Diploma Programme
Programme du diplôme
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Markscheme

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Environmental systems and societies

Standard level

Paper 2

18 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 category with the lowest approximate percentage of threatened species in **Figure 1(a)**. **[1]**

bony fishes;

(b) Outline **two** reasons why amphibians have the highest approximate percentage of threatened species, as shown in **Figure 1(a).** **[2]**

a. They require both aquatic and terrestrial habitats/specialised niches so more likely to be affected by habitat loss/limitations;
b. They have permeable/soft skin more vulnerable to disease/UV/pollution;
c. Few amphibians have great public/charismatic appeal attracting protection/conservation efforts;
d. They generally have very limited parental care so offspring more vulnerable / high mortality rate in offspring;
e. They often depend on small bodies of water that are particularly vulnerable to drought/global warming/human development of wetlands

***Note**: Only credit marks that are explicitly related to the vulnerability of **amphibians**. General factors such as habitat destruction, hunting or climate change alone are TV.*

(c) Using **Figure 1(a)**, state the approximate percentage of sharks and rays that are threatened. **[1]**

Accept any percentage in the range 31-34;

(d) Describe **one** reason why there is a lack of available data for sharks and rays. **[1]**

a. they are very mobile/migratory species;
b. the oceans are vast and difficult/expensive to do research in / they have a widespread habitat range;
c. difficult/dangerous species to capture and tag / rays have cryptic behavior;
d. they inhabit inaccessible regions;

(e) Outline **three** reasons why the trend for corals is different to the other categories shown in **Figure 1(b)**. **[3]**

corals …
a. are sedentary/cannot migrate (to avoid pollution or other risks);
b. are r-selected species so high mortality rates (in planktonic phase);
c. (have delicate symbiotic relationship) highly sensitive to small changes in abiotic conditions;
d. are impacted worldwide through ocean acidification (causing bleaching);
e. are impacted worldwide by global warming/climate change /warmer waters (causing bleaching);
f. inhabit areas with high human polluting activity such as urban waste/agricultural run-off/oil spills/aquaculture;
g. have value as souvenirs/trophy/collectors' items;
h. are fragile/easily damaged unintentionally (by boats/nets/storms etc);
i. have very slow growth rates (in sedentary phase);
j. have limited ranges/ocean depths/habitats where they can live;

Credit any response that is consistent with the increasing trend of extinction in corals.
*Do **not** credit "pollution" alone there must be reference to a relevant source of pollutant as in MPf*

(f) **Figures 1(a)** and **1(b)** are based on records for species diversity. Identify **one** other factor that may be measured to assess the diversity of life on Earth. **[1]**

a. genetic diversity;
b. habitat diversity;

*Do **not** accept "evenness/equitability" or "richness" they are already included within concept of species diversity*

2. (a) Describe the overall trend in the recorded annually averaged data shown in **Figure 2**. **[2]**

a. ozone initially declined;
b. ozone stabilized / began to increase slightly;

Note: *do* ***not*** *credit descriptions of the projected values*
Allow 1 mark for overall decline
Precise dates are not necessary for credit (i.e. accept change occurring around 2000).

(b) State **one** chemical responsible for the trend in the recorded annually averaged data between 1980 and 1990 shown in **Figure 2**. **[1]**

halons/CFCs/HCFCsHBFCs/N_2O/methyl bromide/methyl chloroform/carbon tetrachloride/ chlorine/bromine:

Note: *do* ***not*** *credit HFCs/ODSs*

(c) Outline **one** impact of low concentrations of stratospheric ozone on plants. **[1]**

a. cell damage on leaves / reduced leaf size/reduced plant growth/ photosynthesis;
b. reduced phytoplankton in oceans;

(d) Identify the year that stratospheric ozone is predicted to return to 1980 levels in **Figure 2**. **[1]**

Accept any year in range 2041-2043;

(e) Describe **two** reasons for the projected change in ozone levels after 2020 in **Figure 2**. **[2]**

a. Montreal Protocol resulted in unprecedented international cooperation to address loss of ozone (and its influence still continues);
b. banned use of CFCs/ phasing out of CFCs/ ozone depleting substances /refrigerants/aerosols/recycling of refrigerants;
c. alternatives to CFCs (HFCs/HCFCs) were developed reducing harm to ozone;
d. education/awareness campaigns led to changes in consumer preferences;
e. ozone reforms due to natural reversible chemical reactions/processes / ODSs eventually begin to break down/dissipate;

