IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M07/4/ECOSO/SP1/ENG/TZ0/XX+

22076301

ECOSYSTEMS AND SOCIETIES
STANDARD LEVEL
PAPER 1

Monday 14 May 2007 (afternoon)

1 hour

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the number of answer sheets used in the appropriate box on your cover sheet.

1. (a) Outline the term *ecosystem*. *[1]*

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(b) State an example of a flow within a **named** ecosystem. *[1]*

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(c) State **one** example of biological storage within a forest ecosystem. *[1]*

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(d) Calculate the net primary productivity per kg of biomass for the boreal forest ecosystem in **Figure 1** below. *[1]*

Figure 1 Comparison of ecosystem productivity

Ecosystem	Mean net primary productivity / $kg\,m^{-2}\,yr^{-1}$	Mean biomass / $kg\,m^{-2}$	Net primary productivity per kg biomass per year
Temperate forest	1.20	32.5	0.037
Boreal forest	0.80	20.0	. . . . .
Tropical rainforest	2.20	45.0	0.049
Savanna grassland	0.90	4.0	0.225
Tundra	0.14	0.6	0.233

[Source: adapted from *Geography Review*, 1991, **5**, No 1, page 17]

(This question continues on the following page)

(Question 1 continued)

(e) Compare and explain the data for **two** of the ecosystems in **Figure 1**. *[4]*

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(f) Briefly outline a method for measuring biomass of a primary producer. *[3]*

Name of primary producer: . . . . . .

Method: . . . . . .
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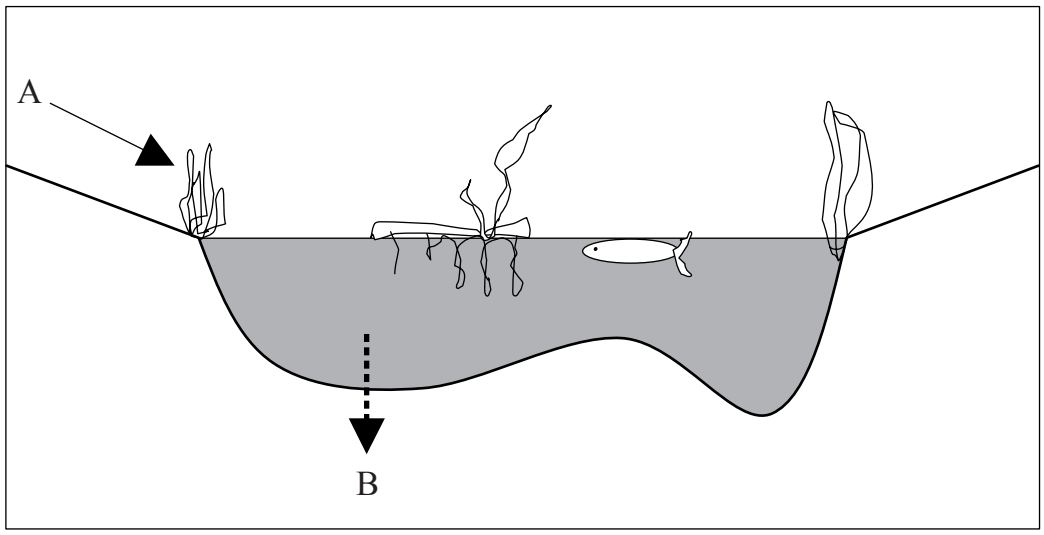
2. **Figure 2** Diagrammatic representation of a eutrophic lake



(a) Define the term *eutrophication*. *[2]*

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(b) Identify process A and process B. *[2]*

Process A: . . . . . .

Process B: . . . . . .

(c) Suggest **one** agricultural source and **one** non-agricultural source that may account for high phosphate levels. *[2]*

Agricultural source: . . . . . .

Non-agricultural source: . . . . . .

(This question continues on the following page)

(Question 2 continued)

(d) Suggest how an environmental manager may reduce the impact of eutrophication. *[3]*

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3. **Figure 3** Renewable energy alternatives, how the energy is produced and their limitations

Alternative renewable energy source	How the energy is produced	Major limitation
Tidal Power	Energy is produced by using the ebbing and/or flooding tide to turn turbines and produce electricity.	. . . . .
Wind Power	Wind turbines are driven by available wind energy. The wind energy is turned into electrical energy via a generator. The electrical energy is supplied to an electrical grid to do work.	Dependent on the wind; no wind equals no energy.
Biofuel	. . . . .	Produces emissions and requires large areas to grow biofuel crop.

(a) State **one** other form of alternative renewable energy source not listed above. *[1]*

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(b) Complete **Figure 3** above for tidal power and biofuel. *[2]*

(This question continues on the following page)

(Question 3 continued)

(c) Most MEDCs are still dependent on non-renewable forms of energy. Suggest reasons why MEDCs have not adopted renewable energy sources. *[3]*

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(d) With reference to a **named** food production system you have studied, describe **two** ways in which food supply per unit area can be increased. *[2]*

Named food production system: . . . . . .

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(e) State the difference between *carrying capacity* and *ecological footprint*. *[3]*

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4. (a) Discuss the strengths and weaknesses of a species based approach to conservation. *[3]*

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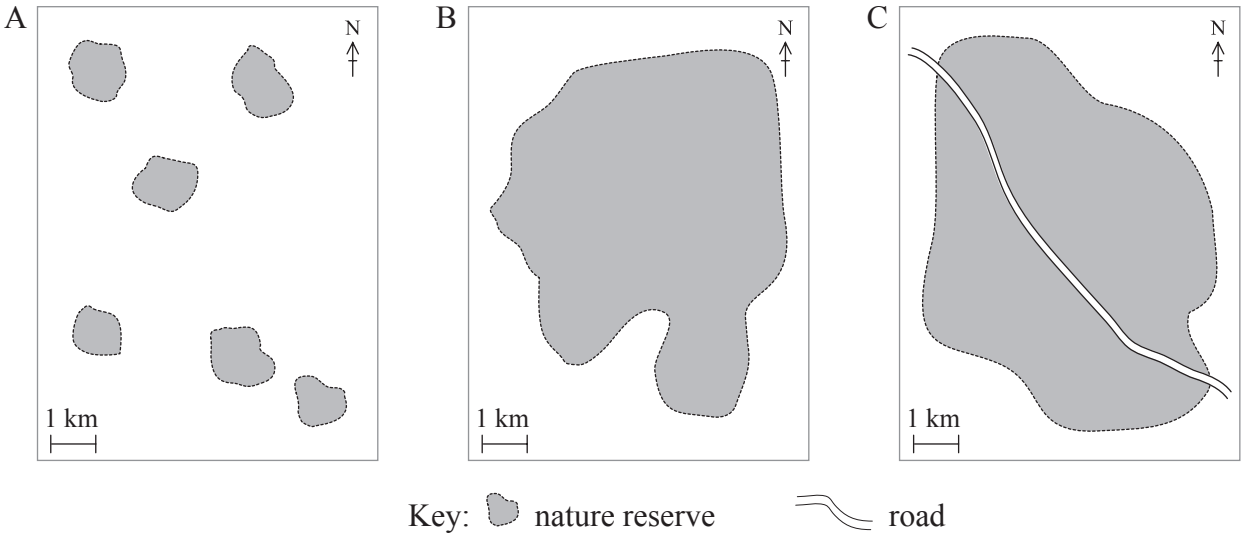
Figure 4 below shows three different shapes of nature reserves.

