MA99 EDUCATION

Human-Environment Interactions: Topic Notes

03

NSW GEOGRAPHY 11-12 SYLLABUS 2022 FOR HSC 2028 AND LATER

1. Land use, land cover and change over time

Change is a central geographical concept in this topic. Earth's natural systems have developed over very long time frames, often over millions of years. Human activity, by contrast, has altered the surface of the planet rapidly, in a very short time frame. Comparing these two rates of change is the starting point for understanding human influence on the environment.

Land cover: the physical material found on the surface of the Earth, such as forest, grassland, water, ice, bare soil, crops or built-up areas.

Land use: the human purpose for a piece of land, such as farming, housing, industry, mining, transport or conservation. One land cover, such as grassland, can support many different land uses.

Interconnection links these ideas. When people change land use, they usually change land cover as well. Clearing native forest for cropping replaces trees with bare soil or plants, which alters how the land stores water and carbon. This in turn affects natural systems and the climate, so land use, land cover, natural systems and climate are all connected.

- **Rapid human change:** deforestation, urban expansion and the spread of farmland can transform a landscape within a single lifetime, while natural processes such as soil formation and ecological succession work over centuries to millennia.

Key idea

Land cover is what covers the surface (forest, water, ice, crops). Land use is why people use that land (farming, housing, industry).

People have changed land cover far faster than natural processes ever could, and those changes feed back into the climate system.

2. Evidence for climate change

2.1 Natural climate change and its drivers

Climate has always changed. Long before humans, the Earth moved between warmer and cooler periods, including ice ages and warm interglacials. This is called **natural climate change** because it is driven by non-human factors.

The main natural drivers of climate change are:

- **Variations in solar output:** small changes in the energy given off by the Sun.
- **Volcanic activity:** large eruptions release ash and gases that can cool the Earth for a few years.
- **Orbital cycles:** slow, regular changes in the shape of Earth's orbit and the tilt of its axis alter how sunlight reaches the surface.
- **Ocean circulation:** currents move heat around the planet and can shift regional and global temperatures over long periods.

2.2 Palaeoclimate evidence

Palaeoclimate means past climate. Because thermometers only reach back to the 1800s, scientists use natural records called proxies to reconstruct climate over thousands to millions of years.

PALAEOCLIMATE RECORD	WHAT IT TELLS US
Ice cores	Bubbles of ancient air trapped in glacial ice reveal past temperatures and greenhouse gas levels going back hundreds of thousands of years.
Tree rings	The width of yearly growth rings records warmer, wetter or cooler, drier conditions.
Ocean sediments	Layers on the sea floor, including tiny fossils, record past ocean temperatures and chemistry.
Coral reefs	Growth bands in coral skeletons record sea temperature and ocean conditions.
Sedimentary rock layers	Rock strata preserve very long-term evidence of past environments and climates.

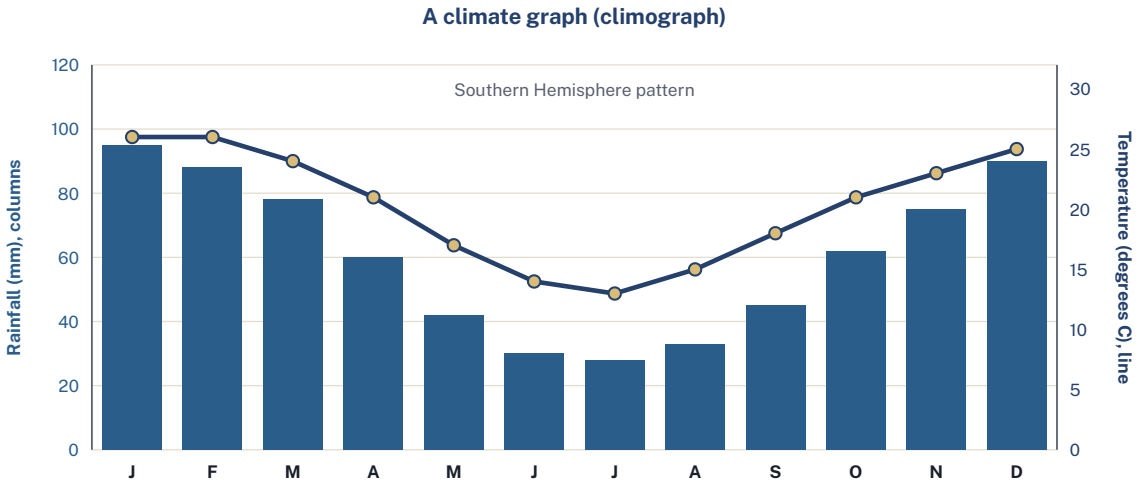


Figure 1 · A climate graph plots average monthly temperature and rainfall, one way geographers read climate data for a place.

