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VCE GEOGRAPHY
SUPPLEMENT SERIES

Unit 3

Changing the Land

Supplement Series

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Aerial view of the Fehmarnbelt Tunnel construction site, showcasing the world's longest immersed tunnel project connecting Denmark and Germany beneath the Baltic Sea. Upon completion in 2029, this 18 km tunnel will reduce travel time between Copenhagen and Hamburg from 4.5 to 2.5 hours, facilitating faster and greener transportation across Europe.

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Contents

1 How to use this supplement series

Keeping your Geography studies relevant

Since the publication of the Third Edition of *Unit 3: Changing the Land* and *Unit 4: Human Population* in 2021, the world's population has continued to grow, and land use has continued to evolve in response to changing needs. As geographers, it is essential to refer to the most up-to-date and reliable data to accurately monitor change over time.

This supplement series is designed to provide, where relevant and available, more recent or live data sets and sources to support and enhance the Third Edition of *Unit 3: Changing the Land* and *Unit 4: Human Population* . The authors have updated all statistical data presented throughout the body text of the chapters, along with revised visual sources such as tables, graphs, and maps—using live data where applicable so that ongoing change can be tracked.

Activity blocks have also been updated, where relevant, to align with the new data provided. In addition, each chapter now includes new questions with corresponding suggested sample answers to further support student learning and understanding.

Each page of this supplement series is presented in a two-column format:

- The left-hand column contains the original data, text or visual from the Third Edition along with its corresponding page number.
- The right-hand column provides updated data, revised text, new sources or live links where more current information is available.

Updated case studies provide relevant new data and digital sources for the existing case studies in the Third Edition.

Updated activities are improved versions of those already published in the Third Edition. These updates either incorporate the latest data presented in this supplement or better align with the current VCE Geography Study Design.

New activities are completely original and exclusive to this supplement. They extend the activities presented in the Third Edition. These tasks are designed to deepen analysis and enhance the application of geographical concepts. Suggested sample answers are provided for each new activity to support self-checking, reflection, and improvement of written responses.

▼ Skyline of Hong Kong.

2 Land use change: an overview

Updated in-text data

ORIGINAL DATA (Page 27)

Australia will continue to change due to many interconnected processes, mainly:

- a growing population from 26 million in 2020 to an estimated 40 million in 2050.

UPDATED DATA

- a growing population from **27.7 million in 2025 to an estimated 40 million in 2050.**

Australian Bureau of Statistics

NOTE: 2050 estimated is a high estimate

ORIGINAL DATA (Page 27)

Melbourne's population could reach 8 million by 2050, up from its 2018 total of 4.5 million.

UPDATED DATA

Melbourne's population could reach **8.5 million by 2050, up from its 2025 total of 5.4 million.**

Australian Bureau of Statistics

ORIGINAL DATA (Page 27)

State Planning Policy Framework (SPPF).

UPDATED DATA

Melbourne's Future Planning Framework **(updated November 2024).**

Victorian Government Planning

ORIGINAL DATA (Page 29)

Land clearance of scrub and trees for agricultural purposes contributed about 9 per cent of Australia's greenhouse gas emissions in 2020.

UPDATED DATA

A greenhouse gas contribution of around **8 per cent in 2020** was quoted in a 2023 report.

Threatened Species Scientific Committee (Nov 2023) for Australian Government Department of Climate Change, Energy, the Environment and Water (2024)

Gold Coast, Australia.

Updated visual sources

Page 20

ORIGINAL DATA

Figure 2.4 Mosman, topographic map extract 1:50,000 and legend.

NEW DIGITAL SOURCE

Google Earth: Mossman, Queensland.

Page 25

ORIGINAL SOURCE

Figure 2.9 (b) Point Cook, Victoria, 2020.

NEW DIGITAL SOURCE

Google Earth: Point Cook, Victoria.

NOTE: Minimal change over time

UPDATED ACTIVITIES

Page 21

Activity 3 and Figure 2.5 (a)

Suggest the types of supporting land uses that are likely to develop as a result of the urban changes shown in Figure 2.5 (a).

Page 24

Activity 6 and Figure 2.8

a. Identify the physical factors likely taken into account prior to the construction of the dam in Figure 2.8.

b. Describe the possible impacts of the use of the dam's water reserves on nearby land uses.

Page 26

Activity 2 and Figure 2.10

Describe at least one positive and one negative impact of constructing a walkway onto a beach area, such as the one shown in Figure 2.10 or another coastal location. Evaluate whether the positive impacts are likely to outweigh the negative ones.

Page 28

Activity 5 and Figure 2.9 (a)

As a rural landowner in the southern part of Figure 2.9 (a), outline the factors that might persuade you to sell your farmland for urban housing development. How could this decision contribute to a larger issue?

Page 29

Activity 2 and Figure 2.14

A one-metre rise in sea level by 2100 could significantly affect coastal areas like the one shown in Figure 2.14. Suggest the potential costs coastal suburbs and towns may face in the coming years to reduce this threat. Justify who you believe should pay for these developments — visitors like those in Figure 2.14, local residents, or governments.

Page 30

Activity 1

Review the images in Figures 2.1, 2.5 (b), 2.8, and one other image from this chapter. Develop a set of criteria to evaluate how desirable each location is for living, working, and recreation. Explain how you would apply your criteria to assess the suitability of each location.

Page 30

Activity 1 and Figures 2.16 (a) (b)

Compare the data in Figures 2.16 (a) and 2.16 (b). How effectively do these data sets, when considered together, indicate where future urban and village land uses might develop?

▼ New housing estates are transforming landscapes into residential neighbourhoods, highlighting the changing patterns of land use in rapidly growing outer suburban areas. Golden Bay, Western Australia, 2023.

alistemon, CC BY-SA 4.0, via Wikimedia Commons

NEW ACTIVITIES

Page 20

Figure 2.4 and Activity 4

f. Login into Google Earth and locate Mossman.
Adjust the image to match the map area of Figure 2.4. Activate historical imagery. Identify changes in land use since the map was produced. Look particularly for changes in urban areas on the coast.

Page 21

Figure 2.5 (a) and Activity 4

In late 2024, the site in Figure 2.5(a) was cleared, and by 2025, construction was underway for an eight-storey apartment and retail development. Describe the changes in land use that may occur once this development is complete.

Page 26

Figure 2.9 (a) (b) and Activity 3

Figures 2.9(a) and (b) show significant changes in land use over a short period of time. Identify changes in land use over a similar area in one of the following locations:

- An inner area of a large urban centre, such as a Central Business District (CBD), or
- A rural area with farming activities.

The location may be within Victoria or elsewhere, and should cover an area roughly the size shown in Figure 2.9.
List the observed changes in land use in order of their extent (from most to least significant), and provide a comment on the scale of these changes—whether they are small and localised, or large and regional in nature.

Page 28

Figure 2.12 and Activity 6

a. Provide a definition of an activity centre, as shown in Figure 2.12.
b. Suggest the regional impact on land use as a major activity centre develops.

Page 29

Figure 2.14 and Activity 3

Access *Built Environment Climate Change Adaptation Action Plan* (July 2024 summary). It is a summary that provides links to more detailed information and serves as an excellent starting point. Discuss with your classmates how this plan could affect land use in an area you are familiar with, such as your local neighbourhood or a regional recreational site. Consider whether there are places you would prefer not to see changed—be sure to explain why. Present a summary of your discussion to the rest of the class.

▼ Front Street, Mossman, Queensland, 2020.
(Notice the sugar cane transporter at the top of the street.)
Kgbo, CC BY-SA 4.0, via Wikimedia Commons

3 Land use change in urban areas

Updated in-text data

ORIGINAL DATA Page 33

The population reached 5.2 million in 2019, an increase of over 2.5 million since 1970.

UPDATED DATA

The population reached over **5.3 million in 2024, an increase of 2.8 million since 1970.**

Macrotrends.net

ORIGINAL DATA Page 33

Based on pre-COVID-19 trends, it was expected that population would grow to over eight million requiring an additional 1.6 million dwellings by 2050.

UPDATED DATA

Melbourne's population is projected to reach around **8 million by 2050, requiring an addition 1.6 million dwellings.**

Planning.vic.gov.au

ORIGINAL DATA Page 33

The Victorian Planning Authority's West Growth Plan projects that this region will eventually accommodate over 377,000 residents and provide at least 164,000 jobs.

UPDATED DATA

The Melbourne West region is expected to account for **21 per cent of Melbourne's growth between 2021 and 2046, leading to a population growth from 863,956 to 1,469,301.**

.id

ORIGINAL DATA Page 42

The residential population of Lilydale is growing steadily and reached 17,594 in 2021.

UPDATED DATA

The residential population of Lilydale is **growing steadily and reached 17,348 in 2021.**

Australian Bureau of Statistics

Melbourne, Australia.

Updated visual sources

ORIGINAL DATA Page 33

Figure 3.2 Melbourne's population growth by region.

NEW SOURCE

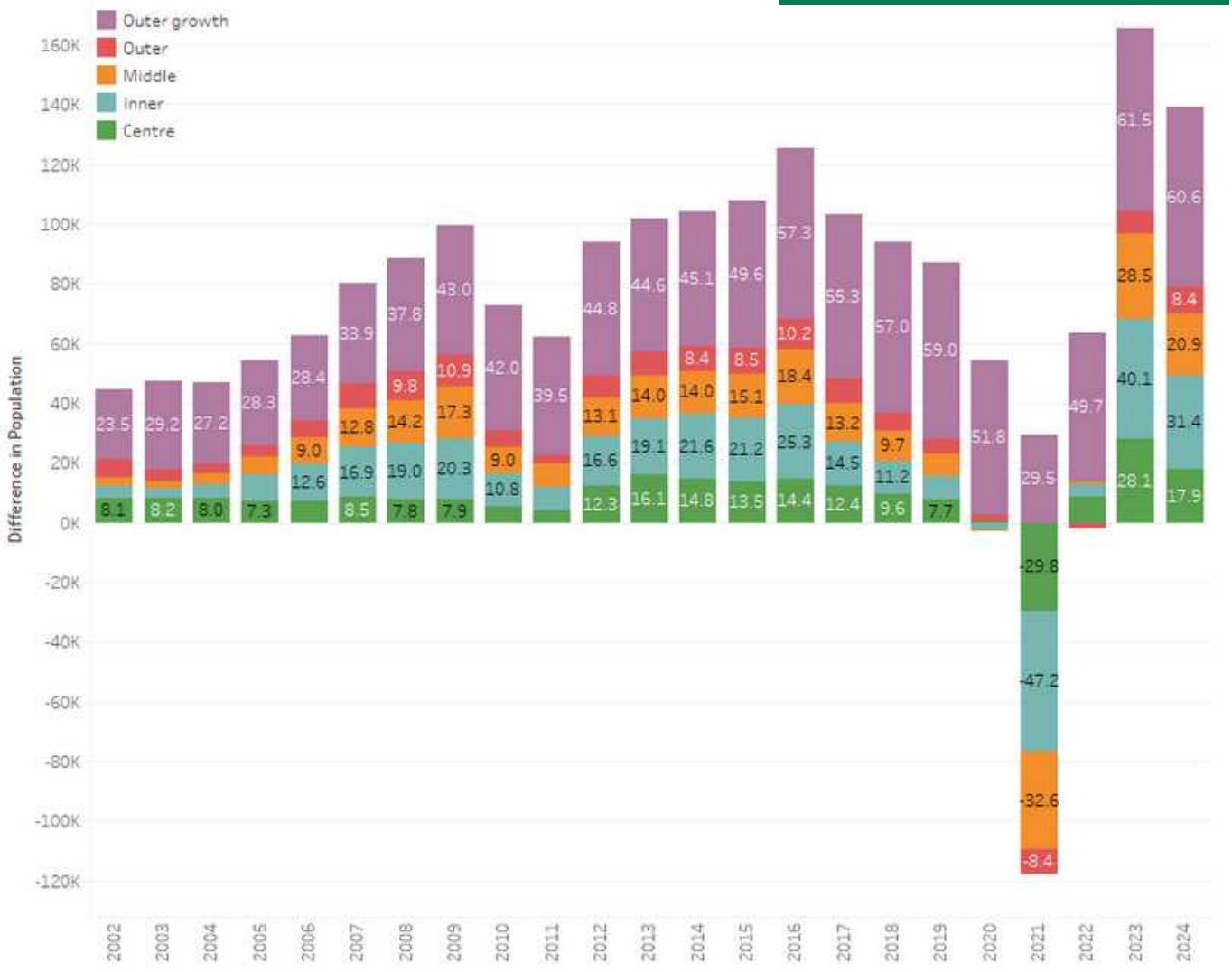


Figure 3.2 Annual Melbourne population growth by region. Source: ABS 2025. Attribution: Chris Loader.