Figure 4



(b) Discuss the strengths **or** weaknesses of the shapes of the nature reserves in **Figure 4**. *[3]*

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(Question 4 continued)

Figure 5 below shows a table of invertebrates caught within a small woodland nature reserve using a series of pitfall traps.

Figure 5 Pitfall trap data for invertebrates

Invertebrates	Number
Springtails	520
Ground beetles	400
Greenflies	43
Spiders	33
Centipedes	34
Flies	24
Harvestmen	27
Woodlice	12
Ants	13
Wasps	17

Simpson's Diversity Index = 2.895

(c) (i) Draw and label a pitfall trap. *[2]*

(This question continues on the following page)

(Question 4 continued)

(ii) The pitfall trap technique was used over a four-year period to monitor invertebrate species diversity. Each year the value fell by approximately 12%. Suggest how this information may be used to manage the woodland nature reserve in the future. *[2]*

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(iii) Outline a method for estimating the population size of ground beetles in the woodland nature reserve. *[2]*

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(d) Outline the relationship between plate tectonic theory and species evolution. *[2]*

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MARKSCHEME

May 2007

ECOSYSTEMS AND SOCIETIES

Standard Level

Paper 1

9 pages

General Marking Instructions

Subject Details: Ecosystems and Societies SLP1 Markscheme

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- An alternative answer or wording is indicated in the markscheme by a "/" either wording can be accepted.
- Words in (…) in the markscheme are not necessary to gain the mark.
- Words that are <u>underlined</u> are essential for the mark.
- The order of points does not have to be as written (unless stated otherwise).
- If the candidate's answer has the same meaning or can be clearly interpreted as being the same as that in the mark scheme, then award the mark.
- Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalising them for what they have got wrong.
- Effective communication is more important than grammatical accuracy.
- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded.
- Units should always be given where appropriate. Omission of units should only be penalized once. Ignore this, if marks for units are already specified in the markscheme.
- Do not penalize candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

1. (a) a community of interdependent organisms and the physical environment they inhabit / *OWTTE*; ***[1]***

(b) *e.g.* water flow through a river ecosystem; ***[1]***
Accept any reasonable answer that identifies a flow and an ecosystem.
*Award **[0]** if no named ecosystem.*

(c) biomass within trees and plants / nutrient within soil; ***[1]***
Do not accept for example "trees" or "soil". The item stored must be identified.

(d) 0.04; ***[1]***

(e) *e.g.* tropical rainforest and tundra;
mean NPP tropical rainforest greater than tundra / mean biomass tropical rainforest far greater than tundra;
NPP per kg biomass of tropical rainforest is far lower than tundra;
Candidates may give figures from the table but they need to make comparative statements.

tropical rainforest hot and wet so greater opportunity to develop large biomass / high rate of photosynthesis and high rate of respiration so NPP/per kg biomass/ per year is low;
tundra cold and dry so low rates of photosynthesis and respiration / plants slow growing, slow accumulation of biomass, relatively large growth in biomass per year; ***[4 max]***
*Award up to **[2 max]** for comparison and up to **[2 max]** for explanation. Award any other combination of two ecosystems.*

(f) *name of primary producer*: *e.g.* grassland;

method: ***[2 max]***
collect all the vegetation (including roots, stems, leaves) within a series of (1m×1m) quadrats;
weigh vegetation;
dry the vegetation until no further weight loss is encountered / dry weight represents biomass; ***[3 max]***
*Award **[2 max]** if no named primary producer.*

2. (a) the enrichment of a water body (lake, stream *etc*.) by increased nutrient inputs (primarily phosphates and nitrates);
depletion of oxygen content of water;
leads to the development of algal blooms;
the enrichment may be natural/artificial;
accelerated by human activity; ***[2 max]***

(b) *process A*: (agricultural) run-off / surface flow / nutrients entering lake;
process B: leaching / sedimentation / seepage / dead remains sinking / infiltration; ***[2]***
Accept other reasonable responses.

(c) *agricultural source*:
fertilizers (containing phosphates and nitrates) / animal waste / manure;
Do not accept pesticides.

non-agricultural source:
detergents (domestic) / industrial effluent / sewage; ***[2]***

(d) identify potential sources of eutrifying materials (detergents, fertilizers, effluents);
identify if source is point/non-point pollution;
put in strategies for removing/reducing these pollutants *e.g.* reduce fertilizers use;
use organic fertilizers / use detergents with no phosphates / prevent run-off, *etc.*;
remove contaminated sediment from water body / dredge it;
re-oxygenate water body;
nets to reduce organic input;
educate water source users about eutrophication problems; ***[3 max]***

3. (a) wave power / solar radiation / heat pumps / water wheels; ***[1]***
Accept other suitable answers if appropriate.

(b) *Award **[2]** if both answers are correct and **[1 max]** if one or two partial answers are correct.* ***[2]***

Alternative renewable energy source	***How the energy is produced***	***Major limitation***
Tidal Power	*Energy is produced by using the ebbing and/or flooding tide to turn turbines and produce electricity.*	good tidal range required / right shape of coastline / interferes with navigation / impact on wildlife / expensive; *(only **one** limitation required)*
Wind Power	*Wind turbines are driven by available wind energy. The wind energy is turned into electrical energy via a generator. The electrical energy is supplied to an electrical grid to do work.*	*Dependent on the wind; no wind equals no energy.*
Biofuel	plant material burned directly to produce heat / transformed into ethanol (used as fuel) / converted to methane (methane digestion); *(only **one** method required)*	*Produces emissions and requires large areas to grow biofuel crop.*

(c) MEDCs traditionally / culturally dependent on fossil fuels;
fossil fuels are energy-efficient / easy to transport / relatively cheap;
changing to renewable energy on a large scale requires massive capital investment / cultural inertia against change to renewables / many renewables depend on environmental conditions that are not constant (*e.g.* wind, sunshine, waves); ***[3]***

(d) *named food production system*: *e.g.* rice paddies

application of fertilizer;
using herbicides;
insecticides;
irrigation;
changing crop type/variety;
using GM crops; ***[2 max]***
*Award **[1 max]** if no named food production system.*
Note: *that food production system must be reasonably specific. Do not accept e.g. agriculture.*

(e) carrying capacity is the number of individuals/species/load an area of land/an environment can support (providing resources and absorbing waste);
ecological footprint is area of land (and water) required to support an individual/population (providing all resources and absorbing waste);
ecological footprint is a theoretical area whereas carrying capacity refers to a real area;
they are the opposite/inverse of each other;
carrying capacity involves sustainable support of a population, whereas footprints are not necessarily sustainable; ***[3]***

