(a)** and **1(b)**:

(i) State **one** country with no expected change in water stress between 2013 and the 2040 prediction. **[1 max]**

Canada/Argentina/Russia/Saudi Arabia/Australia/Mexico/Brazil/India/UK;

Note: *Do not credit names from Fig1(a), e.g. Europe/Australasia, as these are not country names. Credit may be given for valid countries not labelled in Fig 1(b) e.g. Peru/Libya/Sri Lanka.*

(ii) State **one** difference in water scarcity between 2013 and the 2040 prediction. **[1 max]**

increased water scarcity in eg USA/France/Namibia/Spain/China;
increased water scarcity in some countries in sub-Saharan/southern countries in Africa/Middle East;
decreased water scarcity in eg Venezuela/Japan;

Note*: a single named country OR a named region AND the difference (increase/decrease) is required for* ***[1]*** *mark. Credit reference to countries not named in Fig1(b), as long as difference is clearly identified.*

(b) Outline how climate change may affect the availability of freshwater resources. **[2 max]**

increased temperatures/evaporation may lead to increased loss of soil water/aridity/desertification;
increased temperatures/evaporation may cause loss/salination of water supplies lakes *etc*;
changes in precipitation/increased frequency of El Nino events may lead to increase/decrease of water supply/droughts;
rising sea levels may lead to inundation/salination of ground water;
increased temperatures may cause melting of glaciers/ice caps leading to increase/decrease of water availability (i.e. by increased input to lakes/run-off to oceans);

Note: *to gain credit, each statement should clearly identify the "climate change" element (e.g. increased temperature / decreased precipitation / sea level rise / increased monsoons/typhoons/hurricanes / higher frequency of El Nino / increased evaporation), AND its effect to freshwater resources (e.g. increased supply by melting ice sheets of mountaintops / reduced stream discharge / reduced amount of water in lakes / increased soil aridity / increased salinity / increased or decreased groundwater supply).*

(c) Describe **two** water management strategies that can reduce water scarcity. **[2 max]**

desalinisation to increase available supply;
use of water-saving agricultural strategies *eg* drip irrigation/terracing;
aqueducts/pipelines to move water from water-rich to water-scarce areas;
education/campaigns/increased charges so citizens use less water;
reduce production of crops with high water demand e.g. meat/dairy/almonds/cotton;
use of technology to collect/recycle/reuse water e.g. dams/rainwater/grey-water;
clean-up/restoration of polluted freshwater bodies/lakes/aquifers;

Note: *Alternative valid responses may be credited but to gain credit they must identify appropriate strategy and at least indicate its relevance in addressing water scarcity as in MPs above.*

Only credit valid "management" strategies as opposed to personal behaviour choices eg taking short showers/turning taps off.

(d) (i) Describe the overall trend for sandy soil shown in **Figure 2**. **[1]**

as amount/% of vegetation increases the amount of evaporation from soil declines / negative correlation between evaporation and vegetation cover;

(ii) Calculate the change in evaporation from clay soil when the vegetation cover changes from 50 % to 100 %. **[1]**

20 − 5 = 15; *Allow 14–16*

Note: *Response needs to show calculation to gain credit.*

(e) Outline **two** reasons why loam soils are the most productive for plant growth. **[2]**

because it is a good balance of sand and clay avoiding each of their more negative qualities;
not prone to waterlogging / has good drainage (compared to clay);
allows easy root penetration / workability (compared to clay);
allows good aeration / oxygen supply to roots (compared to clay);
stable / not prone to wind erosion (compared to sand);
retains moisture (compared to sand);
retains nutrients/minerals (compared to sand);

2. (a) Identify **two** possible consequences for life on Earth resulting from the depletion of stratospheric ozone. **[2 max]**

increased skin cancer/melanomas/skin aging/mutations;
increased eye abnormalities/cataract/photo allergy/blindness;
weakening of immune systems;
disrupts plant growth / damage leaves thus reducing photosynthesis / loss of plant species;
damage to phytoplankton in oceans / reducing base of food web;
causes death of krill/zooplankton/amphibian larvae reducing diversity/food for higher trophic levels;