(f) Outline **one** factor that may affect the reliability of the model projections in **Figure 2**. **[1]**

a. oversimplification that does not take into account full range of factors;
b. hard to predict consumer/government/industry behaviour;
c. production and release of new ozone depleting substances;
d. countries not following the Montreal Protocol / black market ODSs;
e. difficult to obtain accurate data;

3. (a) State **one** storage of fresh water not shown in **Figure 3**. **[1]**

Lakes/rivers/glaciers/groundwater/aquifers/reservoirs/organisms other than plants;

(b) State **one** input of water into the atmosphere not shown in **Figure 3**. **[1]**

Evaporation (from inland waters/oceans/soil) / sublimation / water vapour from respiration/combustion;

(c) Describe the negative feedback mechanism by which cloud formation may moderate global temperature. **[2]**

temperature rises → more evaporation →clouds increase;
→more shade/albedo/more reflection of incoming solar radiation → temp decreases;

Credit valid responses that include details above in form of full sentences or accurate diagrams.
*Do **not** credit water being a GHG trapping outgoing heat or latent heat flow, as these are part of positive feedback. Do **not** credit to increased outgoing heat from Earth's surface (sensible heat flow) as this is due to lack of clouds (not formation).*
*Do **not** credit "more clouds → more precipitation => cooling effect", as this is, at best a regional impact*

(d) Evaluate the role of reforestation in the mitigation of climate change. **[4]**

Pros:
a. more trees absorb more CO_2 so reduce global warming;
b. reforestation simultaneously increases biodiversity;
c. requires minimal technology/labour/expense;
d. forests are naturally renewable carbon sink/indefinite lifetime;
e. reforestation requires minimal ongoing maintenance;
f. regulating local weather /decreasing extreme weather patterns;
g. protects against run-off/soil erosion/desertification;
h. it increases evapotranspiration which may increase cloud cover increasing albedo/mitigating warming

Cons:
a. it increases evapotranspiration so more water vapour/greenhouse gases/warming;
b. more trees reduce reflected heat into atmosphere/absorb more heat so increase warming;
c. it reduces land availability for agriculture/urban growth;
d. it is not feasible in all locations/habitats;
e. it requires large areas to make a significant difference;
f. can be an expensive/unpopular solution;
g. can take a long time/period of growth before it has significant impact on CO_2;

Award [3] max if only pros or only cons are given.
Pro MPh and Con MPa may contradict one another but both are valid hypotheses and deserve credit
*Do **not** credit vague responses like "improves air quality" or "reduces air pollutants"*

Section B

4. (a) Outline the transfers and transformations of energy as it enters and flows through the first trophic level of a food chain. **[4]**

Transfers: [3 max]

a. solar/light energy absorbed by leaves/chlorophyll/chloroplasts/plants;
b. stored as chemical energy in glucose/organic compounds/ATP;
c. chemical energy transported around plant/moved from leaves to other plant organs;
d. chemical energy in plant biomass eaten by herbivores/passed on to decomposers;
e. heat energy radiated from plant into atmosphere;

Transformations: [3 max]

f. conversion of light to chemical energy in photosynthesis;
g. conversion of chemical to heat energy in respiration / all metabolic processes release heat (heat loss);
h. conversion of chemical to heat energy through decomposition;
i. conversion of chemical energy to other forms of energy (e.g. kinetic) in various metabolic processes;
j. conversion of solar energy to electric energy in the photosynthetic apparatus;

*Do **not** credit reflection of light (albedo), as energy does not enter 1st trophic level.*