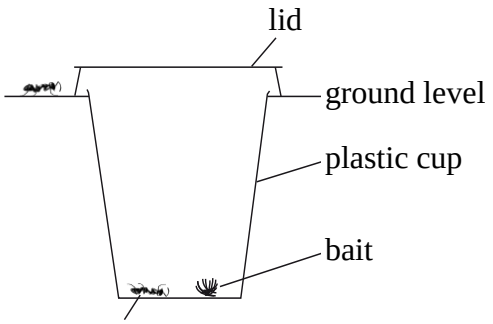
4. (a) high profile/charismatic species catch public attention both nationally and internationally (*e.g.* tiger – India);
however, species based conservation favours charismatic organisms and is less successful in saving "non cuddly" species;
saving a named species requires preserving the animal's habitat this benefits all other organisms in that habitat;
however a species can be artificially preserved (*e.g.* in a zoo) whilst its natural habitat is destroyed (*e.g.* Giant Panda); ***[3 max]***
*Award any three of the above points **[1]** each or any other suitable suggestions.*

(b) *area A*: ***[1 max]***
fragmented and small with a large perimeter area ratio / large edge effect so lots of disturbance;
fragmented so difficult migration between fragments;
small size may limit species contained / limit population sizes;
Accept other reasonable responses.

area B: ***[1 max]***
large perimeter area ratio / relatively small edge effect so less disturbance;
large size promotes high biodiversity;
large size so good for large vertebrates/top carnivores/large species populations;
Accept other reasonable responses.

area C: ***[1 max]***
as large as B but dissected by a road which acts as a barrier to species migration;
road increases edge effect some more disturbance ;
road allows easier access to the interior of reserve for monitoring ;
road gives easier access for poachers;
some evaluative element is required (*i.e.* how the characteristic relates to the ecosystem in a positive or negative way); ***[3]***
Accept other reasonable responses.

(c) (i)



[2]

*Award **[1]** for the diagram and **[1]** for up to three labels.*
Accept pitfalls designed to collect larger species.

(ii) a falling value would suggest a loss of diversity / in this instance a loss in the invertebrate biodiversity;
this data could be used to identify a biodiversity decay problem / kick start a management strategy to assess the cause and reverse the trend; ***[2]***
Award credit if specific management strategies to address loss in biodiversity are suggested.

(iii) use Lincoln index / capture-mark-release-recapture method;
capture ground beetles, mark-release;
after a period of time recapture and count those with and without marks; ***[2 max]***

(d) due to the process of plate tectonics the Earth's surface has gradually broken up and drifted apart over many millions of years;
this process has allowed groups of organisms to become isolated and evolve along different paths dictated by their new surrounding and environmental conditions / plate movement not only isolates groups but also subjects them to new climates and environmental conditions; ***[2]***
Accept other reasonable responses.

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22076302

ECOSYSTEMS AND SOCIETIES
STANDARD LEVEL
PAPER 2

Tuesday 15 May 2007 (morning)

2 hours

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided. Refer to the resource booklet which accompanies this question paper.
- Section B: answer two questions from Section B. Write your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

0107

SECTION A

Answer all of Section A in the spaces provided.

The resource booklet provides information on water resources. Use the resource booklet and your own studies to answer the following.

1. (a) What geographical features make the Maldives susceptible to damage from a tsunami? *[2]*

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(b) List the **three** types of freshwater supply the Maldivian population relies on and state whether each supply is renewable **or** replenishable. *[3]*

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(c) Describe the state of Maldivian groundwater after the 2004 tsunami. Suggest sources of contamination. *[4]*

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(Question 1 continued)

(d) (i) Deduce why water resources may become a limiting factor for Maldivian tourism. *[2]*

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(ii) Outline the trend in global water resources up to 2050. *[2]*

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(e) Discuss and evaluate **three** strategies to make tourism more sustainable in the Maldives. *[6]*

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(Question 1 continued)

(f) Tourism is an important economic activity in the Maldives. Construct a model (diagram) that demonstrates the range of impacts tourism may have both directly and indirectly on Maldivian **ecosystems**. *[4]*

Tourism

(g) State **two** positive impacts of tourism. *[2]*

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SECTION B

*Answer **two** questions. Write your answers on the answer sheets provided. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

*Each essay is marked out of **[20]** of which **[2]** are for clarity of expression, structure and development of ideas:*

[0] *Quality of expression, structure and development is poor.*
[1] *Quality of expression, structure and development is limited.*
[2] *Quality of expression is clear, structure is good and ideas are well developed.*

2. The Gaia Hypothesis proposes that our planet functions as a single organism that maintains conditions necessary for its survival by feedback mechanisms. It was formulated by James Lovelock in the mid-1960s. In his recent book *The revenge of Gaia*, he suggests that we have passed the "tipping point" on global warming and that feedback mechanisms will speed up the rate of global warming.

(a) State what type of system the Earth is and what the inputs and outputs are. *[3]*

(b) Using positive and negative feedback models explain the process of climate change. *[7]*

(c) Scientists use computer simulations to model the effects of changes in the temperature of the Earth. Discuss the advantages and disadvantages of this modelling. *[4]*

(d) Describe your personal viewpoint on the global warming issue and justify your position based on the evidence. *[4]*

Expression of ideas *[2]*

3. (a) For a **named** example of pollution that you have studied, describe and evaluate the pollution management strategies that may be used to reduce the impact of the pollutant. *[7]*

(b) Describe and explain the impact of changes in ozone concentration on ecosystems and organisms. *[6]*

(c) Justify whether you believe that sustainable development is possible on Earth in the long-term. *[5]*

Expression of ideas *[2]*

4. (a) Distinguish clearly between *succession* and *zonation* using **named** examples and diagrams. *[6]*

(b) Compare and contrast the production : respiration ratios of a food production system you have studied and a natural ecosystem with a climax community. *[6]*

(c) Discuss the characteristics of an ecosystem that would allow it to support high biodiversity and explain what the threats are to this ecosystem. *[6]*

Expression of ideas *[2]*

5. M Wackernagel calculates that the Earth has only 1.7 hectares *per capita* available for human use. These 1.7 hectares become the ecological benchmark figure for comparing people's ecological footprints. Assuming no further ecological degradation, the amount of available biologically productive space will drop to 1.0 hectare *per capita* once the world population reaches its predicted 10 billion by 2040.

[Source: WWF *Living Planet Report of 2004*]

(a) Explain how population pyramids data can allow countries to monitor population changes. *[5]*

(b) Discuss the relationship between population, resource consumption and technological development, and their influence on carrying capacity and economic growth. *[6]*

(c) Discuss the advantages and disadvantages of reducing use, reusing and recycling resources. *[7]*

Expression of ideas [2]

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22076303

ECOSYSTEMS AND SOCIETIES
STANDARD LEVEL
PAPER 2

Tuesday 15 May 2007 (morning)

2 hours

RESOURCE BOOKLET

INSTRUCTIONS TO CANDIDATES

- Do not open this booklet until instructed to do so.
- This booklet contains **all** of the resources required to answer question 1.