ORIGINAL SOURCE Page 34

Figure 3.3 Distribution of land use in the Port Phillip and Western Port regions (Source: Bureau Of Meteorology, 2018).

NEW DIGITAL SOURCE

Australian Land Use Profiles – 2018 update.

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

ORIGINAL SOURCE Page 35

Figure 3.5 Satellite images taken on **(b)** 27 March 2020 show the extent of physical changes that have occurred at the former Eastern Golf Course site.

NEW DIGITAL SOURCE

Google Earth: 463 Doncaster Road, Victoria.

ORIGINAL SOURCE

Page 39

Figure 3.12 The growth of the population and number of dwellings in Mount Evelyn (2001–2016).

ORIGINAL SOURCE

Page 43

Figure 3.19 The past and projected growth of Lilydale's population (1991-2041).

NEW DIGITAL SOURCE

Mount Evelyn: 2021 Census All persons QuickStats.

Australian Bureau of Statistics

NEW SOURCE

Year	Population
2021	17,523
2026	19,394
2031	22,983
2036	26,632
2041	30,280
2046	33,904

Figure 3.19
The past and projected growth of Lilydale's population (2021-2046).
Source: Forecast id

UPDATED ACTIVITIES

Page 34

Figure 3.2 and Activity 1

a. How has the net population growth changed between 2009 and 2024?
b. In which regions of Melbourne has the most growth occurred?
c. Suggest reasons for your answers to part a and b.

Page 36

Figures 3.5 (a) (b) and Activity 1

Use Google Earth to access a recent satellite image of the former Eastern Golf Course site at 463 Doncaster Road, Doncaster. Compare this satellite image with Figures 3.5(a) and 3.5(b). Describe the extent to which the geographic characteristics of the site have changed as a result of the new residential development.

Page 38

Activity 2

Visit the website of the Merri-bek City Council, formerly Moreland City Council and access their Nature Plan.
a. Using a table, summarise the Council's achievements.
b. Outline how land management within urban regions such as Merri Creek corridor can help to provide positive environmental and social impacts.

Merri Creek from an observation point in Fairfield, Victoria, 2022.
Philip Mallis from Melbourne, CC BY-SA 2.0, via Wikimedia Commons

NEW ACTIVITIES

Page 34

Figures 3.3 and 3.4 and Activity 2

a. Describe the distribution of urban land use. Describe the overall pattern, provide examples and quantification, and state any exceptions.

b. Visit this link to access data relating to land use in the Port Phillip and Western Port region. Use the data to describe the land use within the agricultural and non-agricultural classifications.

Page 36

Activity 6

Use Google Earth Pro to access historic and recent satellite imagery of the Burwood Brickworks site (70 Middleborough Road, Burwood East) or the former Boronia Heights Secondary College site (40 Mount View Road, Boronia). Use the satellite images to outline the sequence of changes over time and identify any visible stages of the redevelopment process.

Page 38

Activity 7

a. Choose a region of Melbourne that has experienced urban sprawl, such as the south-east near Pakenham or the north near Craigieburn.

b. Use historic satellite imagery on Google Earth Pro to examine the extent of the sprawl over the past decade. Use the ruler tool to measure and quantify the scale of this change.

c. Based on your observations, predict whether this urban sprawl is likely to continue and estimate how far it may extend in the future.

Page 41

Activity 8

Visit the community profile for Mount Evelyn and access data about population, households and dwellings.

a. State the increase in Mount Evelyn's population and number of dwellings that is forecast to occur between 2021 and 2046.

b. Explain why the change in the size of dwellings is significant when considering the impacts of land use change on urban waterways.

Page 45

Activity 9

Visit the website for Kinley to explore the progress of the new housing estate.

a. Kinley has been rated a 6 Green Star Community. Outline the features of this development that have contributed to this award.

b. Refer to the proposed development in the Town Centre. Suggest one positive and negative impact of this aspect of the development.

c. Explore the availability of land and updates to the Masterplan. Comment on the development's progress.

Page 45

Figure 3.18 and Activity 10

Using Google Earth, access a recent satellite image of the Kinley estate.

Compare your satellite with Figure 3.18 and comment on the progress of the development.

▼ Oblique aerial photograph of Lilydale Lake and surrounding urban environment.

4 Land use change in rural areas

Updated visual sources

ORIGINAL SOURCE — Page 46

Figure 4.1 (b) Satellite image of Chadstone Shopping Centre and surrounding suburbs in 2019.

NEW DIGITAL SOURCE

Figure 4.1 (b) Google Earth image of Chadstone Shopping Centre and surrounds in 2024.

Google Earth

ORIGINAL SOURCE — Page 48

Figure 4.3 (b) A new urban centre being built on the peri-urban fringe near Cranbourne. When completed, this development will house a shopping centre, library, medical facilities and shared community spaces.

NEW DIGITAL SOURCE

Figure 4.3 (b) Google Earth image of the same site, August 2023, Strathlea Drive.

Google Earth

NOTE: Look around but be careful not to move the image too far or it will revert to 2019.

▼ To account for a growing population and increased public safety at level crossings, many train stations have been upgraded around Melbourne. The newly re-built Pakenham Train Station, June, 2024.

Marcnut1996, CC BY-SA 4.0, via Wikimedia Commons

NEW SOURCE

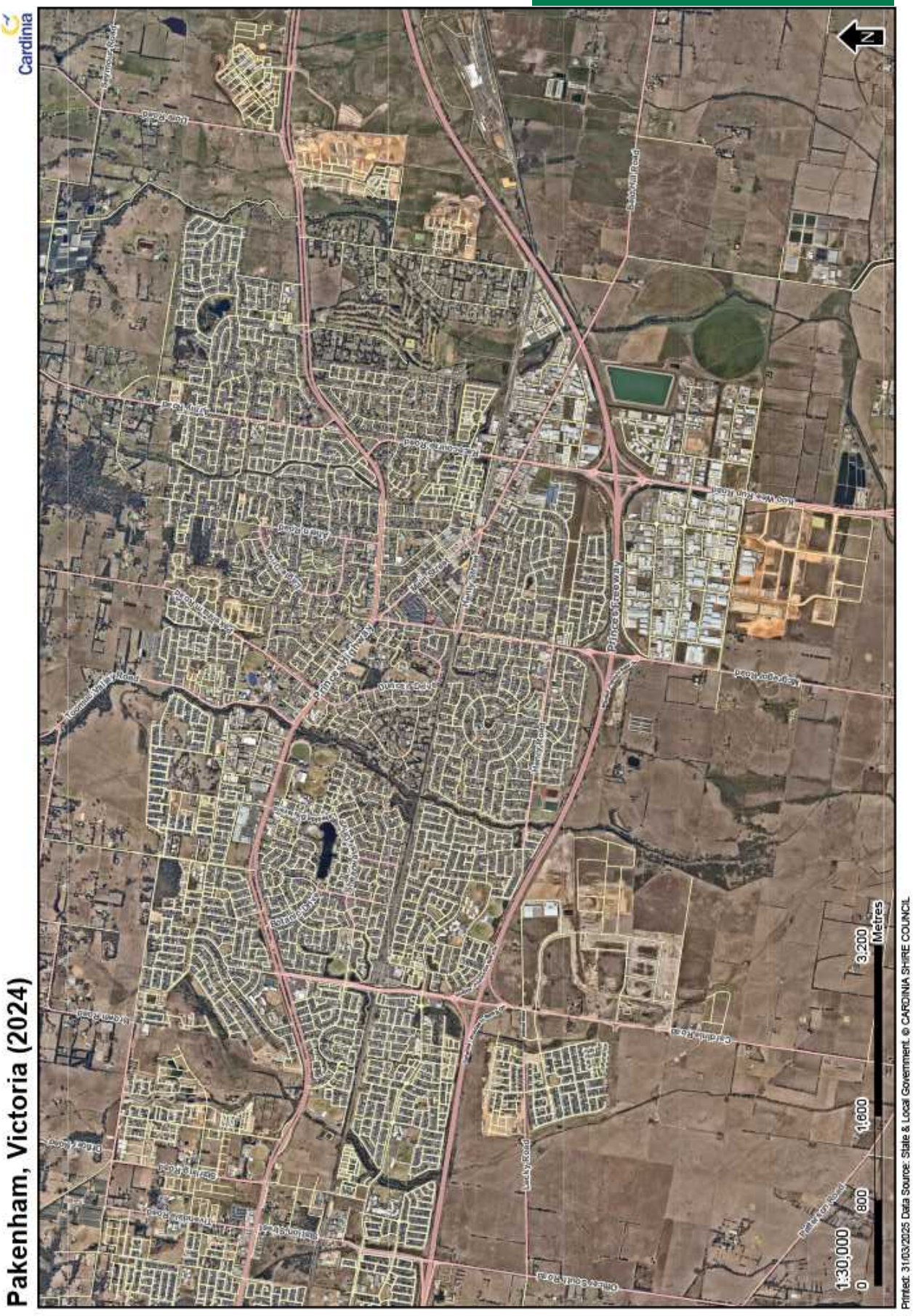


Figure 4.7 (e) GIS map of Pakenham in 2024 showing housing estates over the planned growth area (31/03/2025). Attribution: State & Local Government. © CARDINIA SHIRE COUNCIL

UPDATED ACTIVITIES

Page 34

Figure 4.7 (a) (c) (e) (new) and Activity 2

a. Use the same base map from Question 1 and produce an overlay map using tracing paper to show the changes in land use in 2019, again using data from Figure 4.7 (c). Describe the changes in rural land use in Pakenham from 2002 to 2024.

NEW ACTIVITIES

Page 48

Activity 5

Visit the Google Maps link and compare Strathlea Drive as it appeared in 2019 (while under construction) with the most recent Google Earth image from August 2023. Be careful not to move the cursor too much, as it may revert to the 2019 imagery. Identify the new services and land uses visible at this site and compare them with those from 2019.
Do these new services meet the needs of people living on the peri-urban fringe?

Page 51

Figure 4.3 (a) and Activity 8

Referring again to Figure 4.3 (a) and the most recent Google Street View of the Cardinia General Store, explore the area surrounding the store. Consider how the area around the store has changed over the years. Clyde is now located 6 km to the west of the store, and Pakenham lies 6 km to the north. If you were operating this business, what changes would you make, and what would you keep, to ensure the long-term sustainability of the store?

Page 53

Activity 2

b. Why do you think growth has recently occurred on the southern side of the Princes Freeway along Koo Wee Rup Road in 2024, even though it was not planned for in 2020?

Page 53

Activity 7

Explore the area around Cardinia Station. What types of services currently exist in Pakenham? How have these services contributed to Pakenham's rapid expansion? Explain why there is a large car park adjacent to Pakenham Station. What does this suggest about the level of interconnection experienced by residents in and around Pakenham?

