Environmental systems & societies SL

Timezone 2

To protect the integrity of the assessments, increasing use is being made of examination variants. By using variants of the same examination, students in one part of the world will not always be responding to the same examination content as students in other parts of the world. A rigorous process is applied to ensure that the content across all variants is comparable in terms of difficulty and syllabus coverage. In addition, measures are taken during the standardisation and grade awarding processes to ensure that the final grade awarded to students is comparable.

Contents

Grade boundaries

Standard level overall

Grade:	1	2	3	4	5	6	7
Mark range:	0-11	12-23	24-33	34-45	46-57	58-69	70-100

Standard level internal assessment

Grade:	1	2	3	4	5	6	7
Mark range:	0-4	5-8	9-13	14-16	17-20	21-23	24-30

Standard level paper one

Grade:	1	2	3	4	5	6	7
Mark range:	0-4	5-9	10-12	13-16	17-21	22-25	26-35

Mark range:

Standard level paper two

Grade:	1	2	3	4	5	6	7
Mark range:	0-6	7-13	14-18	19-26	27-33	34-41	42-65

Standard level internal assessment

The range and suitability of the work submitted

There was a mix of different types of IA work: surveys, data mining, field work and lab work. This may be due to schools being fully back to post-pandemic "normal" where field work and in-class laboratory work is feasible again. There are still a number of descriptive essays using secondary data and this is not appropriate for the criteria.

Common topics were: a connection between carbon dioxide/environmental footprint and gender or age. Freshwater and climate change were often part of data mining. The use of seeds and plants in the lab with various treatments.

Most teachers make comments either directly on student work, or the separate document. Teacher comments assist the moderators in making the judgment for the mark.

There was a range of data analysis techniques from ANOVA analyses to simple averages and percents.

The quality of secondary data investigations varied the most, usually with too little data being used. Also many surveys have poor questions and are often not well analyzed.

There were some scripts that were written in an essay style and therefore not suitable to be assessed against the criteria. Some scripts had no environmental issue being a health or another science focus.

Student performance against each criterion

Identifying the context

The majority of RQs were relevant to ESS, and often included the EI. Students generally perform well in this criterion.

Common areas of weakness are unfocused or broad RQs, a too general EI and poor linking of the EI to the RQ asked. Many candidates gave well rounded local connections to their investigations.

RQs in general could be more focused, many were vague e.g. what is the effect of GDP on CO_2 emissions from 9 different countries between years x-y? There are far too many uncontrolled variables. The term "effect" or "affect" is vague. Students should be encouraged to be more specific in their research questions.

Some EIs are still only focused on human health. This is not appropriate for ESS.

The choice of the EI should inform the decision on the wording and focus of the RQ. The third aspect making the connection is essential here.

Planning

All students, bar a few, attempt a plan. Planning for sufficient data collection to answer the RQ and providing justifications for the choices made in the plan are often the hardest aspects of this criterion. The aspect most often missing is the ethics & risks.

The procedure to collect data should enable the investigation to be repeated. The method is often lacking in enough details to ensure repeatability.

Field based investigations must detail the rationale for the site choice, and detail the actual sites chosen. Then the collection of a sample or data from the site must also be specified. When students doing field work included images of set-up and locations this was helpful.

Survey or questionnaire investigations should include the questions, and justify why these questions are asked. The survey should not be in an appendix. How and why the participants are chosen, and how the survey is distributed are part of the procedure for a survey.

Secondary data investigations must mention the source used to collect the data and the ethics behind why this is a suitable data source. How the data is extracted from the database or website should be detailed in the plan.

In laboratory investigations the justification for the independent variable treatments should be given. When possible, lab work should include a control set up. Adequate relevant data for lab work usually means 5 different treatments with 5 trials each.

The collection of sufficient data varies depending upon the type of statistical manipulation that will be done to answer the RQ. This must be addressed in the plan. Secondary and survey data usually require more data points than a lab based investigation.

There is no need to copy out test kit instructions or how to set up a spreadsheet, calculate statistics or how to create a survey. It is sufficient to state that an application or kit has been used, giving the name for repeatability purposes.

Some students had a planning section that did not address the RQ.

Results, analysis and conclusion

All raw data collected and used to reach a conclusion should be in this section of the report. A number of students included the raw data in an appendix. This is not appropriate.

