YEAR 12

GLOBAL INTERACTIONS 12

FOURTH EDITION

GRANT KLEEMAN • DAVID HAMPER • HELEN RHODES • SUSAN CALDIS

12

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Pearson acknowledges the Traditional Custodians of the lands upon which the many schools throughout Australia are located.

We respect the living cultures of Aboriginal and Torres Strait Islander peoples and their ongoing connection to Country across lands, sky, seas, waterways and communities. We celebrate the richness of Indigenous Knowledge systems, shared with us and with schools Australia-wide.

We pay our respect to Elders, past and present.

Content warning
Some of the images used in Global Interactions Fourth Edition might have associations with deceased First Nations Australians. Please be aware these images might cause sadness or distress in Aboriginal and/or Torres Strait Islander communities.

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Global Interactions

The *Global Interactions Fourth Edition* series is written for the NSW Geography 11–12 Syllabus (2022), for implementation from 2024. *Global Interactions 12* has been developed to support the teaching and learning of the contents of the NSW Geography Syllabus (Year 12). It has been written by one of Australia's most experienced and accomplished team of geography educators. It provides comprehensive coverage of the syllabus's core topics and its various options.

Student book

- Chapter and unit structure closely reflect the NSW Geography 11–12 Syllabus (2022)
- Full-colour text with engaging and highly visual design
- Dynamic, contemporary and relevant textual examples, images, graphs and maps
- Topic-based units written in accessible language with clear and concise explanations of key terms and concepts
- A variety of learning and comprehension activities for regular revision and consolidation
- Spotlight features and case studies that describe and encourage in-depth investigation, and address the syllabus's focus on 'place'
- Front-of-chapter glossary for easy reference
- Written by an experienced author team:
  - **Grant Kleeman** (lead author) is one of Australia's leading geography educators. He is an experienced teacher educator, geography teacher, author, curriculum consultant and examiner. Grant has been closely involved in the development of the geography curriculum at the state and national levels for more than three decades. He is the coordinating author of numerous texts, including the Pearson Geography NSW series.
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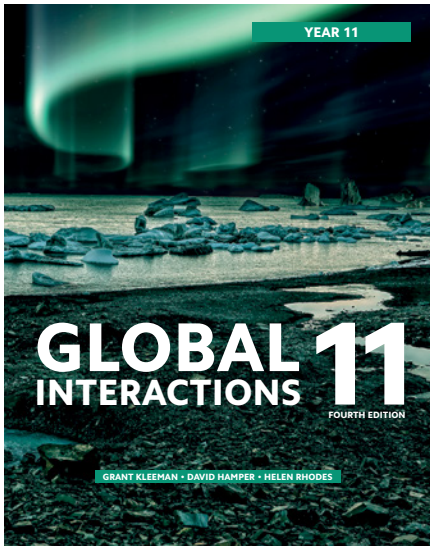
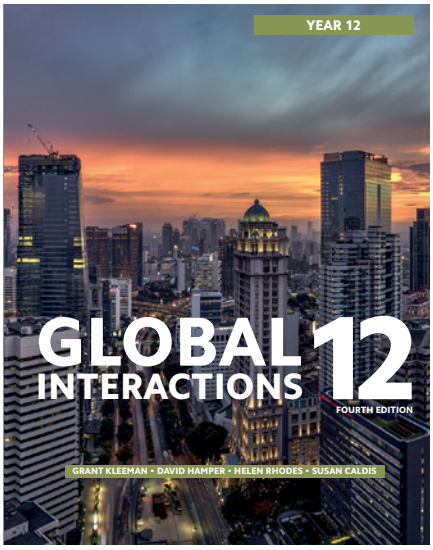
The Publishers wish to thank James Forrest for his contribution to *Global Interactions 12 Second Edition.*

eBook

The eBook allows you to use *Global Interactions* online or offline, anywhere and anytime. The eBook edition retains the look and integrity of the printed book and includes additional resources:

- Digital-only module: Exam skills
- For teachers: Teaching and Learning Program
- For students: Digital resources, downloadable worksheets and interactive activities to support understanding of key geographical tools, including graphs, maps and statistics
- Access to both student and teacher resources





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MODULE G1 **DIGITAL ONLY** **Exam skills: Extended-response questions** 2

How to use

Chapter glossaries

Chapter glossaries provide an easy reference for more than 200 key terms. Glossary words are marked in bold in the main text. Glossaries appear at the front of chapters.

Case studies

Three levels of case studies—smaller ones within units, unit-long case studies, and full chapter case studies—allow students to dip in or deep-dive into a specific event or location. Unit-level and smaller case studies (see below) offer a good introduction to a specific event or place and are written to extend students' knowledge and understanding. Case study chapters offer a far deeper exploration. See page 1 for more about the case study chapters.

Activities

Activities have been created to cater for the full range of student abilities. Many activities are based on the stimulus material presented and aim to facilitate the development of the skills used by geographers.

Using a ladder approach (lower to higher order), the activities:

- guide students towards an understanding of the content specified in the syllabus
- extend students beyond the text and involve them in a variety of learning experiences
- engage students in higher order tasks, applying inquiry skills and tools.

Spotlights

Spotlights offer real-life contexts for key ideas, concepts or issues discussed in the unit. They are designed to develop students' knowledge and understanding of the concepts and processes that are central to the study of geography at this stage of learning.

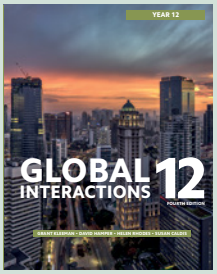
eBOOK RESOURCES

Visit the digital toolkit in the Resources folder of eBook for student support with key geographical tools, including reading and creating graphs and maps, and understanding statistics. Also, access blank maps and graphic organisers.

To locate these resources in the eBook, go to your eBook edition on pearsonplaces.com.au and select VIEW MORE.

To access these resources when you are in the eBook, select the folder icon on the navigation pane.

Plus the eBook edition includes a digital-only module at the end of the eBook, which supports students' exam skills as they prepare to answer extended-response questions.



Using Global Interactions 12

Structure

The text is organised into three sections, corresponding with the three focus areas of the Year 12 Geography Syllabus.

1 Global sustainability

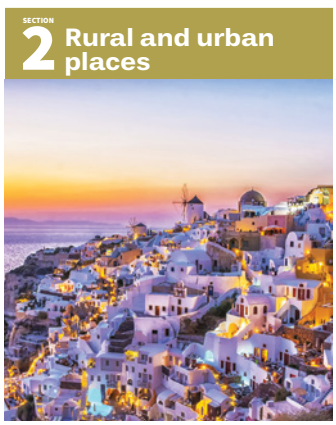
This section focuses on sustainability in the contemporary world and how to evaluate it. It identifies what sustainability is, the nature of sustainable development, the principles underpinning this development and the opportunities and challenges of this activity. This knowledge is contextualised through three case study chapters. Each case study chapter investigates a specific global economic activity, its nature, spatial dimensions, the factors influencing it, its current and future trends, and the sustainability strategies linked to the activity.

Students are provided with three case study chapters:

- Global tourism and its sustainability
- Global winemaking and its sustainability
- Global energy production and its sustainability

2 Rural and urban places

This section focuses on human settlements. It explores factors that influence settlements and the challenges experienced in settlements, and strategies for the sustainable management of settlements. This knowledge is contextualised through four case study chapters. These include two New South Wales settlements, one in a rural setting and one in an urban setting. Two case studies for large cities outside Australia include a large in-depth study of New York City and a smaller study of Mumbai. Each of the four studies explores the place's character and location, geographical processes that have shaped the place's identity, its links to other places, the challenges experienced by those living there, as well as the responses and opportunities to improve the liveability and sustainability of the place.

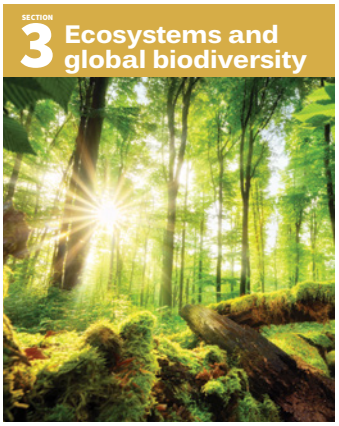


Students are provided with four case study chapters:

- A rural place: Tamworth
- An urban place: Darling Harbour Precinct
- A city outside Australia: New York City
- A city outside Australia: Mumbai

3 Ecosystems and global biodiversity

This section focuses on the nature, complexities and current state of ecosystem functioning and global biodiversity, and strategies for the sustainable management of ecosystems. This knowledge is contextualised through two case study chapters. Each case study examines the ecosystem's characteristics, its functioning, its human-induced modifications, ecosystem management responses and strategies, a comparison with the management approach of a similar ecosystem, and an examination of the role of contemporary research and innovation in the sustainable management of the ecosystem.