Measured records confirm recent warming. The global average surface temperature has risen by about 1.2 degrees Celsius since reliable records began in 1850 (State of the Climate 2024).

3. Causes: the natural and enhanced greenhouse effect

3.1 The natural greenhouse effect

Natural greenhouse effect: greenhouse gases in the atmosphere, such as water vapour, carbon dioxide and methane, trap some of the heat leaving the Earth and keep the planet warm enough to support life. Without it, Earth would be far too cold.

The Irish scientist **John Tyndall** recognised that certain gases trap heat in the 1860s. In 1896 the Swedish scientist **Svante Arrhenius** was the first to link rising carbon dioxide to rising temperature, showing the science behind global warming is more than a century old.

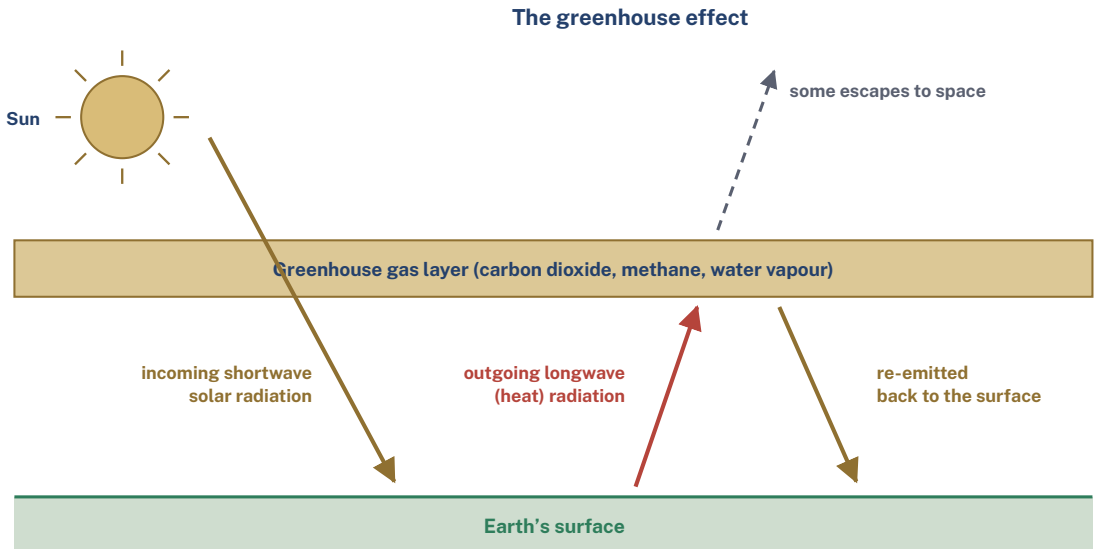


Figure 2 · The greenhouse effect: incoming solar energy warms the surface, and greenhouse gases trap part of the outgoing heat.

3.2 The enhanced greenhouse effect

Enhanced greenhouse effect: the extra warming that happens when human activity adds more greenhouse gases to the atmosphere, so more heat is trapped than the natural effect alone would hold.

Anthropogenic climate change: climate change that is human-induced. Its major contributors are the burning of fossil fuels, land clearing, agriculture and industry.

- **Burning fossil fuels:** coal, oil and gas release carbon dioxide when burnt for electricity, transport and heat.
- **Land clearing:** removing forests releases stored carbon and reduces the number of trees that absorb it.
- **Agriculture and industry:** livestock and rice growing release methane, while cement, steel and chemical production release greenhouse gases through energy use.

3.3 The carbon cycle and how humans disturb it

Carbon cycle: the natural movement of carbon between the atmosphere, oceans, soils, rocks and living things. Combustion, or burning, and deforestation move carbon from long-term stores into the atmosphere faster than natural processes can absorb it.