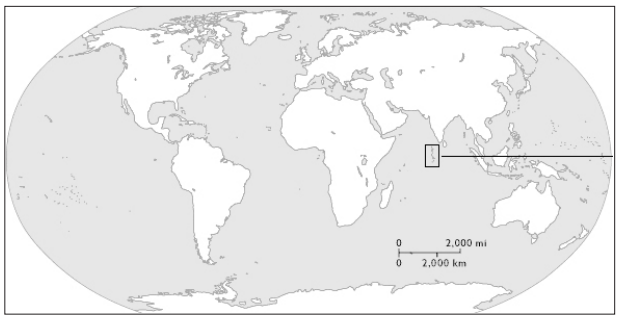
Introduction

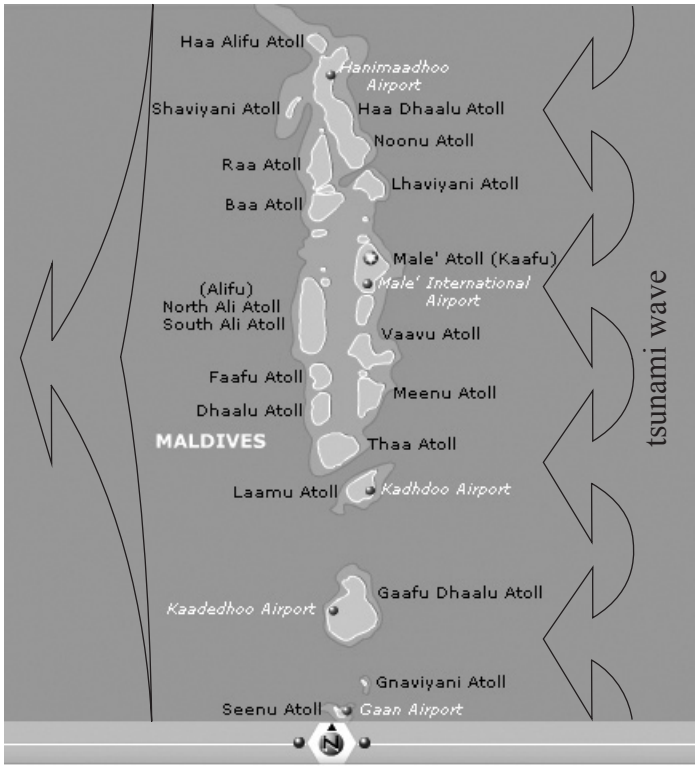
The Asian tsunami* on 26 December 2004 was caused by an undersea earthquake and had a devastating impact across the Indian Ocean, causing unprecedented human, economic and environmental damage to those countries in its path.

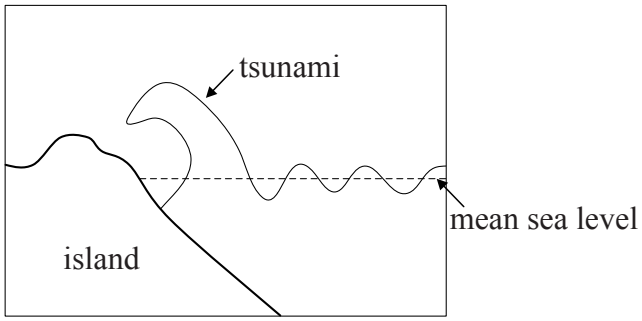
The Maldives are a chain of 200 inhabited islands, with a maximum land height above sea level of just 4 metres. The country suffered relatively small human losses, but *per capita* has sustained the largest economic damage of any country. More than 70 islands were directly affected.

* tsunami: a giant wave caused by earthquakes, volcanic eruptions or undersea landslides associated with active plate margins

Figure 1 — The Maldives and the 2004 tsunami







[Source adapted from: www.nationalgeographic.com and http://www.hoteltravel.com/maldives/maps.htm]

Figure 2 — Freshwater supply in the Maldives

Freshwater Lens formation on islands

A proportion of the freshwater falling as rain on an island infiltrates into the sandy soils and accumulates as fresh groundwater. The freshwater, being less dense than saline seawater, floats on the saline groundwater that infiltrates the island laterally at depth from the sea. Because of density differences, a freshwater lens develops, which in general is thickest at the centre of the island, where groundwater levels are highest (compared to mean sea level). The typical ratio between the height of freshwater above mean sea level compared to the depth of freshwater below mean sea level is of the order of 1:20. Groundwater levels above mean sea level on small islands may be 0.10 metres to 0.50 metres above sea level, resulting in a freshwater lens depth of 2 metres to 10 metres thick.

In the Maldives 99 % of local households use rainwater as their drinking supply and groundwater for other uses. When rainwater dries up, they use groundwater for everything. The tsunami flooded many islands with seawater which contaminated groundwater supplies. Sewage also leaks into groundwater supplies.

Figure 3 — Hydrological model of coral islands

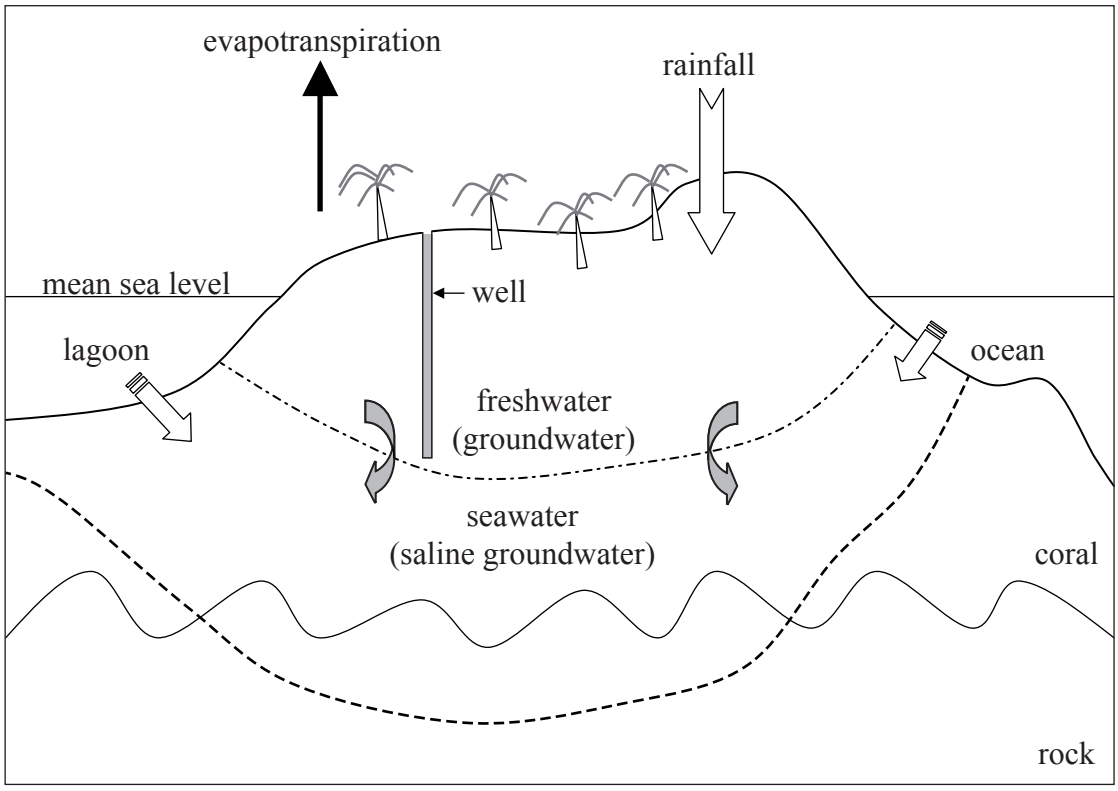


Figure 4 — Desalination prospects for the Maldives

There is a common misconception that, for small marine islands, desalination (the removal of salt from seawater) is an ideal source of freshwater. The experience throughout the small island regions of the world is that with a few exceptions, Male (the capital island) being one of them, the operation of desalination plants is in fact unsustainable.