Students are provided with two case study chapters:

- Ecosystems study: Great Barrier Reef
- Ecosystems study: Fiordland of New Zealand

CHAPTER

1 Geography in the contemporary world

The word geography comes from the Greek γεωγραφία, *geographia*, a combination of two Greek words *geo* (the Earth) and *graphien* (to describe in either a written or illustrative form). As a discipline, geography is all-encompassing. It seeks to enhance our understanding of Earth and its human and natural complexities—not just where places and features are located, but also how they came to be and have changed over time.

The origins of the discipline are unclear, but it is thought to have developed independently in different cultural contexts and was enriched by the interactions between these cultures over time. We know, however, that the core concepts of the discipline—place, space, time and scale—distinguished it from the other physical and human sciences.

The ancient Greeks viewed the poet Homer as the founder of geography. His works, the *Iliad* and the *Odyssey*, while works of literature, both contain a great deal of geographical information. For example, Homer describes a circular world, ringed by a single massive ocean.

The oldest known maps of the world date back to ancient Babylon, from the ninth century BCE. The best-known Babylonian world map is the Imago Mundi from 600 BCE. The Ortelius world map (dated 1570), featured in this introduction, forms part of the *Theatrum Orbis Terrarum*, considered the first true atlas in the modern sense: a collection of uniform map sheets and explanatory text.

First Nations Australians were among the earliest geographers. The study of geography as a recognised academic discipline in Australia dates from 1920, when English-born Thomas Griffith Taylor was appointed foundation head of Australia's first geography department at Sydney University. Today, geography in its various forms is showcased in all of Australia's leading tertiary institutions, and geographers make important contributions to decision-making processes related to a diverse range of environmental and social challenges.

This chapter provides a series of snapshots, highlighting areas of geographical research where Australian geographers are taking a leading role. Hopefully, these will provide an insight into the range of careers available to those studying geography beyond secondary school.

> **Geography: it's all around us!**
>
> **John Wise, Australian geography educator**

1.0.1 A section of the world map drawn by Dutch geographer, cartographer and cosmographer, Abraham Ortelius, circa 1570. Australia did not exist in the cartographer's understanding at this time in history.

Chapter glossary

locational disadvantage the concentration of socio-economically disadvantaged people in locations that lack services, resources and opportunities

marginalised lacking power and influence in society

morphology the study of the physical characteristics of lands, regions or urban settlements

social connectedness the feeling of belonging to a social group and having meaningful interpersonal relationships

social policy courses of action adopted by government dealing with the care of development of individuals in a society, according to a set of standards which the society sets out to achieve

spatial inequalities the spatial pattern of differences in socio-economic advantage and disadvantage

UNIT 1.1

Geographers in contemporary Australia

1.1.1 Ecologists monitor the health of spinifex communities on Credo Station, Western Australia

1.1.2 Degradation of the fragile Australian landscape is widespread. Just west of Charters Towers, Northern Queensland, dryland salinity has caused trees to die and has induced sheet erosion.

Geography provides students with the understanding, skills and tools to help make sense of and contribute to the world around them. Students with a passion for the subject of geography have a range of options when it comes to post-school study and careers. This chapter introduces some of the areas of geographical interest in which Australian geographers excel. Students will engage with many of these areas as part of their geography studies in Year 12.

Environmental change

Australian geographers are world leaders in building an understanding of how the environment of our planet changes, and how societies respond to these changes. Environmental change includes all the changes taking place in Earth's atmosphere, biosphere, hydrosphere and its geomorphology. Geographers investigate the causes, consequences, relationships and responses to a diverse range of environmental changes and how these impact on humans (see Figure 1.1.1).

Land, water and food

The distinctive contribution made by geographers in land, water and agriculture ranges from physical geographical studies of environmental processes to human geographical studies of cultural attitudes to the management of environmental resources.

Geographers make a rich contribution to:

- the basic science of understanding Australian landscapes, particularly concerning the continent's unique vegetation and hydrology
- the degradation of the fragile Australian landscape by European agricultural practices. These include changes to vegetation, increasing erosion, salinity, acidification, pollution, weed and animal invasions, and the depletion of groundwater resources (see Figure 1.1.2)
- landscape and river restoration, which attempts to repair past damage. This includes the revegetation of saline catchments and erosion-control interventions
- spatial changes in farms and production types, and demographic changes in rural areas
- the integrated planning and governance of land and water management at a catchment scale
- Aboriginal and Torres Strait Islander approaches to land and water management.

Health and wellbeing

Australian geographers make an important contribution to our understanding of the factors that determine the health and wellbeing of Australians. Areas of particular interest include:

- **spatial inequalities** in health outcomes, disease concentrations, environmental influences on health, accessibility to health services and the relationship between housing and health
- the relative wellbeing of a population with reference to education, employment, housing, health, accessibility of services, environmental quality, social relationships and **social connectedness**, security and respect

- **locational disadvantage**, which is the idea that socio-economically disadvantaged individuals and households are often concentrated in places—both urban and rural—with poor employment, training and educational opportunities
- social isolation, defined as living without companionship, having low levels of social contact, little social support, feeling separated from others, feelings of being an outsider, isolation and suffering loneliness
- the **social policy** dimensions of the impediments and challenges faced by Aboriginal and Torres Strait Islander Australians.

The economy

The economy, the employment it creates, the incomes it provides and the services and infrastructure it funds, are of central importance to households and individuals. Geographers are interested in the impacts of economic change on places and regions. They focus on the processes producing these changes and ways of promoting regional development. Geographers are interested in:

- analysing the processes driving change in the spatial pattern of the Australian economy
- the changing nature of manufacturing in Australia, specifically the shift from labour-intensive manufacturing to high value-added manufacturing
- the ways in which rural communities respond to economic and demographic change
- the extent to which remote places can take advantage of the economic and demographic benefits associated with mineral and energy extraction
- labour mobility with reference to fly-in fly-out (FIFO) employment.

The Asia–Pacific region

Australian geographers make a major contribution to educating and informing Australians about the region. Areas of specific interest the Asia–Pacific region include:

- the impacts of climate change in the region, including the interacting biophysical and human processes contributing to climate change
- the ways people mitigate and adapt to climate change
- rising sea levels and the implications for the island nations of the Pacific
- the causes of wetland loss and degradation
- linkages of rural communities with urban areas through permanent or temporary migration
- the efforts of local communities and **marginalised** peoples to find development approaches that meet their needs and values
- water management in a multinational context
- food security
- intra-regional migrations.

Natural hazards

Extreme natural events are a recurring feature of the Australian environment. They are mostly weather-related and include droughts and floods, severe tropical cyclones, heatwaves and bushfires. These events become hazards when they cause material damage to infrastructure, industry, environmental resources, and/or the injury or death of people. Geographers investigate a range of hazard-related issues, including:

- the increased severity and frequency of drought resulting from climate change and its impact on rural communities, including the vital role local towns play in providing social support to rural producers
- the effects of flooding on river **morphology**, and strategies to better manage flood risks. Specific examples include the study of riverbank erosion over time, modelling the effects of raising levee heights and identifying priority areas for restoring river-based vegetation that can reduce the severity of flooding

1.1.3 In late 2019 and early 2020, large areas of Eastern Australia were devastated by out-of-control bushfires driven by prolonged drought—a consequence, at least in part, of Australia's warming climate.

1.1.4 Many of Australia's smaller rural settlements are in decline because of economic and technological change. Here, deserted shops line the main street of Terowie, a small town in the mid-north region of South Australia, 220 kilometres north of Adelaide.

- the vulnerability of environments to tropical cyclone damage
- strategies for reducing hazard impacts, including risk assessment, planning interventions, disaster resilience and storm- and bushfire-related building codes
- bushfire management (see Figure 1.1.3)
- mapping communities' vulnerability to heatwaves and the development of mitigation strategies
- the role of communities in disaster management.