(b) Describe how the use of fossil fuels may impact the abiotic conditions of oceanic systems. **[7]**

a. CO_2/greenhouse gas emissions lead to increasing global/atmospheric temperatures;
b. higher levels of atmospheric CO_2 lead to more CO_2 dissolved in ocean water...;
c. ...which leads to ocean acidification / reduced pH;
d. increased global temperatures cause rise in ocean temperature...;
e. …also cause expansion/increase in volume of ocean/rising sea levels *(same MP if linked to melting of glaciers MPg)*;
f. ...also may increase algal growth, which absorbs more sunlight / making water even warmer / increasing oxygen availability in water (locally);
g. …also cause melting of ice caps/glaciers...;
h. … which, in turn, dilutes salinity of surrounding sea;
i. rising sea temperatures reduce solubility of gases/available oxygen [*no contradiction with local impact in MPf*];
j. changing salinity/temperatures will cause changes in ocean currents/conveyor belt;
k. oil spills may cause pollution/reduce light penetration...;
l. ...regionally reduced light penetration/killing of phytoplankton results in reduced oxygen levels (due to reduced photosynthesis) [*no contradiction with local impact in MPf*];
m. changing weather patterns/events may affect wind-driven oceanic currents;
n. lower pH may cause death of sea life (e.g. coral) which will decompose (aerobically), thus increasing CO_2 in oceans / or decompose anaerobically in deep ocean, thus increasing CH_4;
o. Increased GHGs/temperature may increase ocean evaporation leading to loss of water / increased salinity;

Note: *Do **not** credit mention of acid rain, NOx, SO_2 emissions affecting ocean pH.*
*Do **not** credit use of oil in manufacturing petrochemicals (e.g. plastics)*
Credit may be given for any other valid responses linking fossil fuel use to some abiotic change in oceans.

(c) With reference to named societies, to what extent are their energy choices affected more by their geographical location than the environmental impact of any energy resource? **[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 demonstrate:

- **understanding concepts & terminology** of renewable/non-renewable energies; wind; solar; hydro; geothermal; fossil fuels; global warming/climate change; acid deposition; ozone depletion; photochemical smog; oil spills; political/economic factors affecting energy choice; availability, cost, sustainability of each energy source; energy security etc.
- **breadth in addressing and linking** energy choices of a range of different countries in different locations to environmental impacts and local availability of energy sources.
- **examples** of named energy sources, and countries energy choices, and environmental impacts; etc.
- **balanced analysis evaluating** extent to which energy choice is determined more by location or environmental impact.
- **a conclusion that is consistent with, and supported by analysis and examples given** *e.g. Although worldwide there is increasing awareness of environmental impacts of energy sources like fossil fuel, the quest of energy security and economic prosperity may lead to continuous dependence on locally abundant fossil fuel reserves.*

Please see markbands on page 18.

5. (a) Outline how the principles of sustainability can be applied to the use of soil systems. **[4]**

a. sustainability is meeting current needs whilst not depleting potential to meet future needs;
b. any minerals extracted from soils by crops need replacement (e.g. organic fertilizer, crop rotation, land fallow);
c. humus content/decomposer communities need to be maintained/conserved (e.g. use compost, green manure crops, reduced tillage, agroforestry farming);
d. irrigation methods should be managed to avoid depletion of local water supply (e.g. drip irrigation, avoid over-irrigation);
e. irrigation methods should be selected to reduce leaching of minerals/run-off (e.g. sub-surface irrigation, avoid over-irrigation);
f. measures should be taken to prevent erosion of soil particles (by wind/water) (e.g. cover crops, terracing, contour ploughing/cropping, windbreaks);
g. soil texture should be maintained by avoiding excessive trampling (caused by heavy machinery, intensive livestock farming/overgrazing);
h. use of biological pest control in place of insecticides/toxins;

Credit any valid example, equivalent to above marking points, showing how a soil resource was replaced and/or recovered after its extraction, use or management and/or ensuring sustainable consumption and production.
*Do **not** credit reference to bedrock, mining ores and underground aquifers*.

(b) Explain how the process of succession leads to an increase in the fertility and resilience of soils**.** **[7]**

a. growth of pioneer species (soil bacteria and fungi) promotes weathering of rock;
b. death of colonizing species increases humus/organic content;
c. greater humus content/production of soil particles increase water-holding capacity;
d. dead organic matter promotes growth of decomposer community;
e. decomposers provide nutrient cycling/maintain available minerals;
f. growth of root systems provides stability/prevent erosion;
g. plant roots increases weathering of rock / humus formation;
h. burrowing animals (e.g. earthworms) improve soil texture / aeration;
i. increased animal community adds organic material (e.g. feces) for decomposition;
j. vegetation cover provides shade reducing evaporation losses;
k. greater diversity of plants leads to greater diversity of soil microbes further promoting weathering / adding minerals;
l. introduction of *K*-selected species leads to more stable ecosystems / soil system;
m. throughout the process of succession, soil is gradually becoming deeper;