Desalination is expensive (up to US $8/m^3 in Male) and likely to be higher on the outer islands; it requires advanced technical training not commonly available in the outer islands, it needs good cost-recovery to support complex spare part maintenance and it requires the import and storage of diesel fuels. Some or all of these factors that are required to sustain desalination are absent in small islands.

Outside of Male, resorts routinely use desalination plants. This is because tourists use large volumes of water and rainwater cannot meet demand. The small size of the islands means there is no groundwater available. The money generated by the resorts ensures engineers can adequately service the desalination plant, without which the resorts would close.

Figure 5 — Well water quality in three Maldivian islands after 2004 tsunami and the WHO (World Health Organisation) recommended maximum background levels

Island	**Nitrate / mg l^{-1}**	**Ammonia / mg l^{-1}**	**Phosphate / mg l^{-1}**	**Chloride / mg l^{-1}**
Kulhuduffushi	29.2	2.4	0.5	529
Filladhoo	32.9	6.8	0.9	1200
Dhidhdhoo	43.8	0.7	0.3	402
WHO guidelines	***50.0***	***1.50***	***Background<0.1***	***250***

Figure 6 — Climate of the Maldives

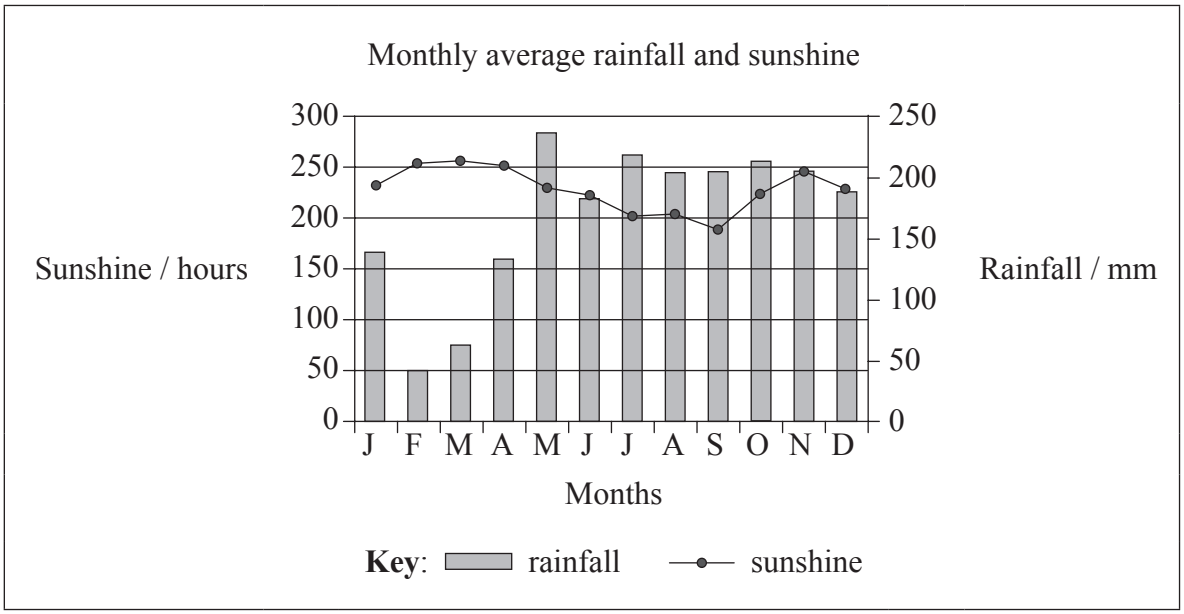


Figure 7 — Climate change and sea level rise in the Maldives

The islands of the Maldives rise, on average, up to 4 metres above sea level. In 1987 and 1991, storm surges flooded a large number of islands, including one-third of the capital where one-quarter of the country's population lives. Unusually high waves forced the international airport to close, causing great damage to tourism and constraining emergency relief operations. Recent surveys have shown that almost one-third of the 200 inhabited islands were faced with serious beach erosion problems.

Sea level rise is not a fashionable scientific hypothesis but a fact. Already in this century, the seas have risen between 10 cm and 25 cm. The prevailing scientific consensus holds that human action, affecting the world climate, will cause the seas to rise more rapidly in the future.

Countries need to pursue immediate measures by relocating their populations away from areas of risk and taking protective measures to prevent flooding. For small island countries relocation is not possible and because defences against flooding are prohibitively expensive to construct, considerable external assistance would be needed.

Figure 8 — Trends in island tourism, adapted from *www.ourplanet.com*

Tourism is expected to go on growing by approximately 5 % per year. World Tourism Organization (WTO) projections suggest that international arrivals will rise to 800 million in 2007 and one billion in 2010. The vast majority of tourists will continue to come from the developed world, but economic expansion and *per capita* income growth in developing countries – such as Brazil, China and India – will, over the long-term, add to the upward trend. This outlook makes tourism one of the most economically strong sectors of the global economy.

In order to enhance the long-term viability of the tourist sector, many small island developing countries have embarked on forward-looking strategies to improve efficiency.