Rural and regional Australia

Rural and regional Australia comprises all those areas outside the state and territory capital cities. With a population of eight million—one-third of the nation's population—non-metropolitan Australia features a wide variety of environments, economies and settlements. Australian geographers are particularly interested in investigating, describing and explaining:

- dynamic population and environment interactions in non-metropolitan settings
- the demographic, socio-cultural and economic characteristics of different rural and regional towns (see Figure 1.1.4)
- how and why these characteristics differ over space and from place to place
- the diversity and complexity of rural and regional Australia
- Aboriginal and Torres Strait Islander geographies of rural and regional Australia.

Australian cities

Australia is a highly urbanised country with two-thirds of the population living in its state and territory capitals. These cities have a wide range of environmental, economic, infrastructure, social and cultural issues, and not surprisingly are the subject of extensive geographical study. Areas of particular interest include:

- the relative position of Australia's cities within global and national city networks
- the internal structure of Australian cities with reference to the changes in population density patterns, including a renewed trend towards medium- and high-density inner-city living (urban consolidation) (see Figure 1.1.5)
- strategies to improve transport solutions within Australia's cities
- the funding of critical urban infrastructure
- the ways people move through different types of housing during their life and the effects of life events on their ability to maintain their position in the housing market
- attitudes towards ethnic diversity
- Aboriginal and Torres Strait Islander peoples' history of ownership and the subsequent dispossession of places, their right to maintain a connection with and presence in urban places of significance, and the recognition of this history and their rights
- urban heat islands and their impacts
- water in urban areas, including bio-retention systems to retain and treat stormwater, the rehabilitation of degraded urban waterways and the diversification of urban water sources by recycling stormwater and wastewater
- urban sustainability with reference to the relationship between the low residential densities of Australian cities as a barrier to improving sustainability, as it results in high levels of private car use and water consumption
- the impacts of urban renewal projects on small businesses and low-income residents.

1.1.5 The process of urban consolidation is transforming Australian cities. Here, apartment tower blocks sit alongside commercial office towers on the Brisbane River in the city's CBD.

Coastal and marine environments

Australia's diverse coastal landscapes are highly dynamic—constantly changing because of both marine and terrestrial processes. As the home to most of the Australian population and a focus for tourism and recreation, the coast is also a major site for human–environment interactions. This makes it an important area for geographical research. Areas of specific interest include:

- the study of coastal processes focusing on the interactions between the hydrodynamic processes (waves, winds, tides and currents) that erode or deposit coastal materials, and the landforms that these processes produce (see Figure 1.1.6)
- the rate of sea-level rise and the associated changes to the coastal environment
- the vulnerability of estuaries and their adjacent floodplains to inundation and erosion as a result of climate change
- the socio-economic vulnerability of Australian coastal communities to climate change
- coastal planning and management policies.

1.1.6 Rising sea levels threaten the built environment of coastal settlements. Here, storm waves have damaged homes lining Sydney's Collaroy Beach.

Activities

Acquiring and processing geographical information

1 Does the scope of the work undertaken by geographers surprise you?

2 Rank the areas of study—represented by the headings in this chapter—in the order of the most interest to you, beginning with the one of greatest interest.

   a Using the Go With Geo website (www.gowithgeo.com.au) investigate the scope of the area of geography of greatest interest to you.

   b List the tertiary degrees that would equip you with the necessary knowledge and skills to work in this area. Identify the tertiary institutions offering such degree programs.

SECTION

1 Global sustainability

Modern humans, or Homo sapiens (the sole surviving species of our genus), have been around for about 200 000 years—a mere blink of an eye compared to the 3.8 billion years that life has existed on Earth. Over this relatively short time, and especially since 1900, the impacts of human activity have reached even the most remote places. No ecosystem or natural system remains untouched.

We have cleared vast forests and grasslands to grow food and build cities that are now home to more than half the world's population. We use Earth's raw resources and exploit its oceans and reservoirs of fresh water. We pollute its waterways, its atmosphere and its soils. The demands of our rapidly growing population threaten the existence of many species and Earth's great centres of biodiversity—its rainforests and coral reefs.

Achieving a more sustainable way of living will be essential if we are to protect the natural systems upon which all life depends. Sustainability, in this context, refers to the capacity of Earth's natural systems to survive or adapt to changing environmental conditions indefinitely. Applied in the context of development, it involves meeting the needs of the present without compromising the ability of future generations to meet their needs.

When thinking about sustainability, it's important to remember that it's not 'our' world! We are its custodians. The world belongs to our children, our grandchildren, our great-grandchildren and all future generations. Protecting this treasured place is our obligation, our legacy, our gift to the future.

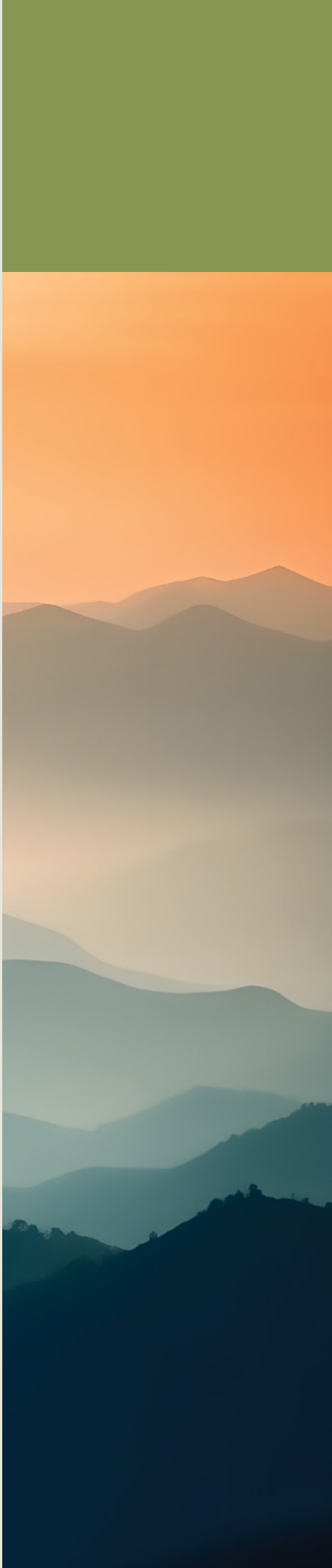
Sustainability is the integrating theme of the New South Wales Year 12 geography syllabus.

Content focus

In this section, students investigate sustainability in the contemporary world and how it can be evaluated. They contextualise and consolidate their understanding through an investigation of a global economic activity. Case studies of tourism, winemaking and energy production are provided.

In this section

Chapter 2 Sustainability in the contemporary world
Chapter 3 Global tourism and its sustainability
Chapter 4 Global winemaking and its sustainability
Chapter 5 Global energy production and its sustainability



CHAPTER

2 Sustainability in the contemporary world

Sustainability is the practice of using natural resources responsibly today, so they are available for future generations. However, many of Earth's resources are being depleted faster than they can be replaced. The principle of sustainability offers an alternative. It is built on the understanding that resources are finite and should be used conservatively and wisely, with a focus on long-term priorities and the consequences of the ways they are used. In real terms, sustainability is about our children and our grandchildren and the world that we will leave them. Sir David Attenborough, the famous British naturalist and broadcaster, observes that we can live sustainably:

> We have to recognise that every breath of air we take, every mouthful of food we take comes from the natural world. And that if we damage the natural world, we damage ourselves … We have the power. We have the knowledge to actually live in harmony with nature.

This chapter explores sustainability in the contemporary world. The focus is on understanding what sustainability and sustainable development are and examining the principles of ecologically sustainable development. The text investigates what is involved in planning for and achieving global sustainability, the reasons for monitoring and evaluating global sustainability, and the criteria used in these assessments.