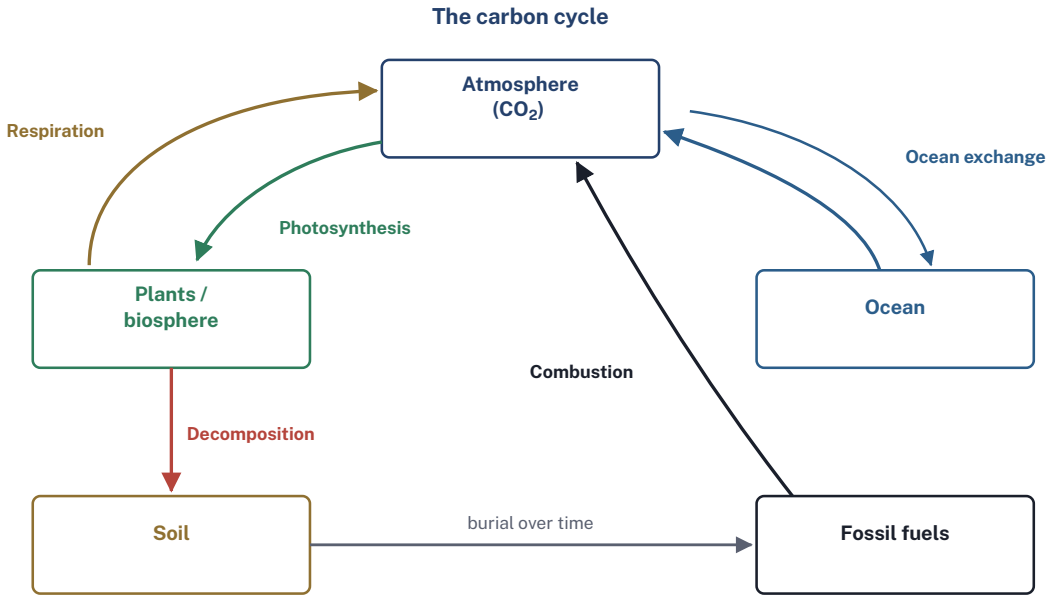


Figure 3 · The carbon cycle: humans disturb the balance by burning fossil fuels and clearing forests, adding carbon to the atmosphere.

The result is measurable. The global average concentration of carbon dioxide reached 419.2 parts for each million in 2023, and the carbon dioxide equivalent of all greenhouse gases reached 524 parts for each million (State of the Climate 2024). Levels are now far above anything in the palaeoclimate record.

FEATURE	NATURAL CLIMATE CHANGE	HUMAN-INDUCED CHANGE
Main drivers	Solar output, volcanoes, orbital cycles, ocean circulation	Burning fossil fuels, land clearing, agriculture, industry
Speed	Gradual, over thousands to millions of years	Rapid, over decades to a century
Greenhouse gases	Rise and fall within a natural range	Pushed well above the natural range
Evidence	Ice cores, tree rings, sediments, corals, rock layers	Instrument records, rising carbon dioxide, warming since 1850

> Natural change is real, but it is slow. Human change is real and fast. That contrast is the whole argument.

Key idea

The natural greenhouse effect keeps Earth liveable. The enhanced greenhouse effect, driven by extra human-added gases, is warming it further.

The key difference is rate: human-induced change is happening far faster than natural change.

4. Impacts of climate change

Warming. Australia has warmed by 1.51 plus or minus 0.23 degrees Celsius since national records began in 1910 (State of the Climate 2024). Sea surface temperatures in the Australian region have risen by about 1.08 degrees Celsius since 1900 (State of the Climate 2024). Warming increases the frequency and intensity of heatwaves, droughts and dangerous fire weather.

Glacial retreat and reduced snow. As temperatures rise, glaciers shrink and snow cover shrinks. The Australian Alps are projected to lose most of their natural snow, which affects water supply, alpine ecosystems and the snow tourism industry.

Sea level rise. Warmer oceans expand and melting ice adds water to the sea. Global mean sea level has risen more than 22 centimetres since 1900, with about half of that rise since 1970 (State of the Climate 2024). Rising seas threaten low-lying coasts, beaches and coastal settlements.