Figure 9(a) — Outline map of an atoll island, indicating land above sea level

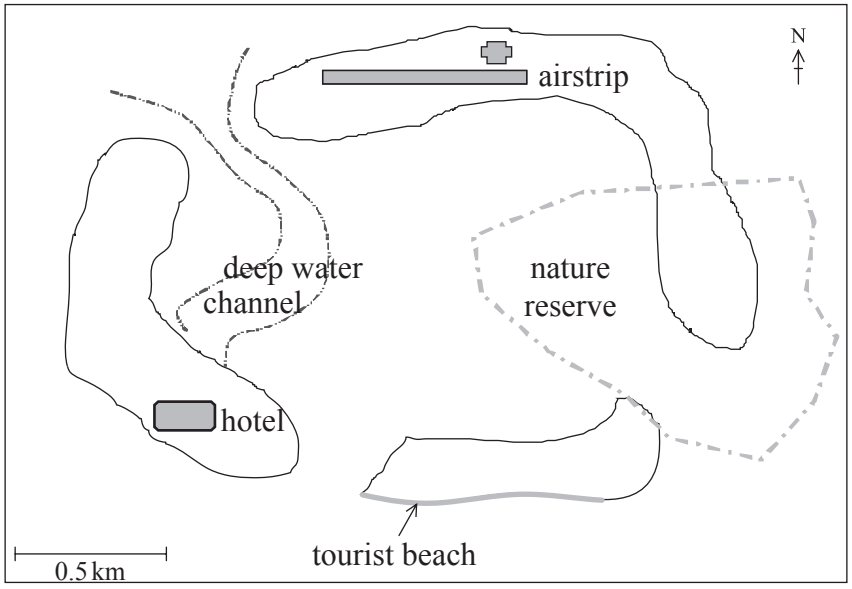


Figure 9(b) — Cross-section of an atoll island

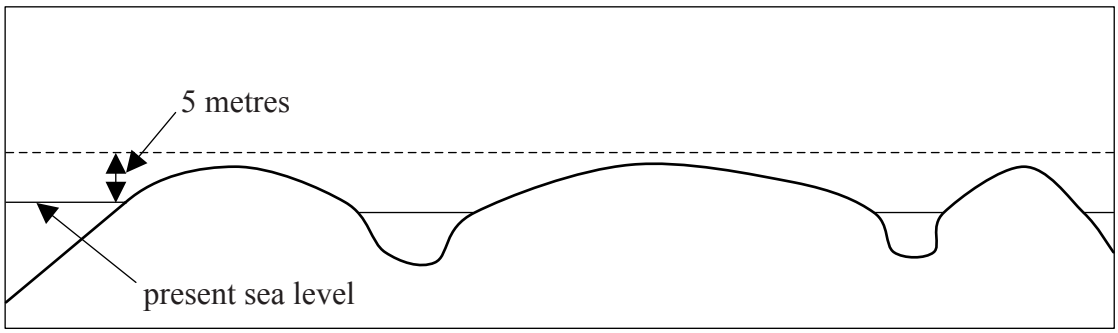


Figure 10 — Countries with chronic water scarcity (below 2740 litre capita^{-1} day^{-1}) in 2000, 2025 and 2050 compared to a number of other countries

Country	**Available water / litre capita^{-1} day^{-1} in 2000**	**Available water / litre capita^{-1} day^{-1} in 2025**	**Available water / litre capita^{-1} day^{-1} in 2050**
Saudi Arabia	325	166	118
Israel	969	738	644
Somalia	3206	1562	1015
Malawi	4656	2508	1715
UK	3337	3270	3315
India	5670	4291	3724
China	6108	5266	5140
USA	24 420	20 405	19 521

[Source adapted from: WRI 1998 in B Lomborg, 2001, *The Skeptical Environmentalist*, CUP]

Figure 11 — Percentage of people living with chronic water scarcity

2000	**2025**	**2050**
3.7%	8.6%	17.8%

[Source adapted from: WRI 1998 in B Lomborg, 2001, *The Skeptical Environmentalist*, CUP]

IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

MARKSCHEME

May 2007

ECOSYSTEMS AND SOCIETIES

Standard Level

Paper 2

12 pages

General Marking Instructions

Subject Details: Ecosystems and Societies SLP2 Markscheme

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.
- Words in (…) in the markscheme are not necessary to gain the mark.
- Words that are <u>underlined</u> are essential for the mark.
- The order of points does not have to be as written (unless stated otherwise).
- If the candidate's answer has the same meaning or can be clearly interpreted as being the same as that in the mark scheme, then award the mark.
- Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalising them for what they have got wrong.
- Effective communication is more important than grammatical accuracy.
- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded.
- Units should always be given where appropriate. Omission of units should only be penalized once. Ignore this, if marks for units are already specified in the markscheme.
- Do not penalize candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

SECTION A

1. (a) the landmass has a low elevation / no land higher than 4 metres;
the islands are relatively small (less than 1 km across);
the islands are in a tectonically active ocean;
not sheltered by large land masses; ***[2 max]***

(b) groundwater – replenishable;
rainwater – renewable;
freshwater from desalination – renewable; ***[3]***
Accept replenishable as a classification of rainwater.

(c) Maldivian ground water has been contaminated with ammonia, phosphates, nitrates and chloride;
nitrates – below WHO guidelines;
ammonia – two island exceeds WHO guidelines ($\times 4$);
phosphate – all islands exceed WHO guidelines ($\times 3$ to $\times 9$);
chloride – all islands exceed WHO guidelines ($\times 2$ to $\times 5$);
sources of contamination – domestic waste / agricultural waste / landfill waste / degrading organics / tsunami debris / sea water / sewage; ***[4 max]***
*Award **[3 max]** for description and **[2 max]** for two or more sources of contamination.*

(d) (i) tourists consume relatively large amounts of freshwater / Maldives has a finite amount of groundwater and annual rainwater budget;
when tourist needs outstrip supply, tourism will have reached and gone beyond these limits; ***[2]***

(ii) by 2050 the numbers of countries with a chronic scarcity (below 2740 litres capita^{-1} day^{-1}) of water will have increased;
between 2000 and 2050 the percentage of people in the world suffering from chronic water scarcity will rise (from 3.7% to 17.8%); ***[2]***
Figures are not required.

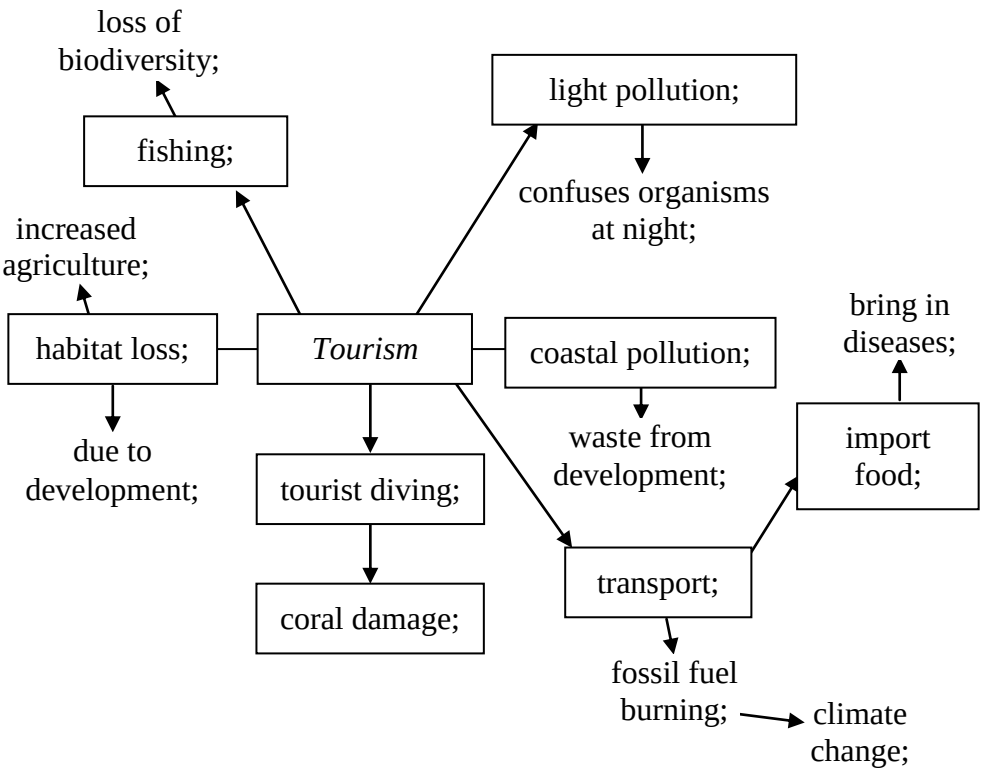
(e) *strategy*: tourist numbers could be limited;
evaluation: which reduces resource use and tourist pressures;
however, also reduces tourist revenue;

strategy: development taxed to pay for habitat protection and conservation;
evaluation: may make tourism more expensive/less profitable, but may guarantee sustainable environment and tourism for the future;

strategy: tourist environmental education;
evaluation: environmentally aware tourist less likely to cause damage, *e.g.* standing on coral / using waste excessively; ***[6 max]***

*Award **[4 max]** if only two strategies addressed, **[2 max]** if only one strategy addressed. Accept any other reasonable suggestions.*

(f)



[4 max]

*Award **[1]** for each impact, up to **[4 max]**. Accept any other reasonable points and model design.*

(g) tourism generates valuable hard currency/revenue for many LEDCs;
generates job opportunities;
introduces people to new cultures, societies, ideas and environments;
highlights conservation issues and environmental problems; ***[2 max]***

SECTION B

General Essay Markscheme
Each essay is marked out of ***[20]*** of which ***[2]*** are for clarity of expression, structure and development of ideas.