> **Nature is not something for human beings to use and exploit as they see fit, solely for their own interests. Nature and humanity are one … To destroy the natural world is to destroy human life.**
>
> **Daisaku Ikeda, Japanese philosopher and educator**

2.0.1 King George Falls, Kimberley, WA

Chapter glossary

Country often used by Aboriginal and Torres Strait Islander peoples to describe a specific place to which they are connected. The concept of Country is complex and incorporates cultural, physical, linguistic and spiritual features

cultural burning the practice of Aboriginal and Torres Strait Islander peoples regularly using low-intensity fire to burn vegetation

ecologically sustainable development (ESD) the effective integration of social, economic, environmental and cultural considerations in decision-making processes to achieve sustainable development

intergovernmental initiatives actions conducted between, or involving the agreement of, at least two governments that will work together to solve problems or progress discussion about issues of global interest

megadiverse a term used to describe countries that are home to the majority of the world's species and have high numbers of endemic species

non-government organisation (NGO) an organisation that operates independently of government institutions and political parties at local, state, national, regional and international scales. NGOs typically have an environmental or humanitarian focus rather than a commercial objective, to address areas such as youth empowerment, environmental protection and the rights of women

pillars of sustainability the factors assessing the nature and effect of sustainable development: social equity, economic viability and environmental protection

spatial autonomy a sense of belonging and personal connection with place

stewardship environmental stewardship involves the responsible use and protection of the natural environment through the sustainable practices of individuals, small groups, non-profit organisations, government agencies and other collective networks

sustainability the capacity of the environment to continue to support our lives and the lives of other living things into the future

sustainable development a process of economic and social change designed to produce an environmentally sustainable economy and a just society

United Nations Sustainable Development Goals (UNSDGs) a call to action for people across the world to address the critical areas of importance: people, planet, prosperity, peace and partnerships. The 17 goals were adopted by the United Nations in 2015 and the intent is for them to be achieved by 2030

UNIT 2.1

Defining sustainability and sustainable development

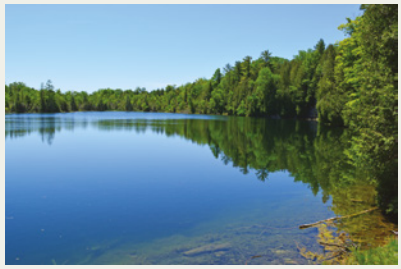
The complexities of **sustainability** and **sustainable development** are best understood through the lens of geography. Geography allows the investigation of both the human and natural worlds and the interactions between them to reveal how societies are organised and how they interact, or could potentially interact, with the environment across time. That is, the integrative understanding of society, the economy and the environment made possible through a geographical lens provides an excellent foundation for exploring what sustainability means. Furthermore, the integrative understanding also leads to an examination of the **pillars of sustainability**.

The concept of sustainability and the process of sustainable development have risen in prominence and priority during the Anthropocene. The Anthropocene epoch is a contested, yet broad term used to describe the timeframe that is said to have started in 1950 and continues beyond the present day. It is a timeframe defined by multiple human-induced global-scale environmental changes, such as biodiversity loss and climate change.

● SPOTLIGHT

Crawford Lake indicates the start of the Anthropocene

Crawford Lake, a small body of water in the Canadian province of Ontario, may be the symbolic starting point for a radical new chapter in Earth's geological history: the Anthropocene, or the age of humans (see Figure 2.1.1). Crawford is a meromictic lake, meaning it has layers of water that do not intermix. These layers contain records of climate and sediments at different points in time.



2.1.1 Crawford Lake contains the markers of a new geological epoch.

The Anthropocene is the latest epoch to be added to Earth's 4.6-billion-year official timeline. Every new phase of Earth's history begins with a 'golden spike'—a spot in the geologic record where proof of a global transformation is perfectly preserved. Hydrogen molecules uncovered in Greenland's ice, for example, denote the start of the Holocene—the 11 700-year stretch of relatively stable temperatures that encompasses all human civilisation, up to and including the present day, overlapping with the Anthropocene. The sediments of Crawford Lake could prove to be just as transformative.

Earth scientists suggest the lake's finely layered sediments provide a thousand-year record of environmental history, including evidence of human-made disruption from the 1950s. It was at this time when scientists say human activities—from nuclear weapons tests to fossil fuel combustion and deforestation—began to leave an indelible imprint on Earth's geologic record. Such spikes are like exclamation marks in the history of the planet.

Earth scientists have argued for some time that Earth's chemistry and climate are now fundamentally different from the conditions of the last several thousand years. All the different components of Earth's system and the ways in which they interact are now fundamentally different to how they used to be.

Crawford Lake is one of 12 'golden spike' sites worldwide. Others include Antarctica's ice, two isolated coral reefs, a mountain-top peat bog and a polluted Californian bay. Each site contains evidence of the same simultaneous surge in human pollution around 1950, especially the sudden spike in radioactive plutonium from nuclear weapons testing. Sadly, the presence of plutonium will serve as the primary marker of the start of the Anthropocene.

Scientists generally agree that Crawford Lake offers the best evidence for the Anthropocene. In addition to nuclear fallout, the lake's sediments hold evidence of industrial pollution, species extinctions and global climate change. Tiny black particles of fly-ash—a by-product of burning fossil fuels—are evident throughout the most recent sedimentary layers. Changes in the types of buried tree pollen demonstrate how the surrounding forest has responded to steadily rising temperatures.

Sustainability and sustainable development

There are important differences between sustainability and sustainable development. These terms should not be used interchangeably. That is, sustainability is a goal and sustainable development is a pathway towards that goal that embraces one or more pillars of sustainability.

Sustainability

Sustainability is broadly understood as a continuation of environment, place, communities and systems into the future. Its intent is to promote an understanding of social justice and develop ecological literacy. The United Nations' (UN's) Brundtland Report (1987) defined sustainability as 'meeting the needs of the present without compromising the ability of future generations to meet their own needs'.

The NSW Geography syllabus definition reflects the Bruntland Report and defines sustainability as 'the capacity of the environment to continue to support our lives and the lives of other living creatures into the future'.

Sustainability implies not using more of a resource than can be regenerated naturally. In other words, sustainability is about working within the carrying capacity of an ecosystem or within an input–output model of resource consumption. An understanding of sustainability enables meaningful participation in significant future-focused debates at a local, national and global scale. In this way, sustainability is both a goal to work towards and a way of thinking about complex systems, environments, people and places, so as to analyse, negotiate, search for transformative alternatives and make appropriate choices for time and scale. There are contested views on how to progress towards sustainability and these are often informed by worldviews such as **stewardship**.

An understanding of sustainability involves being able to imagine alternative futures through interpreting the nature and extent of connected issues at scale. These include agency and government policy, individual footprints, the effects of human population size on the world, and the effects of local and global pollution (see Figure 2.1.2).

2.1.2 Local and state governments can encourage sustainable commuting by investing in safe cycling infrastructure.

SPOTLIGHT

Environmental stewardship

Environmental stewardship is broadly understood as having values aligned to a responsibility for the natural world and caring for nature, based on having positive interactions with the environment. Within an understanding of stewardship is an acceptance that humans are part of a multi-species community and that human actions affect the environment and all who inhabit it.

Stewardship arises from a moral concern for current and future multi-species generations and the belief that individual or collective action occurs on behalf of the environment. This action can be to protect, restore and sustainably use land, waterways and resources. Importantly, these actions are contextually driven, or place- and time-specific.

Examples of stewardship can be found in three distinct areas of Alaska, USA, where children in each area have a common understanding of stewardship. Researchers found that Alaskan children's actions are contextualised according to the socio-cultural and geographic influences of place. Alaska is in the Arctic region, so there is consideration of climate extremities and its rapid social, economic and environmental change. Caring for snow is more common than caring for plants across each area. Interior Alaskan children are concerned with pet care, such as dogs (see Figure 2.1.3), while children from the other two regions, which are closer to the coast, are more concerned with the ethics of hunting and fishing.

Spatial autonomy, a sense of belonging and personal connection with place, has an important role in developing an understanding of sustainability and how to live sustainably on the land.

2.1.3 Indigenous Alaskan child with husky puppies

Figure 2.1.4 Women mobilise in the annual March of the Daisies, to demand sustainable development with justice, autonomy, equality and freedom, Brazil, 2023

Sustainable development

Sustainable development is a process of economic and social change designed to produce an environmentally sustainable economy and a just society (see Figure 2.1.4). An understanding of the nature, scope and possibilities of sustainability is important for working towards sustainable development. The UN's Brundtland Report states that sustainable development requires an integrated approach that considers environmental concerns along with economic development. Education, for example, is part of a strategy for achieving sustainable development.

Today, almost 140 countries in the world seek to implement sustainable strategies. These are current strategies that meet the countries' immediate development needs while ensuring they do not negatively affect future generations. There are limits implied within an understanding of sustainable development, such as those imposed by the current state of technology or the ability of the biosphere to absorb the effects of human activities. However, it is possible for technology and social organisation to be managed and improved to meet current basic needs, facilitate economic growth and allow our multi-species world to thrive and aspire to an improved life.