Ocean acidification. The oceans absorb a large share of the carbon dioxide people release. This makes seawater more acidic, which makes it harder for corals, shellfish and other shell-forming creatures to build their skeletons and shells. The oceans have become measurably more acidic since the Industrial Revolution.

Ecosystem and species impacts. Warmer water stresses corals and causes coral bleaching. The Great Barrier Reef has suffered mass coral bleaching in 2016, 2017, 2020, 2022, 2024 and 2025, six such events from 2016 to 2025 (Australian Institute of Marine Science).

- **Bushfire:** the 2019 to 2020 Black Summer bushfires burnt about 24 million hectares nationally (Commonwealth and NSW inquiries).
- **Flooding:** the eastern Australia floods of early 2022 caused overall losses of about US$6.6 billion, roughly 9.6 billion Australian dollars at 2022 exchange rates (Munich Re, July 2022), and insured losses of about 6.1 billion dollars from 243,057 claims (Insurance Council of Australia, November 2023).

Interconnection and scale run through these impacts: a change in the global atmosphere reaches down to a single reef, a single alpine valley or a single flooded town.

5. Responses and management at a range of scales

5.1 Mitigation and adaptation

Mitigation: action that reduces the cause of climate change by cutting greenhouse gas emissions or removing carbon from the atmosphere. Examples include switching to renewable energy and protecting carbon sinks such as forests.

Adaptation: action that adjusts to the impacts that are already happening or are expected, so that harm is reduced. Examples include building flood levees, changing crops and improving early warning systems.

ASPECT	MITIGATION	ADAPTATION
Aim	Reduce the causes of climate change	Adjust to the impacts of climate change
Focus	Cut emissions, build carbon sinks	Reduce harm, build resilience
Examples	Renewable energy, energy efficiency, reforestation	Sea walls, drought-resistant crops, warning systems
Timing	Prevents future warming	Copes with change already under way

5.2 Management at a range of scales

Scale is essential here. Climate change is a global problem, but responses happen from the international level all the way down to the household. Effective management links these scales together.

SCALE	WHO ACTS	EXAMPLES
International	Groups of nations	The Paris Agreement, in which countries agreed to limit warming, and net zero pledges
National	Governments	Australia's legislated emissions targets and support for renewable energy
Local	Councils, communities, households	Rooftop solar, tree planting, recycling, energy efficiency, local flood planning

International. Under the Paris Agreement, countries agreed to hold global warming well below 2 degrees Celsius and to pursue efforts to limit it to 1.5 degrees Celsius, and many have made net zero pledges.

National. Australia has legislated a target to cut greenhouse gas emissions by 43 per cent below 2005 levels by 2030 and to reach net zero emissions by 2050 (Climate Change Act 2022), and in September 2025 announced a 2035 target of a 62 to 70 per cent reduction below 2005 levels. Renewable sources supplied 39 per cent of Australia's main grid electricity in the 2024 calendar year (Clean Energy Regulator).

Local. Households and communities cut emissions through rooftop solar, energy efficiency, active transport and tree planting, and adapt through local flood and bushfire planning. Small actions add up across millions of people. For a scale question, always give one example at each level: world, nation and street.

6. Sustainability and ecologically sustainable development

Sustainability: meeting the needs of the present without reducing the ability of future generations to meet their own needs. Climate change is a test of sustainability, because today's emissions shape the environment future people inherit.

Ecologically sustainable development (ESD): development that improves people's wellbeing while protecting the environment and the natural systems that life depends on. It tries to balance the economy, society and the environment together.

Core principles of ESD include:

- **The precautionary principle:** where there is a threat of serious harm, a lack of full certainty should not be a reason to delay action.
- **Intergenerational equity:** the health and diversity of the environment should be kept for the benefit of future generations, alongside conserving biological diversity and natural systems.

Key idea

Mitigation tackles the causes, adaptation deals with the impacts, and both are needed.

Sustainability and ESD ask us to act now so that future generations inherit a liveable environment.

Responses only work when the international, national and local scales support one another.

Exam focus

Use the concepts by name: change (fast human change versus slow natural change), interconnection (land use, land cover, natural systems, climate) and scale (international, national, local).