Note: *Do not give credit for responses simply stating it leads to increased UV (Q asks for impact on "life"). Do not credit responses identifying consequences linked to GW. (Increased UV has negligible DIRECT impact on GW …however, INDIRECTLY, eg by reducing primary productivity, it may contribute to GW, but such an indirect link would need to be explicitly stated to gain credit).*

(b) Outline why the Montreal Protocol may be considered the world's most successful environmental treaty. **[2 max]**

clear evidence of successful reduction in CFC use/ozone depletion/size of ozone hole;
protocol prompted production of alternatives to replace CFCs allowing smooth phase-out;
financial assistance was offered to assist in phase out of CFCs (Multilateral Fund);
demonstrated it was possible for governments to work multilaterally;
led to changes in the behaviour of individuals and societies;
very large number of signatories;
secured binding environmental agreements/legal commitments with which countries/industries complied;
there was a widespread/common acceptance/understanding of the effect of CFCs (amongst scientists/public/politicians);

Note: *Simply stating "CFCs were banned" or "banning of CFCs" is not sufficient for credit.*

(c) Outline why governments agreed to phase out the use of HFCs from 2019 in the Kigali Amendment to the Montreal Protocol. **[2 max]**

because HFCs are bad for climate/contribute to global warming;
realisation that environmental issues need to be addressed at an intergovernmental level;
realisation that changes in behaviour are necessary to protect the environment in the future;
in response to development in scientific understanding of issue;
rich countries agreed to provide financial assistance for poorer countries to phase out HFCs;
because technological development has found alternatives to HFCs;

(d) (i) Identify **one** advantage of staggered dates for the phasing out of HFCs for countries at different levels of economic development. **[1 max]**

allows less developed countries more time to raise necessary funding;
allows less developed countries time to develop/import necessary technology/infrastructure;
allows less developed countries time to introduce significant changes in policy/governance;
deadlines are more reasonable so more countries are likely to commit to change;
issue can start being addressed sooner by more developed countries;

(ii) Identify **one** disadvantage of staggered dates for the phasing out of HFCs for countries at different levels of economic development. **[1 max]**

may prolong achievement of complete/global phasing out;
may reduce action to a lower priority than necessary in some countries;
may prompt some multinational companies to relocate to countries with later deadlines;
developed countries, given shorter deadlines, may be more dependent on HFCs so have more to do;
countries avoiding early phase out may benefit from production/trade of HFCs;
cost of early change/application of untested substitutes may lead to conflict from more developed countries;
conflicts arising from different treatments between countries may undermine overall agreement;

3. (a) Identify **one** reason why most plastics may be considered more serious pollutants than other forms of solid domestic waste. **[1 max]**

plastics produced in huge quantities/very widespread (due to usefulness/versatility);
plastics are non-biodegradable / may take hundreds of years to fully degrade / generational problem;
marine animals may be killed through entanglement/suffocation/ingestion leading to starvation;
degraded smaller particles can be easily and widely dispersed;
degraded plastic may become more toxic by absorbing other toxins/releasing POPs;
microparticles can be absorbed by species causing biomagnification/damage to food chains;

(b) Describe a strategy for the removal of plastics from the Great Pacific Garbage Patch. **[2 max]**

map distribution of plastics using satellite imaging;
develop technological means for collecting plastic debris (floating booms/appropriate nets);
achieve financial support from UN/wealthy countries/NDOs;
get political support from all countries bordering the relevant oceans;
solicit assistance of fishing industry in using boats/manpower for collection
shipping of waste to countries that can recycle the waste;

Note: *No mark for strategies aiming at reducing the amount of plastics released (eg stop using disposable plastics) or preventing their release (eg efficient recycling procedures)*