United Nations Sustainable Development Goals

In 2015, the UN released its 2030 Agenda for Sustainable Development. It is a plan for action with 17 goals and 169 targets to be achieved by 2030 among UN member states. These **United Nations Sustainable Development Goals (UNSDGs)** form a framework for improving the lives of populations around the world and are explored in Unit 2.3.

By harnessing the interdisciplinary nature of geography, we can better understand the nature and importance of sustainability. With the UNSDGs in hand, the next step is to envision a pathway towards sustainable development. This occurs by considering the nature, extent and influence of interdependencies that exist between the environment, a multi-species society and the economy. Such interdependencies are evident in the pillars of sustainable development, which are explored in the next section.

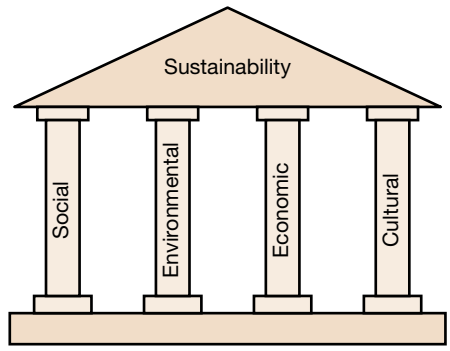
Did you know?

Daisaku Ikeda, a Buddhist philosopher and educator from Japan, stated in his essay 'The Challenges of Global Empowerment: Education for a Sustainable Future', that three goals should be promoted in the quest for sustainable development:

- to learn and deepen awareness of environmental issues and realities
- to reflect on our modes of living, renewing these towards sustainability
- to empower people to take concrete action to resolve the challenges we face.

Pillars of sustainability

The key dimensions, or pillars, of sustainability are understood to be of equal importance and referred to as a triple bottom line when assessing the nature and effect of sustainable development: social, economic and environmental. There is also an argument for a fourth pillar of sustainability: cultural diversity (see Figure 2.1.5). The origins of these pillars are attributed to the need for economic development that takes into account social objectives, resource limitations and ecosystem-carrying capacity, as identified in the Brundtland Report and Agenda 21 (a UN action plan, discussed further in Unit 2.3).



2.1.5 The four pillars of sustainability

THE SOCIAL PILLAR

The social pillar of sustainability focuses on maintaining and improving social equality, by considering the importance and implications of values such as cohesion, wellbeing, reciprocity, thriving, peace, inclusivity and relationships. Social sustainability considers how to preserve future generations and acknowledge the nature and effect of individual and collective impact on others. Laws, information and shared understanding about equality and human rights are used together to encourage and support the social pillar of sustainability.

THE ECONOMIC PILLAR

The economic pillar of sustainability focuses on improving economic growth and standards of living through efficient resource use. Quality of growth is as important as the amount of growth occurring. Consideration must also be given to the monetary value of environmental damage. Profit-making and economic growth of a business are important because they are indications of the service or product being useful and valuable to society. However, the economic pillar of sustainability must consider the nature and rate of growth against potential harm caused to ecological systems and relationships among people. A circular economy model with its closed-loop approach pursuing zero waste options, is emerging as a more sustainable option compared to a linear and more traditional 'take-make-dispose' economy.

THE ENVIRONMENTAL PILLAR

The environmental pillar of sustainability focuses on preserving the environment and adopting a more rational use of resources such as minerals, to maintain biodiversity and improve the quality of the land, air and waterways. The environmental pillar of sustainability considers renewable energy, local suppliers, eco-friendly design and digital transformation as ways to achieve economic growth with minimal harm to the environment and society (see Figure 2.1.6).

Figure 2.1.6 Wind turbines represent a sustainable source of energy.

THE CULTURAL PILLAR

The cultural pillar of sustainability focuses on protecting, developing and expressing values and cultural diversity to achieve a more satisfactory intellectual, emotional, moral and spiritual existence. Access to a diverse pool of beliefs and practices is integral for cohesion and belonging, development, peaceful co-existence, prosperity, creativity and innovation.

The Tjanpi Desert Weavers in Central Australia represent an example of a social enterprise that embraces all four pillars. They create baskets, jewellery and artworks woven from local grasses. The enterprise improves the wellbeing of its employees by bringing employment to women with few other options for work; it uses natural fibres that are sustainably harvested, and it allows its employees to express their culture and creativity through the products they create.

An understanding of the nature of sustainability, sustainable development and pillars of sustainability, together with an understanding of their connection and differences sets the foundation for exploring **ecologically sustainable development (ESD)**. In Unit 2.2, attention is given to the four cornerstones of ESD.

Activities

Acquiring and processing geographical information

1. Explain why geography is described as an interdisciplinary discipline. What does this enable?
2. What is meant by an anthropocentric view?
3. Define sustainability.
4. Define sustainable development.
5. Identify the four pillars of sustainability. What are the key elements of each?

Applying and communicating geographical understanding

6. Study the box, Spotlight: Crawford Lake about the start of the Anthropocene. Complete the following tasks.
   a. Define the term 'golden spike'. Give examples.
   b. Outline the evidence found in the sediments of Crawford Lake that supports the theory that the Anthropocene dates from the mid-twentieth century.
7. Study the box, Spotlight: Environmental stewardship. Explain what is meant by stewardship. Investigate examples of stewardship as practised by Australia's First Nations peoples. Write a report outlining your findings.

UNIT 2.2

Principles of ecologically sustainable development

The predicted or actual outcomes of strategies enacted from each pillar of sustainability are typically evaluated by the four principles of ESD.

Ecologically sustainable development

ESD is broadly defined as the effective integration of social, economic, environmental and cultural considerations in decision-making processes about ways to achieve sustainable development.

In Unit 2.1, the distinction between sustainability and sustainable development was explained to make clear these are not interchangeable terms. ESD too, is a distinct term and is not interchangeable with either sustainability or sustainable development.

Since its first use in 1990, ESD has been an elusive and contested term. Over the past 30 years, discussion, research and strategy on ESD has progressed (see Figures 2.2.1 and 2.2.2).

Today, ecologically sustainable development is broadly understood to encompass each pillar of sustainability (social, economic, environmental and cultural) because an approach that meets only one pillar is not considered to be sustainable. Four principles of ecologically sustainable development are used to assess strategies enacted from the pillars of sustainability. These principles are the precautionary principle, intergenerational equity, conservation of biodiversity and ecological integrity.

2.2.1 One Central Park in Chippendale, Sydney, represents sustainable building development. The mixed-use towers have residential and retail spaces, and include sustainable initiatives such as rainwater collection, hanging gardens, a low-carbon power plant and an internal water recycling plant.

Did you know?

John Muir, a Scottish-American glaciologist, environmental philosopher and advocate for wilderness preservation in the USA, was known for saying, 'When we try to pick out anything in nature by itself we find it hitched to everything else in the universe.'

Precautionary principle

The precautionary principle recognises the limits of science to identify or foresee real or potential damage to the environment as the result of a particular strategy, and steps in to fill this gap to ensure the environment is protected. That is, the principle guides action in situations of scientific uncertainty about environmental impact. In the event

of a reasonable possibility of serious or irreversible harm to the environment, protective action is required and should be taken to mitigate the risk of harm. The precautionary principle states that a lack of scientific certainty about serious environmental damage should not be a reason to postpone protective action. As a result, this principle goes beyond conventional environmental risk management to maintain that before there is conclusive proof of future environmental damage, action should be taken to protect the environment.

Intergenerational equity

Intergenerational equity means that the present generation should ensure the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. However, intra-generational equity also exists, which means people within the present generation all have a right to benefit equally from Earth's resources. Intergenerational equity requires a long-term view towards the biophysical impacts of activities and the development and implementation of infrastructure. Additionally, consideration must be given to the influence and operation of institutional leaders, so that future decisions and practices will help rather than hinder future-focused thinking and strategy.

Conservation of biodiversity and ecological integrity

Conservation of biodiversity and ecological integrity focuses on multi-species diversity across gene pools, ecosystems and among the species themselves. Multi-species diversity is essential for the maintenance and evolution of the life-support systems on Earth. It also has economic, socio-cultural and aesthetic value.

Historically, Australia has a poor record of conservation of and knowledge about its biodiversity. Australia's economic status and identification as a **megadiverse** region, make conservation of biodiversity and ecological integrity imperative fundamental considerations in decision-making processes towards achieving sustainable development. More cautious application of the precautionary principle in Australia needs to occur to amplify and protect biodiversity and ecological integrity.