Page 57

Activity 5

The proposed wedding reception centre, 'Barn Events' from 2020 is now a reality, and its website is included in the link provided. It is located to the east of Pakenham, in the neighbouring suburb of Nar Nar Goon. Explore the website and view the drone footage showing the wedding reception area and its surroundings. The site was once a working dairy farm of over 1,000 acres, which has since been subdivided into smaller parcels of land. In this case, the farmhouse and milking sheds were retained, along with some surrounding farmland.

Explain why, in an outer growth area such as Pakenham and Nar Nar Goon, the land use changed from a working dairy farm to a wedding reception centre. How does this example illustrate land-use change?

▼ Pakenham Place Shopping Centre, purchased by developers in late 2020, is set to undergo a major refurbishment. The redevelopment will feature a new supermarket, fresh food outlets, dining options, and a variety of specialty retailers.

Liamdstuff, CC0, via Wikimedia Commons

5 Investigating land use change: fieldwork

Updated in-text data

ORIGINAL DATA Page 59

As discussed in the previous three chapters, large semi-rural areas neighbouring Melbourne's Urban Growth Boundary are experiencing increased development pressure as the population is projected to double by 2050.

UPDATED DATA

Population of Melbourne is **projected to reach 8 million by 2051.**

Plan Melbourne 2025

ORIGINAL DATA Page 59

Australia has continued to grow its population at one of the highest rates of any of the Organisation for Economic Cooperation and Development (OECD) countries and Melbourne was the fastest growing city in Australia in 2018, adding nearly one million people in 10 years.

UPDATED DATA

Melbourne was the fastest growing city in Australia **in 2023, adding 167,000 people in a year.**

ABS 2024, Capital city growth the highest on record

▼ Fishermans Bend, Victoria, 2020.
Orderinchaos, CC BY-SA 4.0, via Wikimedia Commons

Updated visual sources

ORIGINAL SOURCE

Page 59

Figure 5.2 A map of the Precinct Structure Plans (PSPs) published by the Victorian Planning Authority in 2021. These are completed, active or proposed future plans. There are over 100 PSPs, which are the detailed visions for Melbourne's growing peri-urban and outer urban communities.

NEW DIGITAL SOURCE

A map of the Precinct Structure Plans (PSPs) published by the Victorian Planning Authority in 2022.

Victorian Planning Authority

ORIGINAL SOURCE

Page 71

Figure 5.16 Sea level rise inundation mapping showing the Lorimer and Montague precincts under a 1.1-metre flood.

NEW SOURCE

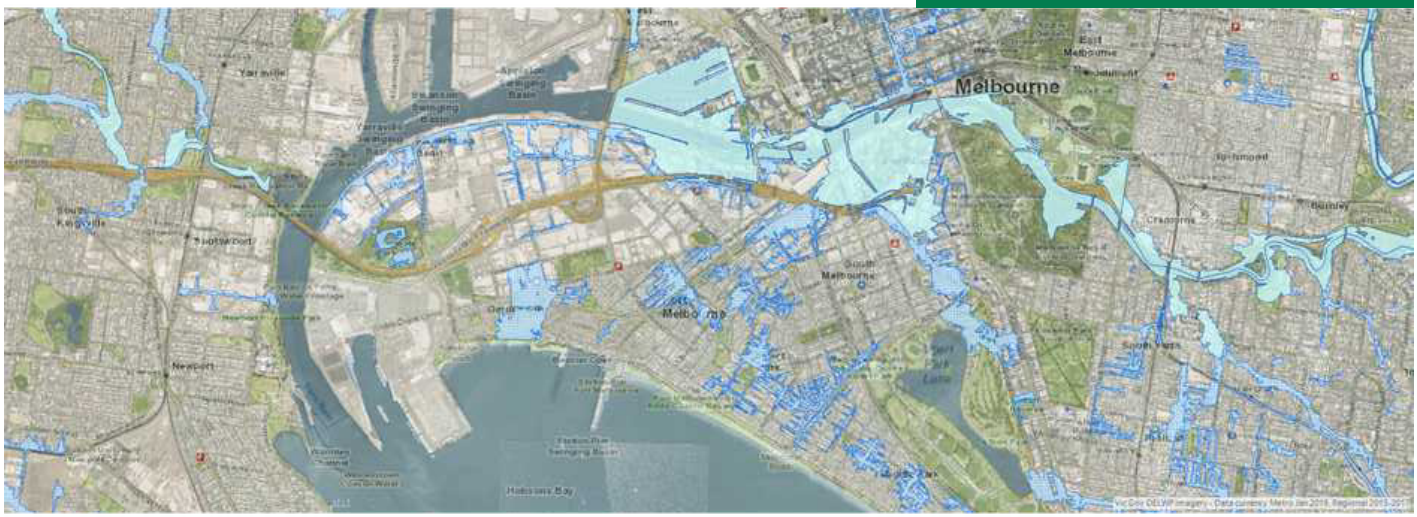


Figure 5.16 Fishermans Bend development area subject to flooding or inundation (2025). Generated using Mapshare–Vicplan.

UPDATED ACTIVITIES

Page 71

Activity 6

Go to the government interactive mapping database at mapshare.vic.gov.au/vicplan.
Select and adjust the layer controls, including contours, inundation, and zoning.
Print your map as a PDF for use in your report. Make sure to edit the PDF so that it meets BOLTSS mapping standards (Border, Orientation, Legend, Title, Scale, and Source).

NEW ACTIVITIES

Page 65

Activity 5

Following your school's policy on the use of artificial intelligence, use an AI chat platform to identify and rank the biggest challenges facing peri-urban Local Government Areas (LGAs). Select two different sources from your findings and critically evaluate their content, considering factors such as reliability, relevance, bias, and depth of analysis.

Page 71

Activity 9

Abiding by your school's policy on the use of artificial intelligence, use an AI chat platform to find data sources related to your research area. For example, you might query: *"How and why have land values changed in Fishermans Bend before and after being zoned as a Capital City Zone (CCZ)?"*
Read through the sources provided and critically evaluate their content, considering factors such as accuracy, reliability, relevance, and potential bias. Provide specific examples to support your evaluation.

6 Land cover change: an overview

UPDATED ACTIVITIES

Page 76

Figure 6.2, Figure 6.3 and Activity 2

a. Refer to Figure 6.3. Identify and describe two inputs of human effort and skill required to manage the land cover.

b. Use Figure 6.2 to name a region of a country where this land cover is present in each of the following continents: Europe, Australia, and North America.

Page 77

Figure 6.11 and Activity 5

In which directions has most urban expansion occurred? What geographical data would you use to determine the reasons for this?

Page 80

Figure 6.14 , Figure 6.15 and Activity 4

Explain two environmental conditions that would make it difficult for the vegetation in Figures 6.14 and 6.15 to thrive.

Page 81

Figure 6.19 and Activity 4

What evidence does Figure 6.19 provide to suggest that the original land cover was sandy desert? Justify the broad land cover category you would now assign to this area.

NEW ACTIVITIES

Page 76

Activity 12

Using the full land cover map over Victoria, calculate the approximate percentage of the two main land covers in the following two areas:

a. North to south, 150 kilometres from the western border

b. North to south, 150 kilometres from the eastern border

Apply these land covers to the categories given on pages 76–78.

Page 77

Activity 6

a. Discuss with another Geography student what features you think have allowed land cover change to occur in an area known to both of you.

b. Decide whether these features were largely the result of natural processes or human activity.

c. In the next decade, what changes in land cover might occur in your discussion area? On what basis did you reach your conclusion?

Page 80

Activity 7

Google Earth: Mayon Volcano, Philippines

Download and zoom out so that part of the coastline and the city of Santo Domingo are visible. Note that the dark brown–purple streaks represent recent lava flows.

For the two following areas, identify the land cover that could change as a result of a major lava eruption. Be prepared to zoom into the specific areas before making an assessment.

a. A lava flow to the southwest reaching Guinobatan.

b. A lava flow to the southeast extending beyond the Mayon Black Lava Zipline Adventure.

Page 80

Figure 6.17 and Activity 5

a. Suggest why planning authorities allowed the land cover to change from cultivated and managed areas to artificial surfaces and associated areas.

b. Justify a planning policy that would allow some of the cultivated and managed land cover to remain in this region.

7 Land cover change: melting glaciers and ice sheets

Updated in-text data

ORIGINAL DATA — Page 82

Globally, an average annual reduction of 87,000 square kilometres of ice occurred between 1979 and 2016.

UPDATED DATA

Between **2000 and 2023, glaciers lost approximately 273 gigatonnes of ice, or around 705,221 square kilometres.** This accounts for approximately 5 per cent of all ice cover. Greenland lost 18 per cent of its ice during this period, and some European glaciers have lost up to 39 per cent of theirs.

The GlaMBIE Team. Community estimate of global glacier mass changes from 2000 to 2023. Nature 639, 382–388 (2025). https://doi.org/10.1038/s41586-024-08545-z

NOTE: This article, published in March 2025, is the most up-to-date on ice loss and shows that the rate of ice loss varies by region. Significant differences between regions make it difficult to provide a definitive estimate of total ice loss.

ORIGINAL DATA — Page 84

The Randolph Glacier Inventory (RGI) has identified 217,175 glaciers covering approximately 726,800 square kilometres of various sizes found in the mountainous regions of North America, South America, Europe, Africa, Asia and Antarctica.

UPDATED DATA

The Randolph Glacier Inventory identified **274,531 glaciers covering approximately 706,700 square kilometres.**

GLIMS RGI, Appendix 1: Glacier count/area per region

NOTE: A new, more accurate survey of glaciers—Version 7.0—was completed in 2023. It identified more glaciers, but showed a significantly reduced total area.

ORIGINAL DATA — Page 97

NASA and the NOAA, both based in the USA, stated that 2016 was the hottest year and 2019 the second hottest year in the Earth's recorded history and that the 10 hottest years on this planet have occurred since 1997.

UPDATED DATA

The World Meteorological Organization confirmed that **2024 was the hottest year on record.** The period from 2015 to 2024 ranks as the hottest decade on record.

World Meteorological Organization (WMO), Press Release

ORIGINAL DATA — Page 97

The average annual surface temperature in 2016 was 0.9°C warmer than 20th Century average temperatures.

UPDATED DATA

In 2024, the Earth was estimated to be **1.3 degrees Celsius warmer than the 20th-century average.**

World Meteorological Organization (WMO), Press Release

ORIGINAL DATA

Page 97

It is estimated that since accurate records have been collected in 1880, the Earth's annual average surface temperature has increased by 0.94°C.

UPDATED DATA

The Earth's average annual surface temperature has **increased by 1.28 degrees Celsius.**

NASA/GISS

ORIGINAL DATA

Page 98

The IPCC 5th Assessment Report.

UPDATED DATA

The **IPCC 6th Assessment report was published in 2023.**

IPCC 6th Assessment Report

NOTE: The Sixth Report provides updated climate assessments and projects impacts on species loss, human health, food production, and fisheries.

ORIGINAL DATA

Page 101

Greenland is losing approximately 249 cubic kilometres of ice directly into the sea per year.

UPDATED DATA

In 2024, the NASA Grace satellite estimated that Greenland was losing 269 gigatonnes of ice per year, contributing 0.8mm to global annual sea level rise.

NASA, GRACE

ORIGINAL DATA

Page 107

Climate summits and IPCC.

UPDATED DATA

The 58th session of the IPCC was held in Switzerland in March 2023.

IPCC, 6th Report Cycle

ORIGINAL DATA

Page 107

IPCC 6 is due in 2022.