All raw data should be processed in some way to show the patterns and trends that allow the RQ to be answered in a conclusion. Various statistical tests appropriate to the data collected can be applied to the data to help determine a conclusion. Most students attempted some processing of the raw data, even if the raw data was initially graphed. A wide range of statistical tests were used by students. All calculations must be checked by the teacher to ensure the maths is correct.

Secondary data and surveys had instances of students presenting data and graphs/charts they had not created themselves. Generally these presentations do not directly answer the RQ making the analysis and conclusions being drawn weak.

Students that included a calculation of validity or reliability and referred to this in the conclusion tended to do well in this criterion.

Discussion and evaluation

The discussion aspect of this criterion is often very brief, missing or does not relate the conclusion to the EI. Stronger investigations have students who use literature and research, as well as their own data to refer back to the EI.

The evaluation aspects are generally answered in more detail. Most students can identify or describe strengths, weaknesses and limitations, and many can discuss these. The modifications for the weaknesses and limitations are usually appropriate but often are not detailed enough. Most students are now attempting some further areas of research but these can be rather superficial.

Applications

The majority of investigations included a solution. A number of students add this to the end of the DEV section rather than having a separate section.

There were many generic solutions with a general evaluation using "more education" or "awareness campaigns". Students seem to find it difficult to have one named solution and then evaluate this. Rather, they describe a number of solutions and give a general evaluation.

Evaluation is usually the weakest part of this criterion.

Communication

The reports are generally well constructed and clear. They are organised and use appropriate ESS terminology.

The conventions of using metric, scientific naming conventions and labelling tables, figures and graphs should always be followed for clarity.

The use of an appendix is penalised in COM.

Reports that used an essay format and had very limited or no sections did not meet aspect 1 or 3 of this criterion.

Most students kept within the 2250 word count. Some students try to circumvent the word count using tables for the plan or evaluation, or even analysis.

Recommendations and guidance for the teaching of future students

The report should not contain school, teacher or student information.

The use of an appendix is inappropriate, it will not be marked.

Academic integrity should be followed and appropriate citations should be made using a consistent referencing system. All source material must be referenced.

All of the criteria should be practised through the practical activities prior to the IA being undertaken.

The IA assessment criteria should be shared with the students and students should have seen some exemplars of complete IA reports.

Teachers should approve the RQ and plan before the student starts to gather data. This should include an indication from the student on which statistical tests they wish to use. The teacher can provide verbal feedback on whether the student's plan and processing will answer the RQ. A descriptive or a human health RQ is not appropriate.

Teachers must give feedback on one complete report and allow the student to edit their report.

Teachers need to provide comments on the final submitted reports to explain the mark they are awarding for a criterion.

Students would benefit from practising writing plans for a variety of types of investigation, including site choices and sample techniques for fieldwork, extracting data from a database and the sharing of a survey. All plans should be in enough detail for repetition.

All plans must have an ethics & risks section.

Raw data must be included in the main body of the report. The details of the processing formula or tool should be stated and ideally a worked example shown.

Data cannot be copied and pasted from a survey or a secondary data source and be considered suitable for the investigation.

Appropriate graphical or display techniques for the data and manipulation should be done. For example, calculating an average of growth over time is not appropriate. Then plotting this on a bar chart does not help answer an RQ looking at whether a change influences growth.

All validity or reliability manipulations should be commented upon in the analysis or conclusion.

The evaluation should look at main issues with the written and actual procedure done.

Only one solution is required in the APP section and this solution should be evaluated. This solution and evaluation should not be generic but rather specific for the EI and conclusion.

An accurate word count should include all components that count towards a mark. Plans and evaluation in table format will still be part of the overall word count. Data, citations/bibliography, figure titles and section headings are not counted as part of the word count.

Teachers are asked to ensure that the reports do not exceed the word count or if they do, then to clearly indicate on the report (with a line) the exact place where the word count has been reached.

Teachers should encourage candidates to present the sections of their reports in the order suggested by the criteria. Reports that have a Conclusion and or APP before DEV at the end of the report may risk being considered unorganized.

Further comments

Better guidance is needed in the planning stages and ongoing monitoring to ensure the IAs will be appropriate and enable the student to complete all aspects of the criteria to the best of their ability.