2.2.2 A feature of Singapore's Gardens by the Bay is its Supertrees. These vegetation-covered structures are embedded with environmentally sustainable functions. Some have solar panels on their canopies to harvest energy for lighting the Supertrees at night, while others are integrated with the adjacent conservatories and serve as air-exhaust outlets.

Did you know?

The legislated definition assigned to ESD varies across Australia. In Commonwealth legislation, ESD is a set of decision-making processes to effectively integrate both long- and short-term economic, environmental, social and equitable considerations. In Queensland and New South Wales, ESD is emphasised through the precautionary principle and intergenerational equity. In WA and Victoria, there is no specific mention of ESD, although an understanding of the principles is embedded in government policy and documents.

SPOTLIGHT

Bananas growers in search of sustainability

Bananas are grown across the tropics and subtropics. Approximately 150 million tonnes are produced annually. This puts global banana production between the volumes produced for tomatoes (174 million tonnes) and apples (83 million tonnes) annually. India and China are the biggest producers of bananas (see Figure 2.2.3). The important exporters of bananas are Ecuador, the Philippines, Guatemala, Costa Rica and Colombia. Bananas are mostly imported by the European Union (EU) and the United States.

2.2.3 Banana harvesting Kerala, India

Banana cultivation and production are threatened by climate change, pests and disease, deforestation, a lack of genetic variation in cultivated bananas and power imbalances in trading relationships. However, wild or non-cultivated bananas are known to have beneficial traits for generating disease-resistant and climate-resilient qualities. Irrigation systems are often developed to maintain productivity and water security in the face of climate change. Pests and diseases are spreading globally and cause direct harm to banana production, but pesticides have ecological implications and cause indirect harm to human health. The banana industry is characterised by a power imbalance between international businesses that own plantations and supply chains and the local agricultural workers employed to cultivate and harvest bananas.

While there is a call for diversification and modification of the cultivated banana gene pool to ensure crop continuity, it is a time-consuming, labour-intensive process. Additionally, consumers are reluctant to accept genetically modified bananas. Environmental awareness is growing among banana consumers and banana retailers have an aversion to reputational risk. As a result, voluntary certification schemes have been started to help banana producers demonstrate a commitment to social, economic and environmental sustainability. Certified bananas are popular among banana purchasers and retailers. Signing up to a certification scheme, for a fee, means that producers are graded by a registered agency and receive price premiums and potential market access as a reward for meeting sustainability standards.

Certification schemes include Organic, Rainforest Alliance and Fairtrade. Organic certification was established in 1972. The focus is on maintaining soil health and ecosystem services through crop rotation and similar practices. Organic certification also requires the replacement of commercial fertilisers and pesticides with organic fertilisers such as manures and composts. Rainforest Alliance certification was established in 1987. The focus is on ecosystem and wildlife protection, water conservation, improving the working conditions and occupational health and safety of producers, and fostering community relations. Fairtrade International certification was established in 1997. The focus is on ensuring the prices received by producers cover the costs of sustainable production.

Bananas are now one of the most important traded and staple foods. The export trade was designed to supply bananas to Europe and North America as cheaply as possible, whatever the cost to the countries and people producing them. These costs remain today, with agricultural workers often earning less than a living wage and experiencing poor working conditions, while soils and waterways are degraded by agrochemicals. Voluntary certification schemes are one way to achieve sustainable development of the banana industry and improve consumer confidence. Unfortunately, these schemes are expensive, have a high administrative workload and there is minimal evidence demonstrating their effectiveness.

Activities

Acquiring and processing geographical information

1 Define ecologically sustainable development.

2 List the principles used to assess ESD via the four pillars of sustainability.

3 Explain what each of the following means:

- **a** precautionary principle
- **b** intergenerational equity
- **c** conservation of biodiversity and ecological integrity.

Applying and communicating geographical understanding

4 Study the box, Spotlight: Banana growers in search of sustainability. Summarise the challenges faced by the industry and describe how these are being addressed to enhance sustainability. Develop a response to their challenges based on the pillars of sustainability.

UNIT 2.3

Planning for and achieving global sustainability: Opportunities and challenges

Sustainability can be planned for and achieved at scale. There are now processes and frameworks that support sustainability, no matter who is trying to achieve it.

United Nations Sustainable Development Goals

The UNSDGs provide a helpful framework for understanding the opportunities and challenges associated with sustainability. Plans for action and progress towards the achievement of sustainable development goals are showcased through **intergovernmental initiatives**, **non-government organisation (NGO)** activities, corporations, community organisations, individuals, and a range of external influences such as political decision-making and socio-cultural practices.

The UNSDGs are found in the UN 2030 Agenda for Sustainable Development. The agenda was published and adopted in 2015 and builds on the achievements of the UN Millennium Development Goals. The 2030 Agenda for Sustainable Development is an action plan for future thriving by 2030, across five areas of critical importance: people, planet, prosperity, peace and partnerships, laid out in 17 UNSDGs (see Figure 2.3.1).

There are 169 associated targets that provide guidance for action and which integrate and balance the pillars of sustainable development. The goals focus on addressing a range of complex global problems such as disaster response, the eradication of poverty, access to health and education, peaceful and inclusive societies, climate change, sustainable management of resources, water scarcity, food security and loss of biodiversity. UN Secretary-General, António Guterres likens the 2030 Agenda to a 'roadmap' for the future, with 'its goals and targets as tools to get there'.

There are 193 signatory countries to the 2030 Agenda for Sustainable Development. Between 2015 and 2030, each country is required to produce a review of their action and progress towards key goals at least twice. The International Voluntary National Review Synthesis Report drew on reviews from 42 countries during 2021, noting that between 2016 and 2021, over 176 signatories produced a review. The Voluntary National Review Synthesis Report covers areas of progress and constraint for each of the 17 UNSDGs. Recovery from the COVID-19 pandemic and the worsening effects of climate change were identified as key hindrances in making progress towards the UNSDGs. However, the majority of 2021 country reviews were completed by countries that were either landlocked, in a conflict or post-conflict situation, in Africa or were developing small island states, so they experienced a heightened effect from the already existing economic, geographic, environmental or political challenges.

Notable achievements for selected goals include UNSDG 16 Peace, justice and strong institutions. For example, Angola created new anti-corruption laws to facilitate the repatriation of illicitly acquired assets and Sierra Leone established a new Special Court within the High Court to facilitate timely completion of corruption-focused trials. For UNSDG 11 Sustainable cities and communities, in 2020 Bhutan developed its National Housing Policy to provide safe, affordable and energy-efficient housing and Chad noted a slight comparative decrease in urban populations living in informal settlements. For transport solutions, Malaysia is developing low-carbon mobility options by expanding its urban, rail-based public transport network, which is already yielding reduced levels of emissions compared to previous years when such options did not exist.

1. No poverty End poverty in all its forms everywhere.	**2. Zero hunger** End hunger, achieve food security and improved nutrition and promote sustainable agriculture.	**3. Good health and wellbeing** Ensure healthy lives and promote wellbeing for all at all ages.	**4. Quality education** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. Gender equality Achieve gender equality and empower all women and girls.	**6. Clean water and sanitation** Ensure availability and sustainable management of water and sanitation for all.	**7. Affordable and clean energy** Ensure access to affordable, reliable, sustainable and modern energy for all.	**8. Decent work and economic growth** Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9. Industry, innovation and infrastructure Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.	**10. Reduced inequalities** Reduce inequalities within and among countries.	**11. Sustainable cities and communities** Make cities and Human settlements inclusive, safe, resilient and sustainable.	**12. Responsible consumption and production** Ensure sustainable consumption and production patterns.
13. Climate action Take urgent action to combat climate change and its impacts.	**14. Life below water** Conserve and sustainably use Earth's oceans, seas and marine resources for sustainable development.	**15. Life on land** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.	**16. Peace, justice and strong institutions** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17. Partnerships for the goals Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development.			