[0] Quality of expression, structure and development is poor.
[1] Quality of expression, structure and development is limited.
[2] Quality of expression is clear, structure is good and ideas are well developed.

2. (a) Earth is a closed system;
inputs – solar radiation/Sun's energy/light and output – heat energy;
materials recycled within the system / matter recycled (may discuss space ships and meteorites moving a small amount of matter in and out); ***[3]***

(b) climate change is a significant shift in climatic conditions;
may be warming or cooling;
positive feedback allows for movement away from equilibrium and decreases stability;
negative feedback dampens down deviation from equilibrium and increases stability;

example model:
ice caps melting leads to reducing albedo / more dark sea to absorb heat / temperature increase leading to more ice cap melting thus positive feedback;
ice caps melting leads to more evaporation more clouds / albedo effect of clouds stop energy reaching Earth's surface / decrease warming thus negative feedback;

in short-term, positive feedback model appears to operate *e.g.* temperature change over industrial period / in the long-term, negative feedback appears to operate *e.g.* glacial cycles; ***[7]***

(c) *advantages*: ***[2 max]***
allows us to predict;
simplifies complex systems;
can change inputs and see what happens;
can show them to others;
Accept any other reasonable suggestions.

disadvantages: ***[2 max]***
not accurate;
rely on the expertise of the people making them;
on validity of input data;
different people interpret them differently;
can be hijacked politically; ***[4 max]***
Accept any other reasonable suggestions.

(d) *Responses to this question will depend on the candidate's own personal viewpoint but examples could be*:-

example 1:
stating viewpoint: ***[1 max]***
global warming is the biggest threat to life on Earth ever and we are heading for catastrophe;

evidence: ***[3 max]***
evidence for heating of the Earth is overwhelming;
evidence from increasing greenhouse gases caused by human activities;
ice caps retreating;
glaciers retreating;
sea levels rising;
more floods;
hurricanes increase in severity;

example 2:
stating viewpoint: ***[1 max]***
global warming may be occurring but has throughout the life of the Earth and will bring benefits to many people;

evidence: ***[3 max]***
shift of biomass towards the poles will mean crops can grow where they could not before;
more rainfall in some areas is a good thing;
if the Arctic ice melts, we can mine for minerals and oil under the Arctic sea;
large areas of Siberia and Canada will be warmer and easier to live in; ***[4 max]***

Award up to ***[3 max]*** *for any three pieces of evidence. Accept any other reasonable suggestions.*

Expression of ideas: ***[2 max]***

Total: ***[20]***

3. (a) *named example*:
e.g. acid rain;

description: *(e.g. acid rain)*: ***[3 max]***
alter human activity – education of impact of burning coal / switch to non-fossil fuels / burn sulfur-free coal;
regulate and reduce pollution at source – add scrubbers to chimneys / capture CO_2 at source / penalties for having sulfur-rich coal;
clean up and restore ecosystem – lime lakes / remove contaminated soil / lime surrounding landscapes / replant trees in affected ecosystems;

evaluation: *(e.g. acid rain)*: ***[3 max]***
no local effects so difficult to stop people using sulfur-rich fossil fuels / effects often felt in countries distant to source of pollution;
legislation requires regulators to check compliance;
liming treats symptoms, not cause, so needs repeating; ***[7]***

Award any other reasonable suggestions.

(b) troposphere ozone – increase is a problem;
stratosphere ozone – depletion is the problem;

troposphere ozone:
formed as secondary pollutant when photochemical reaction occurs between NO_x and other pollutants;
trees may die / damage to crops / causes irritation to skin and eyes in organisms / other respiratory problems;

stratosphere ozone:
depletion of the ozone layer by CFCs and other halogenated gases / ozone depletion allows more UV light to reach the Earth;
mutation in cells *e.g.* algae / eye cataracts in sheep/humans / skin cancers in humans / tissue damage in photosynthetic organisms; ***[6]***

Accept other reasonable responses.

(c) *Depends on the arguments used but responses require a statement of belief on sustainable development.*

example 1:
statement: ***[1 max]***
I do not believe sustainable development is possible in the long-term as we have finite resources and will not have enough for everyone to use as much as they want / non-renewable resources will run out;

justification: ***[4 max]***
humans are not prepared to reduce their standards of living;
80 % live in LEDCs and are using more and more resources;
cannot find new technologies fast enough to replace fossil fuels;
not enough renewable resources;
humans are incapable of stopping population growth;

example 2:
statement: ***[1 max]***
I believe sustainable development is possible as we have the technology to use renewable resources for all our needs;

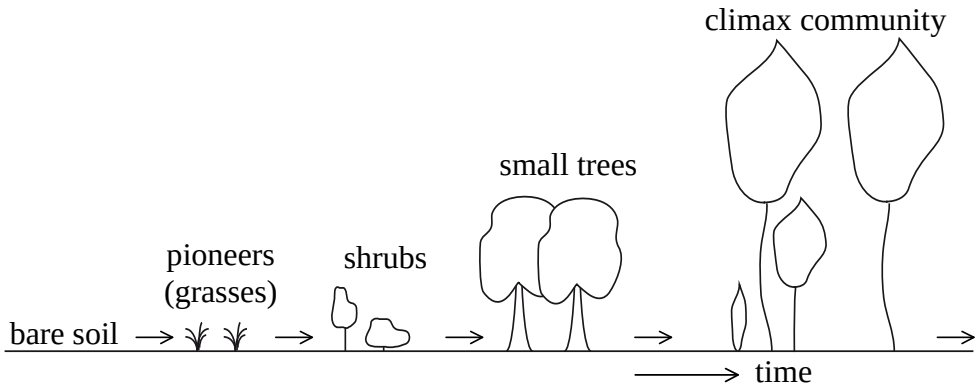
justification: ***[4 max]***
micro generation using wind turbines and solar power *etc*. will provide energy for domestic homes and factories;
transport could use hydrogen powered engine using water as a fuel;
humankind will use less energy, insulate buildings more;
legislation will make us reuse and recycle more;
technological developments in crop growing will mean more production; ***[5 max]***