UPDATED DATA

IPCC 6 was published in 2023. Expressions of interest for scientists to be involved in IPCC 7 to be held in China in late 2025.

IPCC, 6th Report Cycle

ORIGINAL DATA

Page 107

London Tax is approx. A$20 per day. Milan Tax approx. A$10 per day Electric vehicles are exempt in many places. Most European countries subsidise the purchase of electric vehicles.

UPDATED DATA

London Tax is $30 per day. Milan Tax is $13 per day.

Transport for London

UPDATED DATA

NEW

2025 has been declared by the United Nations as the international Year of Glaciers. The United Nations has declared 21 March each year as the World Day for Glacier Preservation.

https://www.un.org/en/observances/world-glaciers-day

UPDATED DATA

NEW

The movie "Canary" was released in 2023 and depicts the life of glaciologist Dr Lonnie Thompson. Dr Lonnie Thompson has tracked the decline of high-altitude glaciers over many decades, most notably in the Andes Mountains.

https://www.canarythemovie.com/

Updated visual sources

ORIGINAL SOURCE

Page 84

Figure 7.5 Distribution of land covered by glaciers and ice sheets.

NEW DIGITAL SOURCE

Figure 7.5 is still accurate except that Venezuela as of 2024 has lost all of its glaciers.

ORIGINAL SOURCE

Page 87

Figure 7.11 Change in the amount of ice on South Cascade Glacier between 1928 and 2014.

NEW DIGITAL SOURCE

The USGS provides regular updates on the South Cascade Glacier and features an interactive map showing its decline up to 2021.

USGS: Ecosystems Land Change Science Program

WGMS: South Cascade Glacier, Cascade Mountains

ORIGINAL SOURCE

Page 90

Figure 7.17 The number of melt days on Greenland ice sheet in 2012, 2013, 2015 and 2019 in comparison to number of melt days between 1981 and 2010.

NEW DIGITAL SOURCE

The National Snow and Ice Data Centre has recent images available.

National Snow and Ice Data Centre

ORIGINAL SOURCE

Page 91

Figure 7.19 Landsat image of Jakobshavn Isbrae Glacier showing its retreat from 1851. The landsat images begin in 2001. Dates prior to 2001 have been estimated from other photos and data.

NEW DIGITAL SOURCE

NASA has recent satellite imagery of this glacier showing changes between 1985 and 2022.

NASA: Jet Propulsion Laboratory

ORIGINAL SOURCE

Page 97

Figure 7.29 Global temperature trends, 1850–2018.

NEW DIGITAL SOURCE

A new graph is available that shows global temperature trends up to the start of 2024.

Climate.gov

ORIGINAL SOURCE

Page 99

Figure 7.31 Global temperature anomalies comparing 2019 to the 1981–2010 average.

NEW DIGITAL SOURCE

Although this map uses a slightly different reference period, it is sourced from the same dataset.

Copernicus: 2023 is the hottest year on record, with global temperatures close to the 1.5°C limit

ORIGINAL SOURCE

Page 100

Figure 7.32 Atmospheric concentrations of greenhouse gases.

NEW DIGITAL SOURCE

The table in this article presents 2022 greenhouse gas levels, which can be compared with the data shown in **Figure 7.32.**

WMO: Greenhouse Gas concentrations hit record high. Again.

ORIGINAL SOURCE

Page 102

Figure 7.34 Global sea level changes as detected by satellites between 1993 and 2019.

NEW DIGITAL SOURCE

This map of global sea level changes from 1993 to 2022, produced by the EU Copernicus Climate Service, can be compared with Figure 7.34, which presents data accurate to 2019.

Yale Climate Connections: How fast are the seas rising?

NEW ACTIVITIES

Page 88

Activity 10

With reference to the animations provided by the USGS and WGMS, describe the changes in the extent of South Cascade Glacier after 2015.

Page 101

Figure 7.29 and Activity 8

Compare global temperature trends in Figure 7.29 in the text with the graph published by NOAA at the link provided.
What are the differences and similarities?

Page 101

Figure 7.31 and Activity 9

Compare the global temperature anomalies shown in the linked resource with those in Figure 7.31.
What patterns or differences do you observe?

Page 105

Figure 7.34 and Activity 7

Compare the sea level trends shown in Figure 7.34 with the map provided by Yale University. The two sources cover a three-year difference.

a. Describe the changes you observe between the two.

b. What factors might explain the patterns you have described?

Page 106

Activity 10

What are the reasons behind the UN's declaration of 2025 as the International Year of Glacier Preservation?
Do you think this response from the UN will be effective? Why or why not?

Updated case studies

GREENLAND

WHAT'S NEW?

Rate of melting: NASA's GRACE satellites estimate that the current rate of ice loss is 267 billion tonnes per year.

NASA: Ice sheets

The current melt day analysis of the Greenland Ice Sheet is available from the National Snow and Ice Data Center at the University of Colorado.

National Snow and Ice Data Center

Jacobshavn Glacier, also known as Sermeq Kujalleq, is still described as the most active and rapidly moving glacier in the world. Recent NASA satellite imagery shows changes from 1985 to 2022.

NASA: Jet Propulsion Laboratory, Retreat of Greenland's Jakobshavn Isbrae Glacier

Changes to traditional ways of life in Greenland have continued, with numerous sources documenting the impact of receding ice and shifting cultural norms on Inuit communities.

BBC: World, Europe

Daily Climate: Greenland

Tourism numbers in Greenland have fluctuated over the past five years. They declined significantly due to COVID-19-related disruptions, particularly affecting cruise ship arrivals. In 2023, numbers began to rise again. The latest available data can be accessed via the link provided.

Tourism Statistics Report Greenland 2023

NEW ACTIVITIES FOR GREENLAND

Page 91

Activity 10

The animation, based on data collected by NASA's GRACE satellites, shows changes in ice mass from the Greenland Ice Cap between 2002 and 2022. Describe the patterns you observe in the animation.

Page 91

Activity 11

The BBC article from 2022 explores further cultural changes to the way of life for Greenlanders.
Describe the changes discussed in the article.

SOUTH AMERICAN GLACIERS

WHAT'S NEW?

Changes to glacier extent have continued at an increasing rate in recent years. The United Nations Environment Programme (UNEP) estimates that the Andes region has lost between 30 per cent and 50 per cent of its ice cover over the past 40 years.

UN Environment Programme: Shrinking glaciers upend lives across South America

Tourist numbers at Perito Moreno Glacier and Los Glaciares National Park in Patagonia increased significantly in 2022 and 2023.

Statistica: Leading national parks in Patagonia, Argentina in 2022, by number of visits

In 2024, the United States National Science Foundation stated that tropical glaciers had the lowest extent of ice cover in 11,700 years.

US National Science Foundation: Tropical glaciers now smallest in 11,700 years, scientists find

There are many similar accounts of the decline of tropical glaciers, such as the Chacaltaya Glacier. Venezuela has become the first country in South America to lose all of its tropical glaciers. The NASA source provided documents the disappearance of the Humboldt Glacier in 2024.

NASA Earth Observatory: Humboldt Glacier's Demise

Andes glacier melt threatens Amazon's rivers & intensifies droughts

Reuters reported in 2023 that Peru has lost 56 per cent of its tropical glaciers over the past six decades due to climate change. Peru holds 68 per cent of the world's tropical glaciers, and rising temperatures have caused significant melting. According to the National Institute of Research of Mountain Glaciers and Ecosystems, this has led to the formation of new mountain lagoons, which pose a risk of overflowing and flooding.

Reuters: Peru glaciers decimated by climate change - report

NEW ACTIVITIES FOR SOUTH AMERICAN GLACIERS

Page 96

Activity 11

This 2023 UN article highlights lifestyle changes resulting from shrinking glaciers.

What are the changes identified in the article?

Page 96

Activity 12

The Landsat images from 2015 to 2024 show the disappearance of the Humboldt Glacier in Venezuela.

a. Why have scientists declared the Humboldt Glacier extinct?

b. Why have the Landsat images been particularly useful to scientists in this case?

▼ The terminus of the Perito Moreno Glacier, Argentina, 2023.

KYRGYZSTAN

WHAT'S NEW?

In response to increasing glacial melting, the United Nations Development Programme (UNDP) announced a project in 2024 to reduce the impacts of glacial lake outburst floods (GLOFs) in Kyrgyzstan.

UNDP: Project to Reduce Risks of Glacial Lake Outbursts in Kyrgyzstan

This paper presents ten years of glacier monitoring and highlights the increase in glacial lakes resulting from melting.

"Monitoring the cryosphere of Kyrgyzstan and forecasting climate change in the Tien Shan"

New projects responding to glacial changes include the use of artificial intelligence (AI) to monitor rates of glacial melting.

Times: Artificial Intelligence to Monitor Kyrgyzstan's Glacial Lakes to Prevent Outburst Flooding

New projects responding to glacial changes include Copernicus satellites tracking glacial lake outburst flood (GLOF) activity in the Kyrgyz Ranges.

EGU: Constantly renewing glacial lakes in the Kyrgyz Range, northern Tien Shan

The World Glacier Monitoring Service (WGMS) has released an update on the Golubin Glacier, showing increased rates of melting in 2022 and 2023.

WGMS: Golubin, Tien Shan

NEW ACTIVITIES KYRGYZSTAN

Page 113

Activity 6

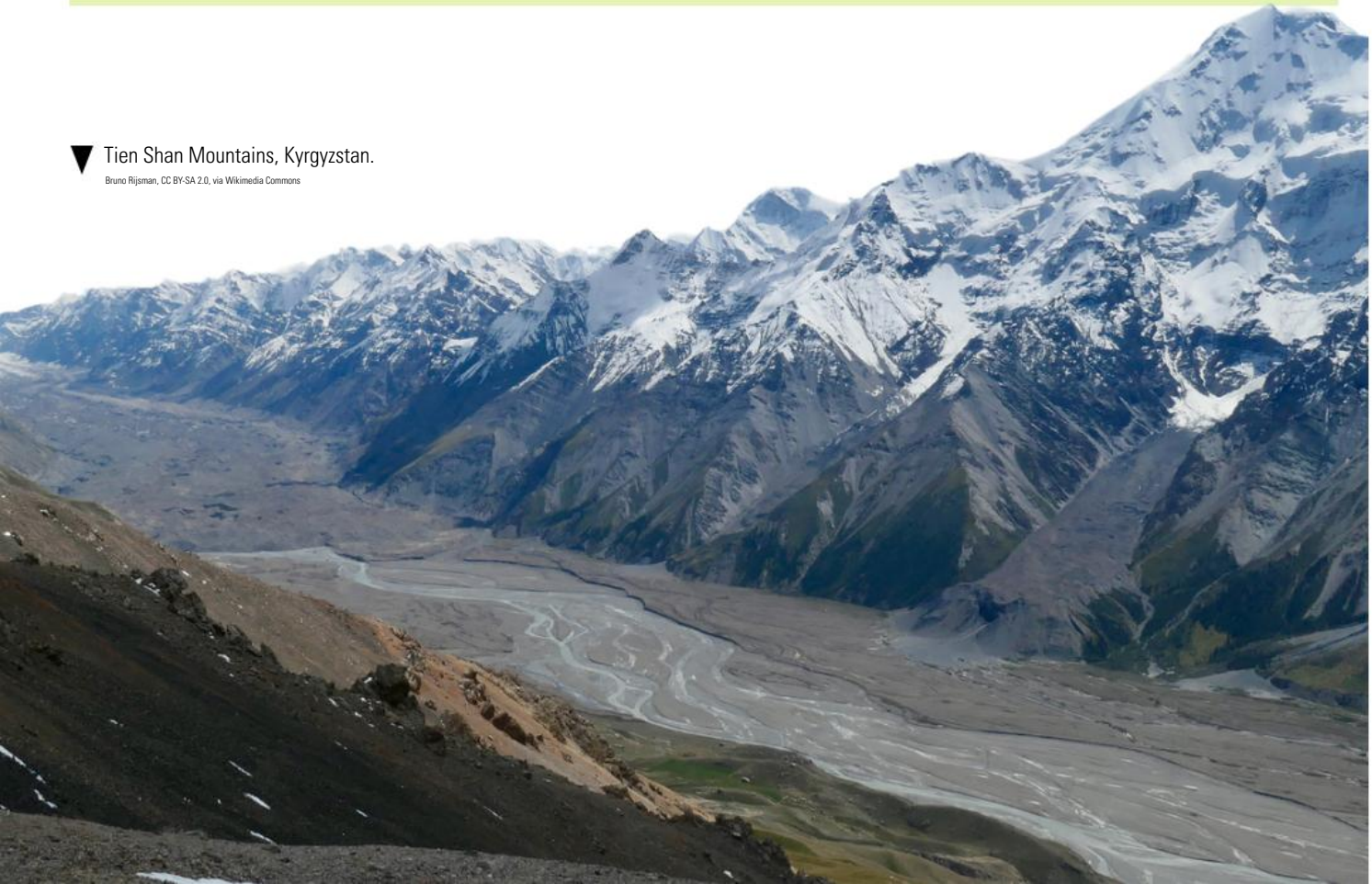
Describe the recent changes in mass balance to the Golubin Glacier.