2.3.1 The 17 United Nations Sustainable Development Goals

In 2018, the Australian Government produced a voluntary review of how Australian businesses, civil society organisations, universities, local communities and individuals are working towards the achievement of UNSDGs in voluntary or paid capacities. The report notes that not all the SDG Indicators are relevant or applicable to the Australian context. However, what is made clear throughout the review is how Australia is actively involved in developing indicators to measure progress towards selected UNSDGs. For example, Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO), an industry representative, Rio Tinto, and a conservation organisation, the Great Barrier Reef Foundation, are collaborating to monitor ocean acidification and develop a methodology for measuring and reporting marine acidity, which connects to

2.3.2 The OECD logo

UNSDG 14 Life below water. The indicator includes surface seawater pH, dissolved inorganic carbon, carbon dioxide levels, temperature and salinity. Data is publicly available through a portal and the Australian Ocean Data Network (imos.org.au/facilities/aodn), and work is ongoing in the development of this indicator. Further information about the implementation of strategies and progress reports is available through the Department of Foreign Affairs and Trade, also on the Australian Sustainable Development Goals website (sdgs.org.au).

The role of global forums, agreements and cooperation

There are different levels and types of action available to plan for and achieve sustainability. It can be useful to explore the role of global forums, agreements and cooperation to understand these different approaches.

Global forums

A global forum is a network of policymakers and interest groups. Typically, they collaborate as a committee with equal weighting to solve a problem that requires a global solution. The Organisation for Economic Co-operation and Development (OECD) is an example of a global forum (see Figure 2.3.2). The OECD, as an international organisation, sets standards and conducts independent analyses on a range of economic and related policy areas. OECD Global Forums have existed since 2008 and cover areas such as agriculture, the environment, development and education.

International agreements and protocols

There are several major international agreements on sustainable development. These include the Rio Declaration on Environment and Development (1992): A political declaration of principles on the environment and development. A key outcome of the Declaration is Agenda 21, a non-binding action plan of the UN regarding sustainable development. Another outcome is a non-binding 'statement of principles' for the management, conservation and sustainable development of forests.

International protocols are a type of agreement. The Montreal Protocol on Substances that Deplete the Ozone Layer, for example, is an international agreement that regulates the production and consumption of nearly 100 human-made chemicals, referred to as ozone-depleting substances. It is one of the rare examples of an agreement that has met with a measure of success.

International cooperation

International cooperation occurs when governments and institutions develop common standards and create programs that can be applied to and implemented beyond more than one country and society. International cooperation is essential to ensure support for plans that respond to areas of global concern, such as the need for the sustainable use and management of water and energy. International cooperation should also generate and disseminate knowledge about how to approach an area of global concern. The UN, specifically its various agencies, is an example of international cooperation focused on creating programs to encourage action for achieving global sustainability through sustainable development pathways.

Intergovernmental initiatives

Intergovernmental initiatives involve at least two governments that work together to solve problems or progress discussions about issues of global interest. One example of an intergovernmental initiative is the Group of Twenty (G20), comprising 19 countries, the EU and the African Union. The group's focus is international economic cooperation. The G20 has an important global role in shaping and strengthening governance of major international issues, such as financial stability and sustainable development. The G20 represents over 75 per cent of global trade and 85 per cent of global gross domestic product (GDP).

Another example of an intergovernmental initiative is the Intergovernmental Panel on Climate Change (IPCC). Its focus is global sustainability. The IPCC assesses the science related to climate change and each year produces a report. In 2023, the IPCC Climate Change Synthesis Report was produced, summarising current knowledge about climate change, its widespread impacts and risks, along with strategies for climate change mitigation and adaptation. The report recognises the valuable nature of diverse knowledge forms alongside the known interdependencies of climate change, human wellbeing, multi-species societies and diversity, and ecosystem health. An increasing diversity of actors involved in climate action is also documented in the report.

SPOTLIGHT

Universities promoting sustainability

Universities are required by governments to develop and make available reports that showcase their activities and initiatives related to sustainability and their contribution towards achieving UNSDGs.

In a 2022 sustainability report published by the University of Wollongong, UNSDGs are used to guide purpose and action as they tackle complex problems and work towards solutions in partnership with the community, businesses, governments and colleagues across different scales (see Figure 2.3.3). For example, UNSDG 3 Good health and wellbeing shapes university research about how to address increasing levels of food insecurity and housing insecurity among vulnerable populations.

A program of research, Pedalling for Change, explores why bicycle commuting has not increased in Australia while leisure cycling has grown exponentially. Data from the research on current and aspiring bicycle commuters informs recommendations to governments about planning a more sustainable approach to commuting while maintaining health and wellbeing priorities. Pedalling for Change research has also resulted in innovative transformative thinking and changes in energy use and infrastructure provision. As a result, the Pedalling for Change program also connects to UNSDG 7 Affordable and clean energy and UNSDG 9 Industry, innovation and infrastructure.

In 2022, the university was identified as a top 100 institution (64th) in the Times Higher Education Global Impact Rankings for these sustainable development goals. Other UNSDGs that the university is addressing include UNSDG 10 Reduced inequalities and UNSDG 13 Climate action, as evidenced by the university's inclusion in the Times Higher Education Global Impact Ranking as a Top 100 institution (61st) and as a Top 50 institution (41st) respectively, for their research and development around those goals.

2.3.3 University of Wollongong actively promotes its sustainability-related research

● SPOTLIGHT

IPCC raises alarm

Key messages in the 2023 IPCC Climate Change Synthesis Report were framed around:

- current status of and trends in climate change
- future climate change risks and long-term responses
- responses to climate change in the short term.

A situational analysis of the current status and trends reveals human activity is the principal cause of increasing global surface temperatures, mostly through greenhouse gas emissions. The rate of global greenhouse gas emissions is said to be increasing and attributed to unsustainable energy use and land use, alongside unsustainable patterns of production and consumption.

The report noted how in the long term, urban systems are critical for being able to reduce emissions and advance climate-resilient development.

Key adaptation and mitigation elements in cities include:

- the design and planning of settlements and infrastructure
- land-use planning to achieve compact urban form with co-location of jobs and housing
- supporting public transport and active mobility (e.g. walking and cycling)
- the efficient design, construction, retrofit and use of buildings
- reducing and changing energy and material consumption.

For governance and policy responses, the report identified a need for institutions to work with diverse interest groups, such as businesses, young people, women, indigenous peoples and grassroots community groups, on local, national and regional scales, to develop support for policy and build consensus towards strategies for climate action (see Figure 2.3.4).

2.3.4 In November 2021, the UK hosted the 26th annual UN Climate Summit where Queen Elizabeth II said if world leaders worked together in a 'common cause' against climate change, they could 'solve the most insurmountable problems'.

Did you know?

Former UN Secretary, Ban-Ki Moon sought to mobilise world leaders to act on global challenges such as climate change, food and water insecurity, poverty and pandemics. In 2015, at a university ceremony in Belgium he challenged us 'to be the first generation to end poverty and the last generation to address climate change before it is too late'.

Non-government organisations

NGOs operate independent of government institutions and political parties at local, state, national, regional and international scales. NGOs typically have an environmental or humanitarian focus, such as youth empowerment, environmental protection or women's rights. Often, NGOs are not-for-profit and rely on the work of volunteers. Common characteristics of NGO operations and purpose include building local capacity, developing local partnerships, empowering communities to manage their own lives, and strengthening humanitarian responses at a local scale.

Australian NGOs must be accredited by the Department of Foreign Affairs and Trade (DFAT) if they wish to access government funding. The accreditation process provides assurance to the Australian public that NGOs are well-managed, community-based organisations, capable of quality program design, implementation and evaluation, to ensure quality outcomes. Australian NGOs include WaterAid Australia, SurfAid International Australia, The Fred Hollows Foundation and Australian Doctors International.

SPOTLIGHT

Sustainable management of Sundarbans coastal forest reserves

Increasingly, NGOs within and beyond Australia are partnering with governments, the private sector, schools and community groups, with the intent to deliver sustainable development programs that prioritise specific UNSDGs and consider the role of each pillar of sustainability. In Bangladesh, three NGOs are working with the government to collaboratively manage forest plantations in the south-western Sundarbans coastal forest reserves (see Figure 2.3.5). They are Friendship, Bangladesh Environment and Development Society, and Bangladesh Resource Centre.

A need for collaborative management of plantations in the coastal forest zone arose in the 1990s against the backdrop of rapid deforestation and loss of biodiversity. In 2022, 21 out of 54 protected coastal forest areas were collaboratively managed, enabling local participation in decision-making processes, a reduction in resource management costs, and the development of locally relevant management plans to reduce poverty while diversifying economic activity in the area.