(c) Compare and contrast a named terrestrial food production system with a named aquatic food production system in terms of their efficiency and environmental impacts. **[9]**

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Answers may demonstrate:

- **understanding concepts & terminology** of terrestrial and aquatic food production; sustainability, food chains/trophic levels; productivity; respiratory losses; harvesting efficiency; use of fertilisers/pesticides/antibiotics; methane production; genetic degradation through escapees; overfishing; desertification; etc.
- **breadth in addressing and linking** food production systems with a range of potential impacts on the environment and issues of efficiency.
- **examples** of aquatic and terrestrial food production systems along with examples of associated impacts.
- **balanced analysis evaluating** the relative efficiency and overall environmental impact of aquatic *vs.* terrestrial production systems.
- **a conclusion that is consistent with, and supported by analysis and examples given** *e.g. Most impacts arising from aquatic food production tend to be more localised than the global impacts associated with terrestrial farming although, in terms of energy, terrestrial farming tends to be more efficient through harvesting at lower trophic levels.*

Please see markbands on page 18.

6. (a) Outline **four** ways in which changes in the population of one species may reduce the carrying capacity of an environment for another species. **[4]**

a. growth of a predator/carnivore population may reduce carrying capacity (cc) for a prey species;
b. prey species may decline, reducing cc of predator;
c. introduction/increased population of a competitor species would reduce the cc of other competing species / increased human population encroaching on habitats results in reduced cc of many species;
d. spread of a parasite/pathogen/disease organism may reduce cc for a given host species;
e. a host species may decline, reducing cc for pathogen;
f. growth of a herbivore population may reduce cc of a plant species;
g. a plant species may decline thus reducing cc for herbivore species;
h. in a mutualistic/symbiotic relationship, the decrease in the population of one species would reduce cc for the other;
i. some species may evolve defence/resistance/adaptation mechanisms that decrease cc for predator/parasite/competitor species (respectively);
j. decline of an "ecosystem engineer species" (e.g. beavers, elephants) would decrease cc for many other species (in the same community); [*"keystone" species would earn credit only in the context of MPs on predation and mutualism*]

*Do **not** credit responses that give no indication of impact on carrying capacity e.g. "predation" or "species preying on other species" does not indicate for which species cc is reduced, so gains no credit.*
*Allow **[1 max]** for reference to human population (considered MPc).*
Credit may be gained through appropriate examples.

(b) Explain how natural processes may lead to the formation of new species. **[7]**

a. mutation/sexual reproduction increases genetic diversity in a population;
b. those individuals with (genetically determined) features best adapted/more fit to their habitat/environment;
c. ...will survive / survival of fittest;
d. …and will reproduce more successfully / leave a larger number of offspring;
e. passing on their offspring these favorable genes/traits;
f. favorable traits will dominate in population / gene frequency/genetic characteristics of a population changes over time;
g. a population may become divided due to plate tectonics/changing landscapes/ colonization of newly emerged habitats/islands;
h. ...leading to genetic isolation of parts/subpopulations;
i. the separated populations may undergo (divergent) evolution / under different selective pressures / in different habitats;
j. accumulating different mutations over generations;
k. the differences between separated populations may prevent them from interbreeding / when populations are unable to interbreed and produce fertile offspring they are considered separate species;
l. the process of natural selection led to speciation;

Credit may be gained through appropriate examples.

(c) Different environmental value systems will have different reasons for conserving species diversity.
Discuss how these different reasons may influence the approach a society takes to conservation. **[9]**

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Answers may demonstrate:

- **understanding concepts & terminology** of ecocentric/anthropocentric and technocentric value systems; biorights; intrinsic value; use and non-use values; deep ecology; cornucopian values; stewardship; *ex situ/in situ* conservation; keystone species; flagship species; reserves; zoos; breeding/re-introduction programmes; gene banks; etc.
- **breadth in addressing and linking** a range of value systems with different perspectives on the nature of living things/species and thus different conservation strategies and goals.
- **examples** of different value systems; different perspectives on living things and different conservation strategies.
- **balanced analysis** evaluating the relative merits and demerits of different value systems and associated conservation strategies toward an appropriate conclusion.
- **a conclusion that is consistent with, and supported by analysis and examples given** *e.g. The kind of value, be it economic, moral or intrinsic, that we attach to living things, will inform strategies we employ for conservation. Ultimately, however, economic value, though it can change with time, will be the most significant deciding factor in a community's choice of conservation strategies.*

Please see markbands on page 18.