Standard level paper one

General comments

The majority of G2 respondents considered the difficulty of the paper to be appropriate. Compared to the paper from last year, approximately 66% considered it to be of a similar standard, 17% believed it was more difficult and 17% thought it was easier. The quality of the paper in terms of clarity of wording, presentation, readability, suitability and inclusivity was considered by most respondents to be either acceptable, good or very good.

Students are often writing outside the answer box, this needs to be avoided as part of the answer may be accidently missed when marking. Instead, an additional answer booklet should be used.

The areas of the programme and examination which appeared difficult for the students

- Understanding the requirements of each command term such as state (e.g. Q2b, Q2c and Q3a) and explain (e.g. Q5b).
- Using subject specific vocabulary and terminology. E.g:
  - for Q2b the term "mutualism" used to describe the species interaction.
  - for Q3a the appropriate terminology used to describe the specific trend such as "steady-state equilibrium" or "fluctuating".
  - for Q7 referring to "carbon dioxide" and "greenhouse gases" instead of using generic terms such as "pollutant" or "emissions".
- Understanding the different values provided by natural capital (Q2c).
- Understanding the factors that could have led to larger areas affected by wildfire in 2020 compared to 2016 (Q3b).
- Understanding the difference between the greenhouse effect and ozone layer (Q3c).
- Identifying the potential conflicts between different users of water resources (Q4a).
- Calculating the percentage increase in water use per person (Q4c).
- Understanding how irrigation could reduce soil fertility (Q5b).
- Understanding farming strategies that could be used to improve sustainability (Q5c).
- Understanding the factors that influence energy choices (Q6).
- Understanding the mitigation of climate change and differentiating this from adaption strategies (Q7).
- Writing an appropriate conclusion which uses positive and negative examples and includes a clear judgement statement (Q7).

The areas of the programme and examination in which students appeared well prepared

- Most students were able to effectively interpret data from the Resource Booklet and performed well on Q1a, Q1b and Q5a.
- Students also performed well on:
  - using a dichotomous key (2a).
  - explaining how wildfires act as a positive feedback mechanism for global warming (3c).
  - outlining two ways of reducing water use (4b).

The strengths and weaknesses of the students in the treatment of individual questions

Question 1(a)

This question was answered well by the majority of students.

Question 1(b)

Most students correctly answered with 'coniferous forest'. A common error was to state only "forests".

Question 2(a)

The majority of students were able to correctly use the dichotomous key to identify both species.

Question 2(b)

About half the students correctly stated 'mutualism'. Many responses incorrectly provided a description of the interaction between the giant sequoia and beetle.

Question 2(c)

Few students answered this question well. A common error was to give an example of a value rather than naming it specifically.

Question 2(d)

This question was well answered by the majority of students.

Question 3(a)

Responses to this question were very varied. Many students incorrectly gave a description rather than stating a trend. Another common error was to suggest that the trend was increasing.

Question 3(b)

This question was generally poorly answered. Many students suggested the differences was due to climate change or global warming without relating this to drier or windier conditions in 2020. A significant number of students incorrectly suggested that there were more fires in 2020 than in 2013.

Question 3(c)

Most students achieved some marks on this question. There were a significant number of excellent responses attaining full marks. A common error was to confuse stratospheric ozone with global warming.

Question 3(d)

Responses to this question were highly variable with many students attaining marks for describing the role of r-strategist species and K-strategist species during succession. A significant number of responses were too generic and lacked the specific detail or terminology required for credit.

Question 4(a)

Few students were able to identify a potential conflict between different users of freshwater. Many responses incorrectly focused on problems associated with water supply such as reduction in snow melt.

Question 4(b)

This question was well answered by most students. A common error was to focus on only one way rather than two different ways of conserving water.

Question 4(c)

Many students struggled to correctly calculate the percentage decrease in water use from the values given in Figure 6(c).

Question 5(a)

This question was answered well by most students.

Question 5(b)

Many students struggled with this question, with a significant number either repeating their response to Q5a or copying material from the resource booklet. Few students achieved the maximum of 3 marks.

Question 5(c)

Responses to this question varied widely with most students achieving some marks.

Question 6

Responses varied widely. A significant number of students gave excellent focused responses whereas other students gave answers that were too vague for credit e.g. just stating "accessibility" or "cost".