Always support impacts with dated evidence, for example warming of 1.51 degrees Celsius in Australia since 1910 and carbon dioxide at 419.2 parts for each million in 2023 (State of the Climate 2024).

For an assess or evaluate command word, make a clear judgement and weigh strengths against limits.

Keep mitigation and adaptation distinct, and be ready to give an example of each at more than one scale.

About this resource

MA99 EDUCATION

Scope

NSW Geography, Year 11. Written to the NSW Geography 11-12 Syllabus 2022, Human-Environment Interactions, for students sitting the HSC in 2028 and later years. Every worked context uses real places and dated statistics from named sources (the ABS, the United Nations, State of the Climate 2024, the Australian Institute of Marine Science), with each figure dated and its source named where it is used, and every number was recomputed from its inputs before printing.

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Human-Environment Interactions: Practice Questions

03

NSW GEOGRAPHY 11-12 SYLLABUS 2022 FOR HSC 2028 AND LATER

1. Instructions

Instructions: attempt Section I, then Section II. Support your answers with dated evidence and the geographical concepts of change, interconnection and scale. The marking guide follows the page break.

2. Section I · Multiple choice

Question 1

1 MARK

Which of the following is an example of land cover rather than land use?

A Farming
B Housing
C Forest
D Conservation

Question 2

1 MARK

Which of the following is a natural driver of climate change?

A Burning coal
B Volcanic activity
C Land clearing
D Cement production

Question 3

1 MARK

Ancient air bubbles that reveal past greenhouse gas levels are trapped in:

A Tree rings
B Ocean currents
C Ice cores
D Sand dunes

Question 4

1 MARK

The enhanced greenhouse effect is best described as:

A The natural warming that keeps Earth liveable
B Extra warming caused by human-added greenhouse gases
C Cooling caused by volcanic ash
D The reflection of sunlight by ice

Question 5

1 MARK

Who first linked rising carbon dioxide to rising temperature, in 1896?

A John Tyndall
B Svante Arrhenius
C Charles Darwin
D James Cook

Question 6

1 MARK

Which of the following is an example of adaptation rather than mitigation?

A Installing rooftop solar
B Building a sea wall to protect a coast
C Replacing coal power with wind power
D Planting a forest as a carbon sink

Question 7

1 MARK

According to State of the Climate 2024, the global average concentration of carbon dioxide in 2023 was about:

A 280 parts for each million
B 350 parts for each million
C 419 parts for each million
D 524 parts for each million

3. Section II · Short answer

Question 8

2 MARKS

Define the terms ‘land use’ and ‘land cover’.

Question 9

3 MARKS

Identify three natural drivers of climate change.

Question 10

4 MARKS

Describe two types of palaeoclimate evidence and what each reveals about past climate.

Question 11

5 MARKS

Explain how human activity has disturbed the carbon cycle and enhanced the greenhouse effect.

Question 12

2 MARKS

A country plans to cut its greenhouse gas emissions from 600 million tonnes to 342 million tonnes (hypothetical data). Calculate the percentage reduction.

Question 13

2 MARKS

In 2024 renewable sources supplied 39 per cent of a grid's electricity (hypothetical data). Calculate the percentage supplied by non-renewable sources.

Question 14

4 MARKS

Compare mitigation and adaptation as responses to climate change.

Question 15

6 MARKS

Examine the observed impacts of climate change on Australia, using evidence.

Question 16

5 MARKS

Explain how responses to climate change operate at a range of scales.

Question 17

8 MARKS

Assess the effectiveness of Australia's national responses to climate change.

4. Marking guidance

Section I · Multiple choice

QUESTION	ANSWER	WHY
1	C	Forest is physical material on the surface (land cover); the others are human purposes (land use).
2	B	Volcanic activity is a non-human driver; burning coal, land clearing and cement production are human causes.
3	C	Ice cores trap ancient air bubbles that record past greenhouse gas levels.
4	B	The enhanced greenhouse effect is the extra warming from human-added gases, beyond the natural effect in option A.
5	B	Svante Arrhenius linked carbon dioxide to temperature in 1896; Tyndall recognised the effect earlier, in the 1860s.
6	B	A sea wall adjusts to an impact (adaptation); the others cut emissions (mitigation).
7	C	Carbon dioxide reached 419.2 parts for each million in 2023; 524 is the figure for all greenhouse gases combined.