*Award **[1]** for a definition of sustainable development.*

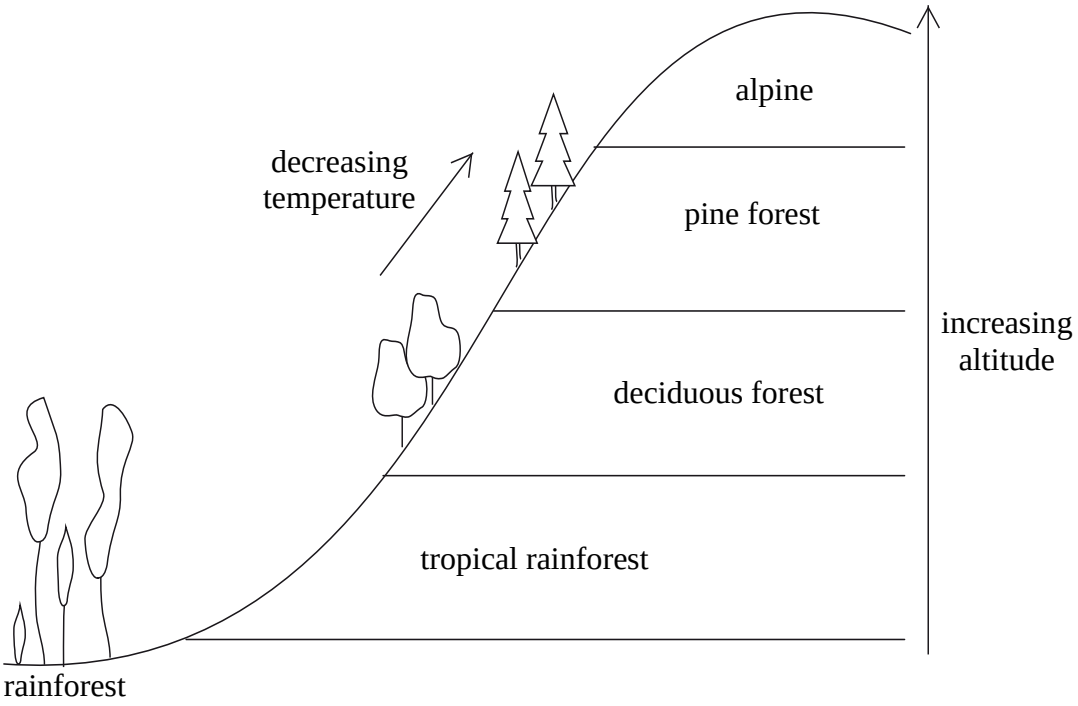
Expression of ideas: ***[2 max]***

Total: ***[20]***

4. (a) *succession*: orderly change over time in an ecosystem;
succession *e.g.* temperate forest development;



zonation: the arrangement/patterning of plant communities/ecosystems, into parallel/sub - parallel bands in response to change, over a distance, in some environmental factor;
zonation *e.g.* changes in ecosystems up a mountain with increasing altitude;
Accept other reasonable responses.



[6 max]

*Award **[1]** for definition, **[1]** for example and **[1]** for a diagram of each process.*

(b) food production system *e.g.* intensive wheat production;
natural ecosystem *e.g.* deciduous woodland;

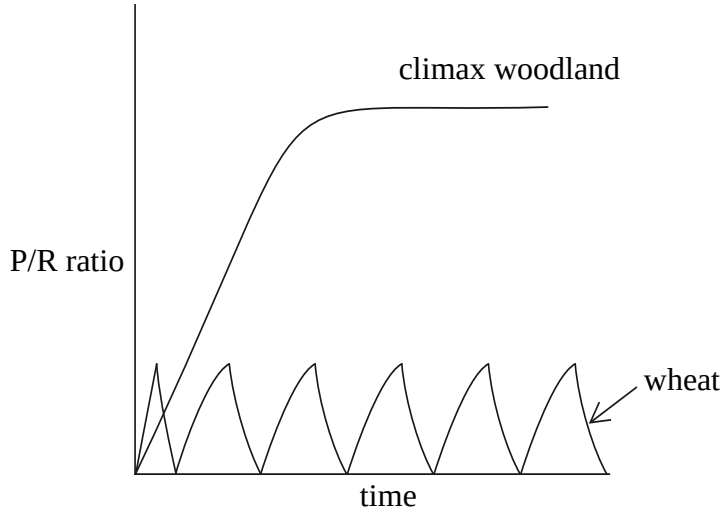


Diagram is not required though concepts may be expressed in words.

both wheat fields and woodlands have low initial productivity;
increases rapidly as biomass accumulates;
wheat harvested before production : respiration = 1;
herbivores controlled or isolated from the food production system;
natural woodland consumer community increases so naturally high productivity is balanced by consumption and respiration;
woodland reaches climax when production : respiration = 1 / all productivity is balance by respiration; ***[6 max]***
*Award **[2 max]** for examples and **[4 max]** for comparisons.*

(c) *characteristics*: ***[3 max]***
greater habitat diversity;
complex ecosystem;
various niches;
different nutrient and energy pathways;
large size;
little human activity;
minimal pollution;
plentiful abiotic factors *e.g.* water, light, heat;
different trophic levels;

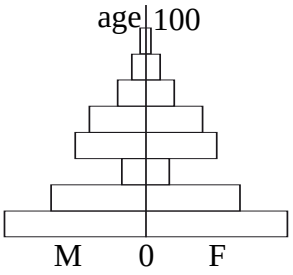
threats: ***[3 max]***
pollution – kills some species, makes conditions impossible for others / Trent Biotic Index organisms / degradation of ecosystems;
selective logging;
hunting of top carnivores;
human activities – burning / building;
grazing animals;
climate change; ***[6 max]***

Award credit if named examples are used.

Expression of ideas: ***[2 max]***

Total: ***[20]***

5. (a) population pyramids give age/sex structure for country;
age/sex pyramids identify percentage of providers and dependents within a country;
allows for monitoring change in dependent to provider ratio;
measures the size/structure of a population over-time;
number in fertile age bracket;
expanding/contracting population;
gender ratios;
birth rate and death rate;
impact of events, *e.g.* wars, disease, *etc*.



[5 max]

*Award **[1]** for a diagram.*

(b) global population continues to rise / *per capita* resources consumption increasing / resource exploitation is reaching its limits;
technology can increase carrying capacity *e.g.* GM crops/fertilizers/alternative energy sources;
must use resources more effectively;
as resources are depleted they become more economically expensive;
economic growth means demand for resources is increasing so cost increases (crude oil);
may not be sustainable in the long-term; ***[6]***
Accept any other reasonable suggestions.

(c)

	Advantages	***Disadvantages***
reducing use	resources are conserved / last longer;	hard to do / slows economic growth / reduces standard of living in present consumer culture;
reusing	reduces resources use; saves energy in extraction, processing or recycling;	health and safety issues / loss of technological edge;
recycling	reduces resource use *e.g.* aluminium recycling versus energy efficient; reduces landfill / increased environmental awareness; *e.g.* aluminium cans/bottles;	not economic as lot of energy required to recycle *e.g.* plastics/paper / lower quality materials;

[7 max]

*Award **[1]** for each advantage and disadvantage. Award credit for relevant examples.*

Expression of ideas: ***[2 max]***

Total: ***[20]***