Question 7

Most students achieved some marks for this question, but few achieved the full 6 marks. Some responses inappropriately repeated material from the resource booklet without connecting it specifically to emissions of greenhouse gases or carbon dioxide in order to mitigate climate change. A significant number of responses focused on sustainability rather than climate change. Very few students provided a well-balanced conclusion. Many conclusions were either one sided or vague.

Recommendations and guidance for the teaching of future students

- Students should be encouraged to read the question carefully and thoroughly. Students should practice reading exam style questions to try and understand what is being asked and then how to answer the question directly.
- The requirement of each command term should be taught. It may be useful to practice answering the same question using a different command term to really understand the difference between describe, explain, evaluate etc. Students should also know which command term requires them to include counter arguments and a clear conclusion/appraisal.
- Students need to practice reading data from a wide variety of charts and graph. It may be useful to increase the use of different types of graphs as a teaching tool to try and help improve interpretation of data and where appropriate extraction of data for use in calculations.
- Students should be given examples of the range of calculations used in ESS and provided regular opportunities to practice these.
- Students should be taught how to plan a 6-mark question with for and against arguments. They should be taught and be able to practice how to write a well-balanced conclusion with a clear value judgement

supported by evidence. Providing students with exemplars of good conclusions from the markscheme and encouraging them to write further examples could be helpful.

- Students should be encouraged to consider the number of marks that are awarded to a question and ensure that enough information has been included to earn full marks (e.g. reasons, impacts, limitations, or examples).
- Students should be encouraged to give focused answers to questions using appropriate ESS terminology. They should avoid using generalised words or phrases such as "pollution/emissions", "impacts/affects", “change” or “greener” as these are too vague for credit. Responses need to be specific, for example, if pollution is being emitted, what kind of pollution and what is its impact.
- Students need to ensure that handwriting is clearly legible. If answers are not readable, they cannot be credited. Only dark ink should be used as scripts will be scanned and marked on-screen.
- Students need to keep their responses within the answer box and if extra space is required continue the response on additional pages. If continuing an answer on additional pages, the student should state "see answer booklet" at the end of the answer box and write the exact number of the question on the additional page.
- Students should be discouraged from leaving blank responses.

Students need to apply their subject knowledge and understanding of ESS to this paper. Hence, educators need to ensure the whole syllabus is covered in sufficient detail. This includes ensuring students:

- are able to do a variety of calculations including percentages, percentage increases/decreases, annual increases/decreases.
- are able to correctly round numbers to two decimal places.
- understand the different species interactions and are able to use the correct terminology.
- understand the different values of natural capital.
- are able to identify and state trends from various datasets.
- understand the factors that contribute to wildfires.
- understand the differences between stratospheric ozone depletion and global warming.
- understand the process of (secondary) succession following a forest fire.
- understand conflicts between different groups over the use of freshwater resources.
- understand how irrigation can reduce soil fertility.
- understand different strategies within farming that can be used to increase sustainability.
- understand the causes of climate change and the strategies that can be used to mitigate climate change.

Standard level paper two

General comments

G2 feedback was largely very positive and showed satisfaction with the level of difficulty, clarity, overall quality and fairness. A couple felt it too easy if anything, but the great majority found the level of difficulty quite suitable. Scores showed an appropriate distribution largely in line with previous sessions.

The areas of the programme and examination which appeared difficult for the students

Explanations of biomagnification and bioaccumulation; evaluating pyramid of productivity; restoration of systems subjected to acid deposition; details of how ecological footprint can be measured; sustainable strategies for aquatic food production; factors affecting human population dynamics; details of environmental value systems, especially anthropocentrism; practical details of applying Simpson's diversity index; details of habitat-based conservation; principles of energy and matter pathways through ecosystems.

The areas of the programme and examination in which students appeared well prepared

Calculating %; reading values from a graph; relationship between fossil fuel use and production of nitrogen oxides and ozone; impacts and conditions for the formation of tropospheric ozone; addressing issue of food waste in LEDCs; details of solid waste disposal strategies; nature of an environmental impact assessment; impacts of urbanisation and agriculture on freshwater resources; impacts of tectonic plate movement on biodiversity; examples of habitat-based conservation; characteristics of a fertile soil; anthropogenic changes to the atmosphere and their impact on food production systems.