(c) Explain why the data in **Figure 6** show no correlation between plastic consumption and plastic waste deposited in ocean for the countries listed. **[4 max]**

laws/policies against depositing plastic in sea may be less stringent/well-enforced in some countries (*eg* China);
some countries may have greater discharge from rivers into sea (*eg* China);
some countries may have greater population densities near to coast (*eg* India/China);
some countries may have more efficient garbage disposal/recycling systems (*eg* Japan/USA);
industrialisation involving plastic production/use may have higher priority in some countries (*eg* China/India);
estimated data may be inaccurate/unrepresentative/based on false assumptions;
data may be politically biased/not verified independently;

Section B

Part (c) questions in Section B are all to be assessed using the markbands on page 18 with the guidance given below for each question.

4. (a) Outline **two** ecosystem services in a named biome. **[4]**

Examples may include:

Tundra:
permafrost/glaciers in tundra;
…provides important storage in hydrological cycle;
ice in tundra provides reflective surface/increases planetary albedo;
…thus moderating global temperatures;
Wetlands:
decomposers/high productivity in swamps/wetlands;
…provides filtration of inorganic nutrients / water purification;
storage of water in wetlands;
…prevents flooding / provides ideal resting grounds for migratory birds;
Tropical rainforests:
high biodiversity in TRF;
…promotes ecotourism/recreation;
high rate of photosynthesis in TRF;
…maintains balance of O_2/CO_2 in atmosphere;
Boreal/temperate forests:
tree populations in boreal/temperate forests;
…prevent soil erosion on mountainsides;
forest canopies in forests;
…provide shade/shelter/habitat for diversity of species;

Note: *Numerous valid examples can be credited, but to gain full credit (2 marks per service) candidates must identify relevant component of biome* ***[1 mark]*** *and outline the service it provides* ***[1 mark]*** *as in MPs above.*
Be careful only to credit "services" (maintenance/establishment of favourable conditions) and not "goods" (consumable/harvestable/physical products).

Award ***[2 max]*** *if no biome is identified. If more than one biome is given, credit only highest scoring biome addressed.*

(b) Explain the causes, and the possible consequences, of the loss of a named critically endangered species. **[7]**

*Causes **[4 max]** could include:*
habitat loss / deforestation;
habitat degradation / pollution;
narrowly distributed / endemic;
poaching / overhunting;
illegal trafficking of species;
disease;
small population size/gene pool / inbreeding;
specialised niche;
slow reproduction rate / specialised reproductive behaviour;
high trophic level/top predator;
low/negative cultural value;
influence/competition/predation from invasive species;

*Consequences **[4 max]** could include:*
loss of an aesthetically attractive organism;
loss of ethically significant life / breach of biorights;
loss of biodiversity;
increase in organisms upon which the species fed or competed with;
decline in other organisms due to loss of food source;
if keystone species, widespread impacts/cascade effects on food chains/ecosystem;
economic costs from loss of ecosystem services provided by the species;
economic costs from loss of tourism opportunities;
social impacts on local culture as important/significant cultural loss;

Accept reference to decline of any species that is endangered, critically endangered or currently extinct.
If more than one species is addressed only credit the highest scoring example.

***Note:** MPs given above need to be embedded in a valid case-study/account of a named species to gain full credit and not simply listed as bullet points as per MPs. e.g. The distribution of thylacine/Tasmanian tiger became limited/endemic to Tasmania in early 20th century (MP3); As it was thought to be a threat to sheep farming, it was hunted (MP11); bounties were given to promote the level of hunting (MP4). The introduction of domestic dogs spread disease amongst thylacines (MP6) leading to further decline.*

*If MPs are simply given without such context of a **named** species and its specific issues then give **[2 max]** for causes and **[2 max]** for consequences.*

(c) Discuss, using examples, whether habitat conservation would be more successful than a species-based approach to protecting threatened species. **[9 max]**

Answers may demonstrate:

- **understanding concepts & terminology of** habitat-based methods for conservation; species-based methods for conservation; international and national protection; international, national and local conservation organisations; ecosystem services; food chains and food webs; succession; threats to biodiversity; pollution consequences, *eg* bioaccumulation and biomagnification; threats from climate change; food production systems; human population growth; sustainable development; EVSs;
- **breadth in addressing and linking** range of threats to biodiversity; scale of different threats; challenges in LEDCs to develop sustainably; consequences of different EVSs; variety of habitat-based methods for conservation; variety of species-based methods of conservation;
- **examples** of both habitat- and species-based methods; threatened and protected areas and species; organisations involved in conservation;
- **balanced analysis** of the varying success of habitat and species conservation to protect threatened species;
- **a conclusion that is consistent with, and supported by analysis and examples given** *eg* success of the conservation of threatened species will depend on the context, nature of the threats and a combination of strategies is likely to be necessary with both habitat and species approaches used. If the habitat is not conserved and restored, a species whose population has been increased using species-based methods, will not survive in the wild;

5. (a) Outline the factors that lead to different environmental value systems in contrasting cultures. **[4 max]**

Factors may include:

cultural *ie* some cultures place a high value on nature and thus have a more ecocentric EVS;
religious *ie* some religions deify certain organisms/landscapes and thus have a more ecocentric EVS;
economic *ie* some would argue that more economically wealthy societies tend towards a more technocentric/anthropocentric EVS;
socio-political *ie* some would argue that a society with a strong social political movement would tend towards a more anthropocentric EVS;
experience/history *ie* societies that have experienced anthropogenic disasters may become more prone to adopt ecocentric value systems;

*Award **[3 max]** if only one category of EVS is addressed (question asks for "contrasting cultures").*

***Note:** Full credit can be given where candidate gives a specific example to outline link between factor and EVS. However, if factors are simply named/listed without any explanatory outline broadly linking them to EVS, then award just 1 mark for every TWO valid factors identified up to **2max**.*

(b) Explain why the harvesting of a named aquatic species may be controversial. **[7]**

Arguments against may include:
ethical issues arise over biorights of the aquatic species;
harvesting may contravene international conservation agreements;
species may be endangered/threatened with extinction;
some may consider the harvesting method as cruel/unethical;
if unsustainable, whole regions of the ocean may deplete of fish;
ecocentrics may promote veganism and oppose harvest of animal species;
ecocentrics would oppose any large scale harvesting/food production systems;

Arguments in favour may include:
harvesting necessary for some societies for subsistence/survival;
whole economies may be based on harvesting aquatic species;
fishing as a recreation/hobby brings people closer to nature;
aquaculture may allow harvesting without endangering the species;
if harvesting is within sustainable limits it poses no threat to others;
anthropocentrics would support sustainable harvesting;
technocentrics would support achieving maximum yield/greatest economic return;
.and whatever technology/harvesting method will be most efficient in achieving this;

eg whales
hunting methods are cruel;
unethical to kill animals;
modern technologies are very efficient allowing no chance to the whale to escape (so it's "unfair");
populations are declining / many whale species are now endangered;
conflicts arise over territorial rights among fleet of different nations;
other species (eg dolphins) may be killed in the process / by-catch kill;
large parts are thrown back to sea (so wasting the kill);
increase in illegal whale hunting of endangered species (along with hunting of non-endangered species);
usually harvesting is not sustainable (as it is economic profit that counts);
in most countries (Norway, Japan, Iceland) whaling is not necessary for their subsistence nowadays;
conflicts arise with ecocentric NGOs opposing whaling (eg Greenpeace);

*Award **[6 max]** if no named aquatic species.*
*Award **[4 max]** if response only addresses “arguments in favour” (“controversial” strongly implies arguments against).*
If more than one species is addressed, credit only the highest scoring example.