Section II · Short answer

Question 8 (2 marks). One mark for each accurate definition.

- Land use: the human purpose for a piece of land, such as farming, housing or industry.
- Land cover: the physical material on the surface, such as forest, water, ice or crops.

Question 9 (3 marks). One mark for each correct driver, up to three.

- Any three of: variations in solar output, volcanic activity, orbital cycles, ocean circulation.

Question 10 (4 marks). Two marks for each record: one for naming it, one for what it reveals.

- Ice cores: trapped air bubbles reveal past temperatures and greenhouse gas levels.
- Tree rings: ring width records past growing conditions such as warmth and rainfall. Coral cores, ocean sediments or rock layers are also acceptable.

Question 11 (5 marks). Marks for linking human activity to the carbon cycle and then to warming.

- Burning fossil fuels (combustion) and clearing forests move carbon from long-term stores into the atmosphere.
- This is faster than natural processes can absorb it, so carbon dioxide builds up (419.2 parts for each million in 2023, State of the Climate 2024).
- More greenhouse gas traps more heat, which is the enhanced greenhouse effect and drives warming.

Question 12 (2 marks). Full worked solution.

- Step 1: find the reduction. 600 - 342 = 258 million tonnes (1 mark).
- Step 2: express as a percentage of the original. (258 / 600) x 100 = 43% (1 mark).

ANSWER The percentage reduction is 43%.

Question 13 (2 marks). Full worked solution.

- The renewable and non-renewable shares add to 100%.
- Non-renewable share = 100% - 39% = 61% (2 marks).

ANSWER Non-renewable sources supplied 61%.

Question 14 (4 marks). Marks for identifying similarities and differences.

- Both are responses to climate change. Mitigation reduces the causes by cutting emissions or building carbon sinks; adaptation adjusts to the impacts to reduce harm.
- Example: switching to renewable energy is mitigation; building a flood levee is adaptation. A strong answer notes both are needed.

Question 15 (6 marks). Marks for a range of impacts, each supported with dated evidence.

- Warming: Australia has warmed 1.51 plus or minus 0.23 degrees Celsius since 1910 (State of the Climate 2024).
- Sea level rise: global mean sea level up more than 22 centimetres since 1900 (State of the Climate 2024).
- Ecosystem impacts: Great Barrier Reef mass bleaching in 2016, 2017, 2020, 2022, 2024 and 2025 (Australian Institute of Marine Science); extremes such as the 2019 to 2020 Black Summer fires (about 24 million hectares) and the 2022 eastern Australia floods (overall losses of about US$6.6 billion, roughly 9.6 billion Australian dollars, Munich Re, 2022).

Question 16 (5 marks). Marks for explaining action at international, national and local scales.

- International: the Paris Agreement and net zero pledges.
- National: Australia's legislated 43 per cent cut below 2005 levels by 2030 and net zero by 2050, with renewables at 39% of the main grid in 2024 (Clean Energy Regulator).
- Local: rooftop solar, tree planting, energy efficiency and local flood planning. A strong answer shows how the scales connect.

Question 17 (8 marks). Marks for a clear judgement supported by strengths and limits with dated evidence.

- Strengths: legally binding targets (43 per cent below 2005 levels by 2030, net zero by 2050), a stronger 2035 target of 62 to 70 per cent announced in September 2025, and renewables reaching 39 per cent of the main grid in 2024 (Clean Energy Regulator).
- Limits: impacts are still worsening (warming of 1.51 degrees Celsius since 1910, State of the Climate 2024), Australia is one nation in a global problem, and success depends on links to international and local action.
- Judgement: national responses are increasingly effective but not sufficient alone; they must connect to every scale. Top band answers make the judgement explicit and sustain it.

Attempt record

Come back every few weeks and date it. Improvement in a written subject is invisible from the inside, which is why students who are getting better so often believe they are not.

DATE	MARK OUT OF 48	THE ONE THING TO FIX NEXT TIME

Fill one row every time you sit a set. A tracker with three rows in it is worth more than a perfect one you never started, because the pattern you are looking for only shows up across attempts, not inside one.

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