The strengths and weaknesses of the students in the treatment of individual questions

Section A

Question 1(a)

Great majority could identify the correct trophic level.

Question 1(b)

Great majority were able to identify the positive relationship between POPs concentration and trophic level.

Question 1(c)

Although a good number were able to gain the full available credit for this question, only the smallest minority could correctly attribute biomagnification along the food chain to the reduction in biodegradable biomass through respiration. A majority were under the false impression that it arose due to higher trophic levels "eating more" which, as is evident in the pyramid shape, they clearly don't.

Question 1(d)

Most were able to calculate the % efficiency from the data.

Question 1(e)

Most were able to identify the value of a pyramid of productivity, but fewer acknowledged weaknesses like not representing all species at a given level, or not allowing for species that fed at different levels.

Question 2(a)

Most were able to identify the region where emissions were most reduced.

Question 2(b)

The great majority identified reduction in vehicle use as the reason for reduced emissions during COVID lockdown.

Question 2(c)

Great majority could identify the relationship between NO_x and tropospheric ozone but fewer could explain it.

Question 2(d)

Most were able to suggest at least one impact of tropospheric ozone, although some confused it with depletion of stratospheric ozone.

Question 2(e)

Most could name two conditions for the formation of tropospheric ozone.

Question 2(f)

Around half the candidates could name a method to restore ecosystems damaged by acid deposition.

Question 3(a)

Vast majority were able to identify stage in food production that showed greatest waste.

Question 3(b)

Many were able to suggest a reasonable strategy for reducing waste although a good number mistakenly addressed a strategy for disposing of the waste.

Question 3(c)

A good number of candidates came up with insightful reasons for a difference in food waste found in LEDCs.

Question 3(d)

Most could suggest pros and cons of appropriate waste disposal strategies but some mistakenly addressed method to reduce waste.

Section B

Question 4(a)

Although many could define ecological footprint, few could give any details of how it could be measured.

Question 4(b)

A large proportion of candidates were able to describe one or two ways in which aquatic food production could be made sustainable, but few could come up with more.

Question 4(c)

A surprising proportion of candidates clearly had no idea what was meant by the concept of "population dynamics" but the stronger candidates were able to effectively integrate their response with the demographic transition model and score well.

Question 5(a)

Many responses went no further than vaguely identifying the relative importance of humans and nature.

Question 5(b)

Many candidates could identify one or two pros and cons of an Environmental Impact Assessment but very few gained the full credit available.

Question 5(c)

Most candidates had a reasonably sound grasp of the impacts of urbanisation and agriculture on freshwater resources although few were able to demonstrate a sound analysis of their relative impact.

Question 6(a)

The majority had some idea of Simpson's diversity index but few could give full account of the practical procedures for its application.

Question 6(b)

Most candidates could identify several impacts of tectonic plate movement on biodiversity but their explanations were often not detailed enough to gain full credit.

Question 6(c)

Majority of candidates were familiar with the nature of habitat-based conservation but often failed to identify the limitations in the face of climate change.

Question 7(a)

Majority were able to identify four characteristics of a fertile soil.

Question 7(b)

The majority were able to identify processes of energy and matter flow within an ecosystem but struggled to see the differences and similarities in principle.

Question 7(c)

Most were able to give a range of anthropogenic impacts on the atmosphere but a significant minority mistook the question and addressed impacts of food production on the atmosphere, rather than the other way round.

Recommendations and guidance for the teaching of future students

There were two striking gaps in candidates' knowledge in this exam. One was a relatively small issue – explaining biomagnification. Candidates may benefit from the illustration of increasing the concentration of a salt solution by boiling off water, just like the respiration of biodegradable biomass in a food chain that increases the concentration of POPs.

The second surprising gap was the large number of candidates that did not understand the concept of human population dynamics which is quite a significant component of the syllabus and underlies much of the issues addressed. It is possible they were just unfamiliar with the term, but the term is actually in the title of one of the syllabus sections so it is hard to see how it was overlooked.

It is encouraging to see the general improvement in tackling the Section B part c questions that are probably the most challenging aspect of the exam. Candidates are learning to take a broad approach and weave a wide range of concepts into a convincing, well-exemplified argument leading to a clear and balanced conclusion.