Page 101

Activity 7

a. This paper covers a range of monitoring activities between 2012 and 2022. List three methods used to monitor glaciers.

b. This paper examines changes in glacial lake distribution. What patterns are evident?



▼ Tien Shan Mountains, Kyrgyzstan.

8 Land cover change: deforestation

Author's note: The data in the Third Edition of Chapter 8 is primarily derived from the *Global Forest Resources Assessment Report 2020 (FRA 2020)*. This report, released every five years, is the most reliable source of global and national data on forests and deforestation. Virtually all other sources on this topic rely on FRA data—and the national inventories included in its appendices—for their own reporting. A new edition of the report is scheduled for release in 2025. In the meantime, several references within this supplement reference the FRA website.

Updated in-text data

ORIGINAL DATA — Page 124

Wildfires affect about 3 per cent of global forest area each year, primarily in dry temperate and tropical regions.

UPDATED DATA

However, more current data from researchers at the University of Maryland, suggests forest fires are becoming more widespread, with with the area burned by forest fires increasing by **about 5.4 per cent over the period 2001-2023. T**his study also suggested forest fires are becoming more frequent and severe.

Plan MacCarthy, J., Richter, J., Tyukavina, S., Weisse, M. and Harris, N. (August 13, 2014) The Latest Data Confirms: Forest Fires Are Getting Worse, World Resources Institute's Insights 2025

ORIGINAL DATA — Page 126

… some 10–30 per cent of mammal, bird and amphibian species are currently threatened with extinction.

UPDATED DATA

… some **12-40 per cent** of mammal, bird and amphibian species are currently threatened with extinction.

International Union for the Conservation of Nature

ORIGINAL DATA — Page 126

… deforestation is estimated to contribute about 10 per cent to global greenhouse emissions.

UPDATED DATA

In 2023, deforestation was estimated to have contributed approximately **6 per cent** to global greenhouse emissions.

Climate Council based on article by Friedlingstein et al, (2023) Global Carbon Budget 2023, Earth System Science Data, Volume 15, issue 12, ESSD, 15, 5301–5369

This 2023 data appears to come from a reliable source; however, it may not reflect the medium-term average (e.g. a 5- or 10-year average). As such, the 10 per cent figure presented in the Third Edition may provide a more accurate and representative measure.

ORIGINAL DATA

Page 129

Technological innovations involving remote sensing and spatial technologies such as Global Navigation Satellite System (GNSS) and Geographic Information System (GIS), together with technological means of sharing data, have greatly assisted with the monitoring of forests.

UPDATED DATA

Additionally, geospatial artificial intelligence (GeoAI) can:

- Facilitate accurate land cover identification and classification, which is essential for effective forest management
- Analyse satellite imagery of forests in near real-time, providing immediate and detailed information—including evidence of illegal deforestation—to enable rapid response
- Examine historical data to predict areas at high risk of deforestation, supporting the development of proactive prevention strategies.

Geokno (20 November 2023), Geospatial AI and LiDAR Technologies: Pioneering Tools in Combating Deforestation, Geokno India Private Limited
https://www.esri.com/en-us/capabilities/geoai/overview

Visit the following website to see some examples of GeoAI:
https://www.esri.com/en-us/capabilities/geoai/overview

ORIGINAL DATA

Page 133

Global forest area certified under the two non-government organisations has grown steadily and totaled 426 million hectares in 2019.

UPDATED DATA

Currently, **11 per cent of the total forest areas worldwide are certified** by the Forest Stewardship Council (FSC) or the Programme for the Endorsement of Forest Certification (PEFC).

Malek, E.J., and Rahim, A.R.A. (2021), A thematic review of forest certification publications from 2017 to 2021: Analysis of pattern and trends for future studies, in Trees, Forests and People Journal.

ORIGINAL DATA

Page 137

… the country continues to experience high rates of deforestation, losing over two million hectares of forest since 1990 …

UPDATED DATA

… the country continues to experience high rates of deforestation, losing **over three million hectares of forest since 1990** …

Rainforest Foundation UK

ORIGINAL DATA

Page 139

The forests of the Central Highlands are threatened by large-scale coupe clearfelling within the state forests, in addition to fires including the Black Saturday fires of 2009 which nearly wiped out the last remaining populations of Leadbeater's Possum. Forestry, timber cutting and sawmilling have been major industries in the region since the late-19th Century and expanded to supply post-war housing demand after 1945. The logging now occurs under a Regional Forest Agreement, established in 1998. In 2018 VicForests, the managers of forestry operations in the Central Highlands, was unsuccessful in its bid to gain Forest Stewardship Council (FSC) certification as it failed to conform with established FSC standards.

UPDATED DATA

The forests of the Central Highlands have been used as a source of timber since European settlement in Victoria. Forestry, timber cutting, and sawmilling have been major industries in the region since the late 19th century, expanding further to meet the demand for housing following the Second World War.
In recent decades, timber harvesting in the region's state forests was conducted as large-scale coupe clearfelling under the 1998 Regional Forest Agreement, managed by the state government's native timber harvesting authority, VicForests. However, **all commercial native timber harvesting in Victoria's state forests ceased on 1 January 2024**, following sustained advocacy by environmental groups, ecologists, and some Traditional Owners, as well as declining profits from the state's native forestry operations.

Despite this, some tree felling and log removal continue under the categories of salvage logging, storm recovery, and bushfire fuel reduction. Timber harvesting also remains active in plantation forests and on private land containing native forest.

Victorian Government Department Energy, Environment and Climate Action

Author's note: Data in many of the figures in the existing chapter is primarily derived from the *Global Forest Resources Assessment Report 2020 (FRA 2020).* As noted above, this report is released every five years and remains the most reliable source of global and national data on forests and deforestation.

Updated visual sources

ORIGINAL SOURCE

Page 129

Figure 8.20 The use of geospatial technology to manage forests and address deforestation.

NEW DIGITAL SOURCE

Additional outer circle: Use of GeoAI to help analyse current and historical data about forests.

- Geokno (20 November 2023), Geospatial AI and LiDAR Technologies: Pioneering Tools in Combating Deforestation, Geokno India Private Limited https://www.esri.com/en-us/capabilities/geoai/overview
- Visit the following website to see some examples of GeoAI: https://www.esri.com/en-us/capabilities/geoai/overview

ORIGINAL SOURCE

Page 130

Figure 8.21 Mapbiomas time lapse satellite images of Brazil's forests in **(a)** 1985 and **(b) 2019.**

NEW DIGITAL SOURCE

Access 2023 data for **Figure 8.21 (b)** from Mapbiomass.

- Plataforma.biomass
- NOTE: Map is in Portuguese and setting may need to be changed to English by selecting language options in the bottom left corner.

ORIGINAL SOURCE

Page 131

Figure 8.22 Forest land cover change in Brazil: **(a)** The trend in Brazil's area of forest land cover 1985-2019 **(b)** The relative contribution of different land cover in Brazil in 1985 and **2019.**

NEW DIGITAL SOURCE

Access 2023 data for **Figure 8.22** from Mapbiomass.

- Plataforma.biomass
- NOTE: The site now features a line graph showing the total forest area in Brazil up to 2023 (replacing the version from the Third Edition, which showed data only up to 2019), as an update to Figure 8.22 (a). It also includes a new pie chart illustrating the relative contribution of different land cover types in 2023, replacing the 2019 pie chart from the Third Edition in Figure 8.22 (b).

▼ Roughly one-third of the world's forests have been lost over the past 10,000 years, largely due to a combination of natural factors and human-driven changes such as agricultural expansion.

UPDATED ACTIVITIES

Page 121

Activity 7

Access the most recent edition of the Global Forest Resources Assessment Report. Or alternatively, access the article on the current scale and locations of deforestation.

Page 125

Activity 6

a. Examine how the current global warming is leading to a change in forest land cover. Analyse and describe the interconnection between human activities and natural processes in causing this forest degradation.

- Access up-to-date information on how global warming is affecting forests in the article by MacCarthy, J., Richter, J., Tyukavina, S., Weisse, M. and Harris, N. (13 August 2024), The Latest Data Confirms: Forest Fires Are Getting Worse, available on the World Resources Institute's Insights
- Watch this short video explaining how climate change influences forest fires. Although it's produced by the NSW Government as part of its Climate Change Adaptation Strategy, the content is relevant to forests worldwide
- Alternatively, you may wish to view this related clip from the Next Generation Science website.

Page 128

Activity 2

Access the YouTube video Convenient Truth (Part 1) produced by the United Nations' Food and Agricultural Organisation (FAO) explaining how forests store carbon but can also become a source of greenhouse gas emissions through deforestation.
Use this and the information in Figure 8.18 to explain how keeping forests intact can reduce the severity of climate change as well as assist in mitigating its impacts.

Page 131

Activity 4

a. Some of the spatial technologies commonly used to collect remotely sensed data on forests include satellite images (including Landsat), LIDAR (light imaging, detection, and ranging), terrestrial photogrammetry and AUV/drones unmanned aerial vehicle (drones). Explore the use of this technology to monitor and manage forests:
a. Describe how one of these technologies is used to collect data about forest land cover, referring to the information on p.20-21 (Box 4) of the Global Forest Resources Assessment Report 2020 (main report**)**.

Page 134

Activity 5

Visit the REDD+ website and watch the clip and investigate some of the programs it has engaged in within the developing world.

Page 138

Activity 1

Access the most recent data on deforestation on Cameroon from the Global Forest Watch website and the Global Forest Resources Assessment (FRA 2020). To obtain the most current data on deforestation in Cameroon, follow these steps:
FAO's Hand-in-Hand Geospatial Platform:
On the platform, select the following options:

- Forestry under the 'Land Cover' category
- UN Country Boundaries to delineate national borders
- Explore the Data to access detailed datasets.

Within the data exploration section:

- Choose Forest Area (1000 ha)
- Click the downward arrow to reveal the legend
- On the choropleth map displayed, click on Cameroon.

A graph will be generated, illustrating the changes in Cameroon's forest area from 1990 onwards.
Using this data and the information provided above, summarise for Cameroon

- its location and land cover, including a location map and a sketch map of its forests
- its location within the global distribution of forest land cover, including the region of forest it lies within
- changes in the distribution of its forests over time
- reasons for the change in the distribution
- the impact of deforestation on the environment, economic activities and social conditions
- responses to deforestation at this location at local and national scales
- the use of geospatial technologies to assess and manage deforestation.