(c) Discuss strategies that can be used to improve the sustainability of food production systems. **[9 max]**

Answers may demonstrate:

- **understanding concepts & terminology of** terrestrial and aquatic food production systems; sustainability; MSY; ecological footprint; natural income & capital; quotas; harvesting methods; organic farming; pest management; integrated aquaculture; monoculture v polyculture; food choice; social equality; soil degradation; water pollution; soil conservation strategies;
- **breadth in addressing and linking** technological and management strategies of terrestrial and aquatic food production systems with aspects of sustainability in terms of yield, environmental impacts, conservation, climate change, economics, food choices and social development and in the context of a range of geographical locations, social settings and EVSs.
- **examples** of named food production systems and strategies;
- **balanced analysis** evaluating a range of strategies in a range of food production systems (and social contexts) and how effective they each may be in improving sustainability along with their limitations and counterarguments;
- **a conclusion that is consistent with, and supported by analysis and examples given** *eg* the strategies which can be employed to improve the sustainability of a food production system may be viewed differently by various EVSs and it may take a more anthropocentric approach to balance the success of ecocentric strategies such as diet change and education about this, with the careful, monitored implementation of technological strategies such as the use of genetically modified organisms;

6. (a) Outline how feedback loops are involved in alternate stable states and the tipping points between them. **[4 max]**

negative feedback loops occur when the output of a process inhibits or reverses the same process;
…thus inhibiting change/deviation / maintaining a system in equilibrium/one stable state;
positive feedback loops occur when the output of a process accelerates that same process;
…thus amplifying changes/deviations / driving system away from its equilibrium/stable state;
excessive change/deviation may drive system beyond its tipping point;
…when it will adopt a new equilibrium/alternate stable state;

Credit any of the above MPs if they are clearly shown by means of an annotated diagram or named example.

(b) In 2016, the Earth's atmospheric levels of carbon dioxide reached 400 ppm. Suggest the potential impacts of high levels of greenhouse gases, on human societies in different locations. **[7 max]**

Impacts may include:
increased mean global temperature causing increased use of A/Cs (especially in developed countries);
greater frequency/intensity of extreme weather events causing damage to infrastructure (especially in cities);
long-term changes in climate/weather patterns requiring cultural changes/adaptation in societies;
ocean acidification killing plankton/reducing fisheries (especially significant for coastal populations);
melting permafrost increasing productivity/arable land/water availability (for tundra populations);
decreased water availability/desertification leading to migration/relocation (especially for tropical populations);
biome shifts reducing/enhancing crop productivity (especially significant in crop-growing areas);
biodiversity loss reducing aesthetic value of ecosystems (significant for tourism-dependent societies);
disruption of ecosystem services causing increased flooding (particularly in high rainfall locations);
rise in sea level causing coastal erosion (especially significant to areas dependent on coastal tourism);
coastal inundation causing salinization of underground aquifers/soils (especially for coastal populations);
wider spread of tropical diseases (especially significant for previously sub-tropical areas);

*Award **[4 max]** if there is no reference to different locations (as in brackets above). Do **not** credit effects of high levels of greenhouse gases that are <u>not</u> linked to some impact on human societies, at least implicitly as in examples above.*

(c) Discuss the consequences of changing global per capita meat consumption on the conservation of ecosystems and biodiversity. **[9 max]**

Answers may demonstrate:

- **understanding concepts & terminology of** terrestrial and aquatic food production systems; diet and food choices; ecological efficiency; food chains/pyramids; habitat destruction; pollution; hunting; greenhouse gases; climate change; community based conservation; commercial farming; livestock waste; eutrophication; buffer zones; sustainability; human population growth and carrying capacity; ecological footprints; EVSs;
- **breadth in addressing and linking** changes in meat consumption with cultural values, EVSs, food choices, climate change, ecological footprint, habitat degradation/loss, pollution, threats to biodiversity, conservation efforts;
- **examples** of impacts of different food production systems on range of ecosystems and biodiversity;
- **balanced analysis** of the extent to which increase and decrease in meat consumption (in different societies) impacts ecosystems and biodiversity and the extent to which these consequences can be limited/mitigated/justified;
- **a conclusion that is consistent with, and supported by analysis and examples given** *eg* Increased meat consumption clearly has many negative impacts on the conservation of ecosystems and biodiversity because of the associated habitat loss and degradation through pollution and climate change, although these impacts can be significantly mitigated, particularly for populations where food choices are limited, through more sustainable farming practices.