7. (a) Outline **four** ways in which the geographical location of a human population may influence its ecological footprint. **[4]**

Populations may have lower EFs due to...

a. ...living in tropical regions where there is greater vegetation to capture C emissions;
b. ...living in regions with high land productivity (e.g. temperate grasslands) as less land is required to satisfy consumption rate;
c. ...living in regions with high rainfall (e.g. NW Europe, SE Asia) results in high replenishment rate of water sources;
d. …living in coastal regions with high potential for production of renewable energy (e.g. wind in Denmark, tidal in Sarawak, Malaysia)
e. ...living in mountainous (e.g.Tibet) or desert regions (e.g.Sahara) with harsh (climatic) conditions, which result in small population sizes;

Populations may have higher EFs due to…

a. …living in mountainous regions as high erosion/low productivity makes them less suitable for local farming;
b. …living in higher latitudes/altitudes as climate is often harsh and more energy is needed for heating;
c. …living in desert/semi-arid regions (e.g. North Africa, Central Asia) where there is limited fresh water available for agriculture and consumption;
d. …living in tropical/Mediterranean island regions that require high energy/imported food/water to support tourist industry;
e. …living in flat/plain regions (crossed by rivers) with optimal conditions for human settlements leading to high population sizes (e.g. Eastern China);
f. ...living in regions with large supplies of freshwater/lakes/glaciers (Great Salt Lake, USA) leads to increased water wastage;

Credit any valid points that connect location to consumption patterns (high consumption rate => high local EF) or local productivity (high production rate => low local EF) & impacts on environment (high impact => high EF).
*Do **not** credit different locations with similar EF arguments; e.g. "mountainous region with high wind potential for production of wind energy" and "windy island with high aeolian energy production".*
*Do **not** credit converse KSs; e.g. "mountainous regions more vulnerable to erosion" & "flatland less vulnerable to erosion".*

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(b) A wild population of herbivores may provide a sustainable resource for human consumption. Describe practical procedures for estimating the natural income from such a resource. **[7]**

a. natural income is the yield obtained from natural resources/capital;
b. to measure natural income of herbivores, one needs to measure net (secondary) productivity;
c. measuring annual change/increase in population size/biomass;
d. population would need estimating at start and again after end of year/given time period;
e. population can be measured using mark/release/recapture / Lincoln index;
f. a sample is caught using traps and marked;
g. they are released and given time to mix with whole population;
h. traps are re-set/second sample is caught to identify proportion marked;
i. total population is estimated using equation: n_1 x n_2 / n_m / number caught in 1st sample times total number caught in 2nd sample (after marking) divided by number of marked individuals in 2nd sample;
j. difference in population (divided by given time period) is the net productivity/natural income;

Note: *Credit can be given if equivalent procedures to measure change in biomass rather than population size are described.*

(c) To what extent do different pollution management strategies influence the ecological footprint of a human population? **[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 demonstrate:

- **understanding concepts & terminology** of ecological footprints; production of food and processing of wastes; the three levels of the pollution management model as presented in syllabus; altering activity/controlling release/clean-up and restoration; setting emission standards; monitoring; scrubbers; catalytic converters; carbon sinks; mitigation/adaptation strategies; etc.
- **breadth in addressing and linking** a range of pollution management strategies such as safe/green alternatives, end-of-pipe management, clean-up/restoration strategies and their specific implications for ecological footprints.
- **examples** of specific pollution management strategies adopted by named communities/locations and their impacts on ecological footprints.
- **balanced analysis of the extent** to which the pollution management strategy is increasing or decreasing the ecological footprint of a society.
- **a conclusion that is consistent with, and supported by analysis and examples given** *e.g. Pollution management strategies that alter human activities or control the release of pollutants may effectively reduce a community's ecological footprint but clean-up and restoration frequently involves an addition to the ecological footprint in order to process pollutants already released into the environment.*

Please see markbands on page 18.

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.