Conclude with an evaluation of the efforts to manage deforestation in Cameroon, including a set of criteria which can be used to guide your assessment, and quantified data.

▲ Trees in rainforests account for around 28 per cent of atmospheric oxygen production on Earth.

UPDATED ACTIVITIES

Page 140

Activity 1

Create a report on the case study of the forests of the Central Highlands of Victoria as an example of deforestation on a regional and local scale. Supplement the information provided within this chapter with information from the Great Forest National Park website and the Victorian National Parks Association.

Page 141

Activity 2

Access the map of Hojancha, and explore the different data layers and tools to complete the activities listed in Edition 3, *Unit 3: Changing the Land*, page 141, Activity 2.

c. Using the GIS map, its different layers and tools to complete the following activities:

Continue with the remainder of the existing question.

Activity 4

Based on this information in this chapter, analyse the work of the Foundation for Monte Alto Forest Reserve in reducing the impacts of deforestation at this local scale. Include data in your analysis to support your contentions, and identify the aspects of this local response which have been key to its success.

NEW ACTIVITIES

Page 117

Activity 4

b. Access the FAO's Working Paper 194, which outlines all terms used in the Global Forest Resources Assessment (FRA) reports. Using the definitions in this document, along with the information provided in the textbook on pages 115–116, write a clear definition of what constitutes a forest.

In your response, include:

- The key characteristics that define a forest, such as minimum area, tree height, and canopy cover
- The specific conditions or features that mean areas dominated by trees may not be classified as forest (e.g. plantations for agricultural use, urban tree cover, or areas primarily used for other land uses).

Create an annotated block diagram to accompany your written explanation. Your diagram should visually represent a forest and clearly label key features such as canopy density, tree height, understory vegetation, and any excluded land types that may appear forested but do not meet the formal definition.

c. View the clip on the FAO's FRA process. Analyse the methods used and the reliability of the data it collates.

Page 117

Activity 5

Access FAO's Hand-in-Hand Geospatial Platform:

On the platform, select the following tabs:

- Forestry under the 'Land Cover' category.
    - UN Country Boundaries to delineate national borders
    - Explore the Data to access detailed datasets.

Within the data exploration section:

- Choose Forest Area (1000 ha)
- Click the downward arrow to reveal the legend.

Use the choropleth map it generates to describe the global distribution of countries with more than 18.5 million hectares of forest.

Page 117

Activity 6

Examine a topographic map of an area that includes a protected area, such as a national park or wilderness area, containing some forest land cover. Describe the distribution of forest within the region shown, identifying the spatial association between specific topographic conditions and the location of forest. Consider factors such as gradient, slope aspect, and other types of land cover that may limit tree growth. Use four- and six-figure grid references to provide specific examples from the map in your description.

NEW ACTIVITIES

Page 117

Figure 8.6 and Activity 7

Create an overlay map based on Figure 8.6

- Begin with a blank political map showing national borders
- Draw in the major lines of latitude: the Equator, the Tropic of Cancer, the Tropic of Capricorn, the Arctic Circle and the Antarctic Circle. This will form your base map
- On top of this base map, create three transparent overlay layers:
  - Layer 1: Areas sustaining forest during the Last Glacial Maximum
  - Layer 2: Forest area during the Holocene Climatic Optimum
  - Layer 3: Potential forest land cover today.

Staple each transparent layer to the base map along a different edge (e.g., top, side, or bottom) so you can view and compare forest land cover across the three time periods either separately or together.
Remember to include BOLTSS on your base map and overlays.

Page 117

Figure 8.1 and Activity 8

Create an annotated visual display (AVD) about the main types of forest biomes. Create an A3 copy of Figure 8.1 as your base map. Use the internet to source a photograph of an example of each of the four types of forest shown, ensuring the photographs you select state their location. Place each photograph near its location on the map. Create a label stating the forest type and the location of your example. Place this beneath the photograph and add an arrow to its precise location on your map. Use the following website to create a climograph for each location: https://climatecharts.net/ (click on 'bar graph' format). Reduce the size of the climograph and add these to your AVD at the appropriate locations.

Page 121

Activity 10

Access the Global Forest Goals Report 2021 released by the United Nations' Department of Economic and Social Affairs, which outlines the progress made on its Strategic Plan for Forests 2017–2030.
Select one of the 'Success Stories' case studies placed at the end of each section of this report. Identify the strengths of the case study you have selected and how it helps achieve the Global Forest Goal profiled. Share this information with the class.

Page 128

Figure 8.17 and Activity 1

c. Refer to the information provided on the environmental benefits of forests in Figure 8.17.
Create a block diagram that shows the environmental benefits of forests.

Page 128

Activity 4

Refer to Wood Well Climate.

a. Contrast the processes involved in the absorption and storage of carbon in tropical, boreal and temperate forests.

b. Discuss the direct impact forests have on local climates and the processes that achieve this.

▼ Around 488 Mha of tree cover was lost on a global scale between 2021 and 2023.

NEW ACTIVITIES

Page 131

Activity 5

Access the most current data on Brazil's forests.

a. Refer to the interactive line graph showing the total area of forest in Brazil over the period 1985–2023 (the top green line in the graph). Describe the trend in Brazil's total forest area between 1985 and 2023, including relevant data in your response.

b. Examine the interactive pie charts illustrating the relative contributions of different types of land cover in Brazil for the years 1985 and 2023. Describe the changes in the proportions of various land cover types between these years.

c. Analyse the satellite images depicting Brazil's land cover in 1985 and 2023. Describe the changes in the distribution of forested areas and other land cover types between these years.

d. Considering your responses to questions a–c, suggest the major causes of forest loss in Brazil between 1985 and 2023.

Page 134

Activity 4

b. Refer to the clip on the Forest Stewardship Council.

Use the information it provides, together with the information in the textbook to describe in detail how forest certification helps reduce the unsustainable exploitation of forests.

Page 138

Activity 4

Refer the Global Forest Watch website page on the use of this platform to address deforestation in specific locations.

Click 'Cameroon' in the country options and visit the site with information on the Ajemalebu Self Help (AJESH) program focusing on the Yabassi Key Biodiversity Area (KBA).

Using the information provided, explain the environmental importance of these KBAs and describe how geospatial technologies, with financial and technical support from Global Forest Watch and other organisations, are being used to respond to deforestation at this location.

Page 138

Activity 5

Refer to one of the following programs that have local projects to address deforestation in Cameroon.

Select one program and create a summary of where the program is being used, why it is being implemented, and its achievements in addressing deforestation in Cameroon:

Belabo Council Forest Corridor Community Conservation area, World Land Trust

Bamougoum Chiefdom in the western highlands of Cameroon, UNEP and Rainforest Alliance

Dja et Mpomo and Campo Ma'an Model Forests, African Model Forest Network and IUCN

Mount Bamboutos and Mount Bana in the Western Highlands and the southern periphery of the South Region's Dia Reserve, Rainforest Alliance:

Forest Link projects in Cameroon

Page 140

Activity 2

The Victorian State Government halted all commercial logging in the state's native forests in 2024, including those in the Central Highlands. Read the articles available at the following websites and analyse how this law may benefit the forests of the Central Highlands of Victoria, but also how certain activities that are still permitted in the region's native forests may lead to ongoing degradation—unless the area is converted into a national park.

Environmental Justice Australia (31 May 2024) Has native forest logging really stopped in Victoria

Kolovos, B. (28 July 2024) The fight over the future of Victoria's forests, The Guardian

Page 141

Activity 6

Access Google Earth and zoom in on Hojancha and Monte Alto Forest Reserve in Costa Rica. Take the 3D virtual tour of the region.

According to the Department of Agriculture, Fisheries and Forestry, around 10 per cent of the total volume of logs harvested in Australia between 2022-23 was from native forests.

9 Suggested responses for new activities

CHAPTER 2: SUGGESTED RESPONSES

Page 20

Figure 2.4 and Activity 4

f. There appears to be urban expansion to the south of Port Douglas, particularly at Cooya Beach, where subdivisions extend inland, and at Newell to the north. Urban areas south of Mossman have also expanded, presumably onto agricultural land. Forested land appears to remain intact.

Page 21

Figure 2.5 (a) and Activity 4

Retailing functions will continue but are likely to be more modern than those shown in the image. Given the scale of the development compared with the current buildings, retailing could be more extensive, with increased building height and provision for car parking. The 19th-century façade has most likely been removed, as the question states that the site was cleared.

Page 26

Figure 2.9 (a) (b) and Activity 3

A considerable range of responses is possible, given the wide choice of locations. Key observations might include changes to road widths and directions, building heights, and the amount of vegetation, cropland, or grassland—either increased or decreased. Explanations for these changes are not required.

Page 28

Figure 2.12 and Activity 6

a. An activity centre is closely aligned with the concept of the 20-minute neighbourhood. It promotes more concentrated development near train stations and tram lines, offering housing, employment opportunities, and services such as schools, recreational areas, and green open spaces.

b. Major land use changes could occur on a regional scale, depending on the level of development prior to the plan's initiation. These may include denser housing, such as multi-storey apartments, larger retail complexes, and office buildings, alongside expanded public transport terminals and road networks. Rising land values may further encourage and accelerate these types of developments.

Page 29

Figure 2.14 and Activity 3

A range of answers is likely, given that various locations could be chosen. You may wish to highlight the potential scale of change that could occur due to climate change and government planning strategies. A useful starting point could be Figure 2.14, along with other examples of coastal areas.

CHAPTER 3: SUGGESTED RESPONSES

Page 34

Figures 3.3 and 3.4 and Activity 2

a. Urban land use is distributed in a radial pattern, spreading outwards from Melbourne's CBD. This extends approximately 50 km south-east to Pakenham, 40 km east to Emerald, and 20–30 km to the north and west. In total, urban land use covers an area of 275,794 hectares, accounting for 21.58 per cent of the region. Exceptions to this distribution pattern include small pockets of urban land surrounded by grazing areas, such as Drouin, Healesville, Wallan, and Bacchus Marsh. There is also a linear stretch of urban development along the coastline of the Mornington Peninsula.

b. Within the Port Phillip and Western Port region, non-agricultural land accounts for 57.89 per cent of total land use. This includes urban areas, nature conservation zones, rural residential and farm infrastructure, and production native forests. Smaller areas are also used for mining, waste management, plantation forests, and watercourses. The remaining 42.11 per cent of land is agricultural, primarily used for grazing pasture, with some dryland cropping and smaller areas of other farming types, such as irrigated land and grazing within native vegetation.

CHAPTER 3: SUGGESTED RESPONSES CONTINUED...

Page 36

Activity 6

The satellite imagery shows the following developments over time:

- 2000: The former land use is still visible, including buildings, a quarry, and some existing infrastructure.
- 2005: The site has been demolished and cleared.
- 2012: Site works have commenced, but construction has not yet begun.
- 2018: Construction has started on the western side of the site.
- 2020: The new shopping centre and car park have been completed.

Page 38

Activity 7

a. Answers will vary. This sample response is based on Pakenham.

b. The area surrounding Pakenham has experienced significant growth over the past decade, expanding from around 20 square kilometres in 2015 to approximately 35 square kilometres by 2025. Most of this development has occurred on the western side of Pakenham, east of Officer.

c. Answers will vary. It seems unlikely that development will continue to the north, as this area is forested and mountainous, making it unsuitable for urban expansion. Similarly, the land to the east is less likely to be developed, as it consists of productive farmland and lies further from the CBD. However, the area to the south of Pakenham and east of Clyde appears suitable for development, particularly given its proximity to the existing Princes Freeway. A housing estate has recently been constructed west of Cardinia Road, indicating that further development in this area is likely.