7. (a) Outline how demographic tools can be used to study a human population. **[4]**

demographic tools provide quantitative measures/indicators of changes occurring in the dynamics/growth of populations;
…and can be useful in making comparisons between populations / predictions of future changes;
Crude birth rate (CBR) is the number of live births per 1000 population per year / indicates rate at which births are occurring in a population;
Crude death rate (CDR) is number of deaths per 1000 population per year / indicates rate at which deaths are occurring in a population;
Total fertility rate (TFR) is the average number of children a woman would have in her lifetime in a given population / indicates the rate at which women are producing children;
Natural increase rate (NIR) is the crude birth rate minus the crude death rate / indicates the rate at which a population is growing (ignoring migrational changes);
Doubling time (DT) is the number of years a population will take to double in size at its current rate of growth / indicates how quickly a population is growing compared to its current size;
Demographic Transition Model (DTM) is based on historical population trends showing how populations tend to go through stages of changing birth and death rates as they develop economically / it can be useful for identifying a country's stage of development/making predictions about its future growth;

(b) Urban air pollution can become a problem as human populations develop. Evaluate urban air pollution management strategies at the three levels of intervention. **[7 max]**

*Level 1: altering human activity **[3 max]**:*
reducing transport eg promoting public transport/carpooling/regulating private vehicle use;
using alternative/renewable energy sources / promoting availability of electric vehicles;
development/use of more energy efficient appliances/housing / green architecture;
Evaluations:
large investment required to facilitate public transport use/e-vehicle use;
if electricity for transport comes from fossil fuels than simply moving the problem somewhere else;
requires education/campaigns to overcome human intransigence to changing behaviours;
prevents pollution right at source;

*Level 2: controlling release of pollutant **[3max]**:*
use of catalytic converters on transport;
use of scrubbers on industries;
introduce legislation/regulation/for emissions/pollutant levels;
Evaluations:
technological fixes can be very effective/easy to enforce;
wealthy companies may simply budget for fines and continue to pollute;
does not require change in human activities;

*Level 3: clean-up and restoration of damaged systems **[3 max]**:*
re-greening areas through tree planting/town parkland;
liming of acidified urban water bodies;
restoration of eroded architecture;
medical treatments for consequent health conditions;
Evaluations:
helps to maintain biodiversity/aesthetic value;
only of short-term value / does not prevent ongoing damage to systems;
can be very expensive processes;

*Award **[4 max]** if no evaluative statements have been given.*
Do not credit examples/statements relating to pollution that are clearly not "urban" and/or "air" pollution.

(c) Examine the driving factors behind the changing energy choices of different countries using named examples. **[9 max]**

Answers may demonstrate:

- **understanding concepts & terminology of** energy choices and security; renewable energy; solar; biomass; hydropower; wind; wave; nuclear; availability and reliability of energy supply; scientific developments; economic considerations; cultural factors; political dependencies; climate change; urban air pollution; acid deposition; water pollution; human population dynamics; ecological footprint; sustainability; EVSs;
- **breadth in addressing and linking** driving factors, including political, scientific, socio-economic, environmental, geographical, population dynamics, technological and cultural factors, with changes in energy choices for a range of countries;
- **examples** include a range of countries with various reasons/driving factors for changing their energy choices;
- **balanced analysis** how and to what extent driving factors for changing energy choices differ or are similar in a range of countries.
- **a conclusion that is consistent with, and supported by analysis and examples given** *eg* Although local parameters in terms of geography, economics and cultural values create a diverse array of factors affecting change in energy choices amongst different countries, the global increase in awareness of climate change and its relationship with fossil fuel use has led an increasing number of countries to move towards more sustainable energy sources.

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	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.