Page 41

Activity 8

a. Mount Evelyn is projected to grow by 231 people, from 9,853 in 2021 to 10,094 in 2046. Over the same period, the number of dwellings is expected to increase by 220, from 3,570 in 2021 to 3,790 in 2046.

b. The average household size in Mount Evelyn is anticipated to decrease from 2.85 people per dwelling in 2021 to 2.76 people per dwelling in 2046. This trend, combined with overall population growth, means that even more homes will need to be constructed. As a result, the amount of impervious surface will continue to increase, leading to higher levels of stormwater runoff into urban creeks—unless stormwater disconnection projects like those previously trialled are successfully implemented.

Page 45

Activity 9

a. Examples include:

- A large proportion of open space, green space, and recreational facilities
- Sustainable housing designs that are energy-efficient, include solar panels, and offer EV charging stations
- Public transport infrastructure and dedicated cycle paths to reduce reliance on cars

b. Answers will vary. For example: One positive impact of the Town Centre is the creation of jobs within the new retail and commercial spaces. One potential negative impact is a decline in business for surrounding suburbs, as existing customers may shift their spending to the new development.

c. Answers will vary depending on the progress of the development.

As of March 2025, housing lots in Stage 1 have been subdivided and sold, with construction currently underway. No other parts of the development are available for sale at this time.

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Activity 10

As of March 2025, the southern part of the development—covering approximately 10 per cent of the total site—is under construction. Around 90 per cent of the houses in this section are either complete or nearing completion, while the remaining 10 per cent of the land is cleared but still vacant. No construction has commenced on the rest of the quarry site; however, earthworks appear to be underway in and around the quarry pit in preparation for future development.

CHAPTER 4: SUGGESTED RESPONSES

Page 48

Activity 5

In 2025, it is possible to identify the construction of a chemist, a 24-hour gym, a children's playground or day care centre, and a supermarket using Google Earth. These services cater to the needs of young, growing families living on the outer edge of an expanding Melbourne, providing essential goods and services. At this point in time, services for elderly people have not yet been established, likely because the population in this rapidly growing peri-urban area does not yet require them.

CHAPTER 4: SUGGESTED RESPONSES CONTINUED...

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Figure 4.3 (a) and Activity 8

Given Cardinia's proximity to both Pakenham and Clyde, it is unlikely that the Cardinia General Store could remain viable selling groceries, unless it could match the prices of larger supermarkets. To survive, the owner would need to adapt by focusing on specialty items such as ice cream and coffee—something it appears to already be doing. In the long term, the business would likely struggle if it continued operating as a traditional general store, as it cannot compete with larger centres offering additional services like medical, financial, and postal facilities. Shifting towards a café-style business may offer a more sustainable future by retaining regular local customers.

Page 53

Activity 2

b. Between Koo Wee Rup Road and McGregor Road, on the southern side of the Princes Freeway, a small and seemingly isolated pocket of land use is visible, appearing at first glance to include an oval and residential houses. However, closer inspection—particularly using Google Earth—reveals that this development aligns with the planned growth outlined in Figure 4.7 (a). The rooftops of many buildings suggest light industrial use. What initially appears to be an oval is, in fact, agricultural land featuring a circular boom sprayer. A virtual walk around the area using Google Earth further confirms repeated light industrial land use. This strategic placement helps separate industrial activity from residential zones and indicates that Cardinia Shire Council has remained consistent with its 2020 growth plan.

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Activity 7

Around Pakenham Station, a range of services can currently be observed, including a hotel, childcare centre, newsagent, accountant, optometrist, supermarket, department store, and many others.

Pakenham has been well-positioned for rapid expansion due to the presence of these well-established services, which has likely helped reduce some of the common challenges linked to fast urban growth, such as social isolation and concerns around community safety.

The large car park adjacent to the station serves local residents from Pakenham and surrounding areas who commute to work closer to the CBD.

Despite significant population growth, many residents are unlikely to work locally and instead commute long distances for employment. As a result, internal connections and local trade within Pakenham may be limited. It would be more accurate to say that there is substantial movement of people between Pakenham and the CBD or other employment centres.

Page 57

Activity 5

With many young couples moving to Pakenham and Nar Nar Goon to purchase their first homes on the abundant available land, demand for a wedding reception centre would have naturally increased. This land-use change made strong economic sense and responded to the social needs of the growing number of families and couples in the area.

This straightforward example is an ideal case study for the VCE Geography curriculum, illustrating a rural land-use change. While the original buildings have been retained, their function has significantly shifted to better reflect the current social and economic needs of the community. It is a clear example of change driven by population growth and evolving local demand.

CHAPTER 6: SUGGESTED RESPONSES

Page 76

Activity 12

a. Approximately 50 per cent cereals and 40 per cent grassland. These fit within the cultivated and managed category. The grasslands are primarily used for grazing and would also fit within this category.

b. Native woody areas make up approximately 80 per cent, with the remaining 20 per cent being grasslands. The native woody areas fit within the natural and semi-natural vegetation category. The grasslands are primarily used for grazing and would fit within the cultivated and managed category.

Page 77

Activity 6

Responses may vary considerably depending on the location chosen and the level of understanding regarding how changes have occurred in the area.

In part b, it is important to acknowledge that there may be an overlap or interconnection between natural processes and human activity, and this should be clearly mentioned.

Part c should avoid speculative or unrealistic scenarios. Instead, it should reflect local processes that are already occurring, such as a growing or ageing population, planned changes to infrastructure (e.g. new roads or rail lines), or the increasing impact of climate change on farming areas or coastal zones.

CHAPTER 6: SUGGESTED RESPONSES CONTINUED...

Page 80

Activity 7

a. Guinobatan is an urban area (artificial surfaces), while the land to the northeast and northwest appears to be cultivated (cultivated and managed) with heavily vegetated areas (either tree crops or natural forest). These areas could become bare surfaces if covered by lava, remaining so until they are reclaimed by nature or through human intervention.

b. The steep slopes appear to be heavily vegetated (natural and semi-natural vegetation), with some light green areas that may be too steep for cultivation. South of the Zipline, the landscape appears forested. These areas could also become bare surfaces if covered by lava, remaining that way until reclaimed by natural processes or human effort.

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Figure 6.17 and Activity 5

a. Demand from the market for space for new housing has increased as the urban population grows, prompting government authorities to respond. In addition, policies that favour low-density housing place pressure on farmland and naturally vegetated areas adjoining urban zones, leading to their conversion into residential and associated land uses.

b. Retaining some of the existing land cover could introduce diversity into otherwise monotonous areas dominated by artificial surfaces (e.g. houses and roads). It could also help preserve existing employment opportunities and protect heritage sites, such as Indigenous cultural areas or early settlement locations.

CHAPTER 7: SUGGESTED RESPONSES

Page 88

Activity 10

It is clear that from 2015 to 2021, the animation shows a continued contraction in the extent of the South Cascade Glacier. When this is correlated with the WGMS mass balance data, it is evident that ice loss occurred every year from 2015 to 2022, with 2015 recording the most severe loss on record—minus 3000 mm water equivalent (w.e.).The scale on the graph is presented in millimetres of water equivalent (mm w.e.). A loss of 3000 mm w.e. is equivalent to the glacier losing three metres of water-equivalent ice or snow in that year.

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Figure 7.29 and Activity 8

Both graphs show that global temperatures have risen consistently since the 1980s. Figure 7.29 indicates a temperature rise of around 0.5 degrees Celsius in 2018 and 0.9 degrees Celsius in 2016. Interestingly, the updated graph from NOAA shows that the global temperature rise during the same period is higher than depicted in Figure 7.29. The years 2022 and 2023 were the first in which the global temperature increase exceeded 1.0 degrees Celsius. These discrepancies may be due to the inclusion of more comprehensive data and improved measurement techniques in the more recent dataset.

Page 101

Figure 7.31 and Activity 9

Comparing the world maps of temperature anomalies in 2019 and 2023 reveals some distinct changes. (It is important to note that the scale used in each map differs slightly.) Various patterns can be identified, and the comparison highlights that temperature variations differ considerably across both land and sea, making climatic patterns difficult to generalise.

Some observations include:

- Significant increases in temperature in North America, especially in Canada, as well as in Russia
- Some areas of Australia have experienced cooling
- Patterns of cooling and warming in Antarctica have shifted
- Ocean temperatures have varied, particularly along the west coast of South America
- Some regions, such as parts of Africa and India, have shown relatively little change.

Page 105

Figure 7.34 and Activity 7

a. After comparing the two maps depicting sea level rise, it is clear that sea levels are rising globally, although the rate of rise varies by location. In the Eastern Pacific, sea levels are rising at about 5 mm per year, while in the Western Pacific the rise is closer to 1 mm per year. The most significant increases in sea level include locations along the east coast of Japan, the east coast of Argentina, and the south-east coast of Australia. Many other examples could also be identified. It is important to note that the scales used on each map are slightly different, which should be taken into account when making comparisons.

b. Several factors explain the sea level patterns identified above. These include climate change, which has influenced wind patterns and ocean circulation—particularly events such as El Niño and La Niña. Climate change is also causing more unpredictable weather events, such as storm surges and increased wave activity, which are contributing to changes in sea levels.

CHAPTER 7: SUGGESTED RESPONSES CONTINUED...

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Activity 10

The United Nations is actively working to raise global awareness about the threats facing glaciers around the world due to rising temperatures and the resulting ice melt. More than 2 billion people depend on water that originates from glaciers to meet their daily needs, and the melting of glaciers is also contributing to rising sea levels.

In discussions about the effectiveness of what will become an annual campaign from 2025, it is worth considering whether such initiatives will lead to concrete actions that reduce greenhouse gas emissions. Notably, the countries with the highest greenhouse gas emissions are often not the ones that depend on glaciers for their daily water supply.

CHAPTER 7: GREENLAND SUGGESTED RESPONSES

Page 91

Activity 10

Data collected from the GRACE satellites shows that the mass of the Greenland Ice Sheet has been declining at a rate of 269 gigatonnes per year due to surface melting and iceberg calving. The graphs indicate that accelerated ice losses occurred in 2012 and 2019, while smaller losses were recorded between 2016 and 2018.

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Activity 11

The BBC article highlights some significant adaptations that Greenlanders have had to make rapidly in response to the climatic changes they are experiencing.

Examples of these changes include:

- Increased seasonal unpredictability, which has altered fishing practices — for example, boats are now preferred over dog sleds
- A rise in iceberg calving, creating hazards for ships
- A decline in hunting as a traditional occupation, requiring the exploration of new livelihoods
- Shifts in season lengths, leading to changes in daily life and routines
- It is important to recognise that these cultural and lifestyle changes can have both positive and negative impacts.

CHAPTER 7: SOUTH AMERICA SUGGESTED RESPONSES

Page 96

Activity 11

Like many developing economies, the impact of receding glaciers has had a significant effect on local communities. This has led to:

- Shrinking pastures and changes to farming practices — for example, llama farming has declined while trout farming is on the rise
- A reduction in freshwater availability, prompting the development of water conservation measures to manage usage
- A decline in hydroelectricity generation due to reduced water flow
- An increase in water recycling and rainwater harvesting efforts
- The implementation of drought early warning systems.

Communities in these regions are becoming increasingly reliant on external expertise to address the growing challenges caused by glacial melt.

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Activity 12

a. As the Humboldt Glacier can no longer flow under its own weight, it is now classified as an ice field rather than a glacier.

b. The use of Landsat images and other spatial technologies has made the work of glaciologists and climate scientists significantly more efficient and productive. (This question allows for a variety of responses, including the following examples.) Scientists can now spend more time in laboratories analysing images, rather than collecting data in the field. Fieldwork on glaciers is often difficult due to challenging terrain and harsh climatic conditions. Using satellite imagery also has economic advantages and can encourage greater collaboration.

Landsat images are clear and relatively easy to interpret. They can be reproduced at the same scale, enabling direct comparisons across different years. These comparisons help scientists quickly identify and communicate trends in glacier size and extent, which is particularly valuable for communities that rely on glaciers for water.

CHAPTER 7: KYRGYZSTAN SUGGESTED RESPONSES

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Activity 6

Data collected by the WGMS shows that in both 2021 and 2022, the Golubin Glacier experienced significant ice loss, with more than one metre of water equivalent lost each year. This represents the highest level of ice loss recorded since monitoring of the glacier began.

Page 101

Activity 7

a. Glacier monitoring in Kyrgyzstan uses a combination of techniques involving both primary data (collected in the field) and secondary data.

Types of data used include:

- Aerial photography
- Landsat images
- Analysis of boreholes to assess ice depth and permafrost extent
- Mapping using multiple spatial representations
- Climate measurements
- Reference to historical databases.

b. In two river valleys in Kyrgyzstan, scientists have recorded an increase of between 25 and 35 per cent in the number of glacial lakes over a 23-year period. The map showing glacial lake distribution reveals a concentration of these lakes in the northern and central regions of the country. Consistently rising temperatures due to climate change have been the main driver of increased glacial melting, leading to the growth in both the number and size of glacial lakes.

CHAPTER 8: SUGGESTED RESPONSES

Page 117

Activity 4

a. A forest is a biome dominated by trees, where the foliage forms a continuous canopy. According to the FAO, a treed area must cover at least 0.5 hectares, contain trees that reach a minimum height of 5 metres, and have a canopy cover of at least 10 per cent to be classified as a forest. While this definition includes areas where trees have been planted or seeded by humans, or allowed to regenerate naturally—including forests managed for timber harvesting—it excludes areas where trees are cultivated for agricultural purposes, such as oil palm plantations, as well as treed areas within urban landscapes.

b. The processes used by the FAO to collect data for the FRA reports 'harmonise' the definitions, terms and measures used by all countries, allowing for meaningful comparisons between nations and tracking changes in forests over time. However, the data is collected by forest authorities within each country, which may raise questions about the validity and accuracy of the data—especially given the remoteness of many forested areas and the challenges involved in data collection. Geospatial technologies can assist with this process, particularly when the data is supported by 'ground truthing'.

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Activity 5

Countries with large areas of forest include: Canada, the USA and Mexico in North America; most of South America, excluding Guyana, Suriname, French Guiana, Ecuador, Chile, Paraguay and Uruguay; much of Central Africa, including Nigeria, Cameroon, the Central African Republic, the Republic of the Congo, the Democratic Republic of the Congo, Tanzania, Mozambique, Zambia, Angola and Gabon; in Europe, Spain, Sweden and Finland; Russia; parts of Asia, including China, India, Myanmar, Thailand, Malaysia, Japan and Turkey; as well as Australia and Papua New Guinea.

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Activity 6

Students should identify elements such as the lack of forest in areas with very steep gradients, rocky outcrops, and possibly on slope aspects located in a 'rain shadow', where insufficient rainfall prevents forest formation. In alpine regions, students may be able to identify the 'treeline', above which conditions are too cold or there is insufficient available water for trees to survive. Students should use the term 'spatial association' correctly and identify the degree of association. They should be able to provide examples that illustrate the relationships they have identified, using four- and six-figure grid references accurately to locate their examples.

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Figure 8.6 and Activity 7

Students can use their overlay to visualise how the global distribution of forest land cover has changed in response to major natural climate changes since the last Ice Age.

CHAPTER 8: SUGGESTED RESPONSES CONTINUED...

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Figure 8.1 and Activity 8

Students can use their annotated visual display to visualise and compare the different types of forest biomes found across the world, and to understand how climate is a major factor influencing the type of forest that develops.

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Activity 10

Students should be able to identify how the selected initiative contributes to the sustainable management of the region's forests.

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Activity 6

Data from 2001 to 2023 indicates that forest fires are increasing, with the total area burned rising by approximately 5.4 per cent over this period (MacCarthy et al., 2024). This data suggests that the world is experiencing longer fire seasons, as well as an increase in the extent, frequency, and severity of forest fires. The year 2023 was deemed the worst on record, with 12 million hectares of forest burned, and 2021 was the third worst year, and 2020 the fourth.

Although forests have always been vulnerable to wildfires—caused by lightning strikes and human sources of ignition—human-induced climate change is now the main contributing factor to their increasing severity and frequency. This rise is largely due to:

- Higher temperatures, which dry out forest vegetation, increasing the likelihood of ignition and the forest's propensity to burn
- Changing rainfall patterns and greater rainfall variability, which can affect the forest's 'fuel load' and worsen fire risk. For example, periods of above-average rainfall can lead to more vegetation growth, which is then dried out by drought, creating a larger fuel load
- More extreme weather events, such as storms, heatwaves, and droughts, which raise the risk of fire ignition and help fires spread more rapidly
- Higher levels of atmospheric carbon dioxide, which can lead to increased plant growth and fuel accumulation through a process known as 'carbon fertilisation'.

However, wildfires are not only a result of climate change—they also contribute to it. The burning of vegetation releases carbon dioxide that has been stored in forest floor leaf litter, plant roots, soil, foliage, trunks, and branches. Forests, which contain the highest amount of biomass of any land cover type, therefore pose the greatest fire hazard. They also serve as the largest terrestrial carbon sink, meaning their loss reduces the planet's ability to remove carbon dioxide from the atmosphere. While this capacity is typically restored as forests regenerate after a fire, regeneration may be hindered if fires become too frequent or severe. In such cases, forests may degrade or transition into other types of vegetation.

Some researchers describe this dynamic relationship between forest fires and climate change as the 'fire–climate feedback loop'.

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Activity 4

a. Tropical rainforests:

Because tropical rainforests are located in hot and wet climates, they store a significant amount of carbon in their biomass—such as trunks, branches, leaves, and roots. This carbon is drawn from the atmosphere and incorporated into the plants through photosynthesis. When part or all of a tree dies and falls to the ground, the organic material decays rapidly due to the heat and humidity of the tropics. This decaying matter is quickly reabsorbed into the soil and then taken up again by new plant growth. As a result, nearly all the carbon stored in tropical rainforests exists in the above-ground vegetation.

Boreal forests:

In boreal forests, most of the carbon is stored below ground. The colder climate slows down the decay process—especially in areas where the soil is frozen for part of the year. This slower decomposition releases less carbon back into the atmosphere and allows carbon to accumulate in the soil over millennia. It is estimated that 80 per cent to 90 per cent of all carbon in boreal forests is stored underground.

Temperate forests:

Temperate forests also store substantial amounts of carbon, particularly in regions with high rainfall that support dense forests with tall trees. Many temperate forests include old-growth trees—some of the oldest and largest trees in the world—which are especially important carbon stores. Approximately half of the carbon in temperate forests is stored above ground in vegetation, with the rest stored below ground in soils and roots.

b. Apart from their impact on global greenhouse gas concentrations, forests also influence local climates in several ways: by providing shade; releasing water into the atmosphere through transpiration; contributing to cloud formation—which can absorb and reflect incoming sunlight; and reducing wind speeds by disrupting airflow.

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Activity 5

a. The amount of forest in Brazil has declined over recent decades. In 1985, there were approximately 604 million hectares of forest in the country. By 2005, this had decreased to around 535 million hectares. The decline continued after this date—though at a slightly slower rate—with forest land cover totalling 502.5 million hectares in 2023.

b. In 1985, forests covered 71 per cent of Brazil's land area, but by 2023 this had declined to 59 per cent. Over the same period, non-forest natural vegetation also decreased—from 6.2 per cent in 1985 to 5.4 per cent in 2023. In contrast, farmland increased significantly, rising from 19.8 per cent of the country's land cover in 1985 to 31 per cent by 2023. Non-vegetated areas (which may include urban areas, settlements, mining, and other land uses) also increased, from 0.55 per cent to 0.8 per cent.

c. Between 1985 and 2023, there has been a marked increase in farmland and non-vegetated areas, while forest cover has clearly decreased. In central Brazil, large areas of forest have been replaced by farmland and patches of non-vegetated land, which may represent urban expansion, particularly in the southern and central regions. Although a significant area of forest remains in the northwest, it has been fragmented by agricultural land and no longer retains the ecological integrity it had in 1985. Much of the forest within 300 kilometres of the Atlantic coastline, southeast of the Amazon River, also appears to have been cleared for farmland.

d. The data in Q5a–c suggest that the primary cause of forest loss in Brazil between 1985 and 2023 is the expansion of farmland, which has encroached upon and fragmented forested areas. While non-vegetated areas have also increased—contributing to some forest loss, particularly in central and southern regions—these made up only 0.8 per cent of total land cover in 2023. In contrast, farmland increased from 19.8 per cent to 31 per cent over the same period, making it clearly the main driver of deforestation in Brazil.

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Activity 4

b. Forest certification is a system that allows consumers to make informed choices about their purchase of timber and other forest products. It is designed to promote environmentally appropriate, socially beneficial, and economically viable management of the world's forests. The process involves an independent third party—known as the certification agency—assessing where a specific timber or forest product is sourced and reviewing the conditions of its 'chain of custody' from the forest to the consumer.

There are several certification agencies, but the two largest currently are the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). The agency employed by the producer conducts an audit of the product, evaluating each step in the chain of custody against specific, pre-determined environmental, social, and economic criteria. This includes factors such as how sustainably the product is harvested, as well as the pay and working conditions of those involved in its harvesting, processing, transport, and sale.

If the product meets or exceeds the agency's set standards, it will receive certification. The producer benefits by being able to label and promote their accreditation—provided they meet the required threshold—while consumers can use this certification to make ethical and sustainable purchasing decisions.

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Activity 4

The Yabassi Key Biodiversity Area (KBA) in Cameroon is a region of rich biological diversity, home to several endangered primates and birds, and serving as a wildlife corridor for migratory species. A local community group, Ajemalebu Self Help (AJESH), with financial and technical support from Global Forest Watch and other organisations, and in consultation with Cameroon's Ministry of Forestry, is developing a system to monitor the forests of this KBA using drones and field observations, alongside tools and data provided by Global Forest Watch.

The primary focus of this monitoring strategy is to detect illegal deforestation activities within the KBA. Once trained, AJESH employs volunteers to carry out weekly monitoring of the area. The information they collect is used to identify illegal deforestation 'hotspot' sites, which are then mapped and recorded using the Global Forest Watch platform.

In addition to supporting immediate forest protection efforts, the data gathered contributes to Cameroon's assessment of progress towards its international environmental commitments and will also inform the KBA's long-term forest conservation strategy.

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Activity 2

While some of the forests in the Central Highlands of Victoria are currently managed as national parks—and therefore enjoy a high level of protection from threatening processes—much of the forest still exists within state parks and on privately owned land. Although commercial logging operations in the region's native forests—and across all of Victoria's native forests—were halted in 2024, a number of activities permitted in state parks can still lead to forest degradation. These include trail-bike riding, horse riding, dog walking, hunting, fishing, fossicking for metals, four-wheel driving off-road, and unrestricted camping.

In addition, significant activity related to bushfire prevention, fire management, and storm recovery has occurred in the region's forests. These activities—such as removing fallen trees, clearing forest floor debris, and creating firebreaks—can reduce the habitat value of the forest for some native species. Furthermore, commercial logging remains permissible in forests located on private land. For these reasons, designating a larger portion of the Central Highlands as national park would help reduce forest degradation, enhance connectivity between remnant forest areas, and improve the overall ecological quality of the region's remaining forests.