The ongoing work of the three NGOs has created a pathway towards natural resource management to achieve UNSGDs, including UNSDG 1 No poverty, UNSDG 8 Decent work and economic growth and UNSDG 15 Life on the land. Despite this, managing the Sundarbans remains challenging. The NGOs have oversight of plantation operations. However, they do not have formal or final decision-making authority in the collaborative management relationship; they can only inform, facilitate and consult with government, local communities and other interest groups such as external business operators.

An unequal power relationship between each actor in the collaborative management relationship maintains an emphasis on the economic pillar of sustainable development and jeopardises the future sustainability of the plantation in the coastal forest zone.

2.3.5 Satellite image of the Sundarbans in Bangladesh showing the vast forest in the coastal region of the Bay of Bengal

Corporations

Corporations are expected to uphold the ethos of the 2030 Agenda in their business activities and to be accountable for steps taken towards achieving UNSDGs. Although the scale and scope of the UNSDGs are unprecedented, there are multiple ways for corporations to contribute, regardless of their size, product or service.

One way in which corporations can actively and publicly demonstrate their commitment towards UNSDGs is through the UN Global Compact initiative, the world's largest corporate sustainability initiative. The Compact requires corporations to align their operations and strategies with 10 principles that connect to specific UNSDGs, which stretch across human rights, labour, environment and anti-corruption. For example, the principles under environment require businesses to:

- support a precautionary approach to environmental challenges
- undertake initiatives to promote greater environmental responsibility
- encourage the development and diffusion of environmentally-friendly technologies.

As such, UNSDG 14 Life below water, UNSDG 15 Life on the land and UNSDG 9 Industry, innovation and infrastructure have the most relevance to the Compact. By joining the UN Global Compact, corporations are held accountable for doing business responsibly and pursuing opportunities to deliver on UNSDGs by developing innovative, collaborative and impactful business models and systems of change.

Did you know?

Sir Richard Branson, British entrepreneur and founder of the Virgin Group of businesses, writes extensively on his blog about transformative, innovative solutions for a sustainable future, and is a long-term champion for corporations to understand their role and responsibilities for enacting change. He states, 'Government and business must come together on the interlinked issues of conservation, economic development and renewable energy. There are thousands of businesses, many in the tourism industry, that depend on an intact marine environment for their long-term survival.'

● SPOTLIGHT

Community organisations and the sustainability of life below water

The Philippines' Trowel Development Foundation was awarded an Equator Prize for its work focused on ending illegal fishing and restoring fish habitats (see Figure 2.3.6). Its work connects with UNSDG 14 Life below water. Due to the Foundation's work, a local community increased their average fish catch from 2 kilograms per 8-hour fishing expedition to 30 kilograms per 8-hour expedition, which enabled them to multiply their local income and maintain food security.

Another Equator Prize awardee was the TRY Oyster Women's Association from The Gambia, which focuses on UNSDG 14 Life below water and UNSDG 5 Gender equality, was able to secure fishing rights for 300 women. Also, by developing oyster harvesting, processing and distribution activities, the Association was able to generate income for over 500 women across 15 villages. Each Equator Prize awardee was recognised for developing an equitable, inclusive, and sustainable pathway for their community that addressed environmental concerns in response to specific sustainable development goals.

2.3.6 Efforts to end illegal fishing and restore fish habitats in the Philippines also have the effect of strengthening the Filipino fishing industry.

Community organisations

Community organisations are informal, small-group collectives. They are often unfunded, voluntary and diverse in interest or focus. Public, collective and active engagement from community organisations at a local scale such as city councils, and community groups such as suburb progress associations, individuals or neighbourhood special-interest groups are crucial for achieving national targets of sustainable development. Local grassroots initiatives can engage with UNSDGs through their place-based needs and priorities, amplifying the urgent need for action.

Acknowledgement of community organisations and their impact in the way they take steps to achieve chosen UNSDGs is not always possible. However, the UN Development Program has established the Equator Prize to celebrate and recognise outstanding community efforts among local and indigenous groups to advance local solutions to reduce poverty across the tropics. Community initiatives are assessed against the following criteria: impact, innovation, scalability or replicability, social inclusion, gender equality, resilience, adaptability and self-sufficiency.

● SPOTLIGHT

Australian geographers declare a climate emergency

A community of Australian geographers have declared a climate emergency. The declaration is part of their sustained activism to publicise their concerns about the impact of drought, floods bushfires and extreme weather events on land, waterways, seas and skies (see Figure 2.3.7). This Australian community of geographers includes teachers, academics, rangers and students from across the country. With funding from the Geographical Society of NSW, they held a symposium where experts shared their research on the nature and impacts of climate change and the importance of social and environmental justice. Discussion at the symposium resulted in the Geographers Declare initiative.

2.3.7 The incidence and severity of drought in Australia is predicted to increase because of climate change. This photo shows the remains of cattle that perished during a drought, Milparinka, Western NSW.

Individuals

Individuals are often encouraged to actively participate in sustainability-focused initiatives and adopt small activities into their daily routines to help achieve the objectives of UNSDGs. Individual action is often voluntary and over time can gain momentum to include a group of people, which can evolve into a grassroots project. Typically, individuals who actively engage with and participate in sustainability-focused initiatives are driven by a set of personal values and awareness about the need for social justice and environmental protection.

The UN has developed the SDG Zone, a website that provides advice on how to engage with and act upon the goals. It also has inspirational activism stories of success from corporations, community groups and individuals. Activities known to have a cumulative positive impact on the environment and communities are varied. These include:

- purchasing from local produce suppliers or producers who are regenerative agriculturalists and supporting initiatives, such as Paddock to Plate and 100 Food Miles
- eating less meat, poultry, and fish, for example, participating in Veganuary or Meat-Free Mondays
- composting food scraps to recycle nutrients
- engaging with the circular economy movement
- sharing social media posts that promote awareness about activities that support UNSDGs.

Did you know?

In Switzerland, 181 individual sustainability activists were asked about their intended and actual participation in a range of initiatives including volunteering or use of a given service. It was found that individuals were motivated to act if they believed that they and like-minded people could contribute to sustainable development.

Influences on sustainability planning and decision-making

There are multiple influences to consider and balance in planning and decision-making processes about sustainability and the pursuit of sustainable development, including political, economic, technological, social, cultural and environmental. Such influences are interconnected, yet not always equally weighted in consultation and decision-making processes about sustainability, although it is possible to examine each influence in isolation. For example, a holistic assessment of the sustainability of a river, such as the Darling River (see Figure 2.3.8), is dependent on understanding the web of influences from:

- political, economic and technological decision-making about water regulation, irrigation, allocation and flow
- the effect of political decisions on Aboriginal water rights
- the outcomes of environmental conditions such as drought, flood, salinity, algae and biodiversity loss
- the effect of lobbying and protests from Barkandji traditional owners and local community members in Wilcannia, whose ability to thrive socially, culturally and economically depends on water levels in catchment and the overall health of the river.

2.3.8 The Darling River near Bourke, NSW

Activities

Acquiring and processing geographical information

1 What is a global forum?

2 Describe the similarities and differences between intergovernmental initiatives, corporations and NGOs in how they plan for and achieve sustainability.

3 Explain how communities and individuals act around and have an impact on achieving UNSDGs.

Applying and communicating geographical understanding

4 Study the text under the heading, United Nations Sustainable Development Goals and the box, Spotlight: Universities promoting sustainability. Describe the nature and purpose of the goals and explain how they can be used to understand the opportunities and challenges associated with sustainability in educational settings, such as universities and your school.

5 Choose an example of the greatest impact in planning for and achieving sustainability. Justify your choice.

UNIT 2.4

Indigenous peoples' practices and benefit-sharing

Worldwide, indigenous peoples' practices and benefit-sharing are both sustainable and contribute to sustainable development. Actioning UNDSDGs to achieve sustainable development requires an interdisciplinary, multi-level, bottom-up or grassroots approach. The practices and benefit-sharing approach of indigenous peoples embodies stewardship and demonstrate the significance of community knowledge for global solutions. In these approaches, all community members, human and non-human, including deities from the spiritual world, have duties and responsibilities to respect and nurture one another.

Indigenous ways of knowing, being and doing are a holistic continuum of relational and spiritual practice. The value and wisdom of nature are folded into, and not separate from, the systems, lores and practices that communities operate within. For example, in Quechua (Peru), Mam (Guatemala), Māori (New Zealand) and Yolngu (Australia) communities, food is understood as part of a living system, integral to ancestral cultural knowledge and stories about kinship, collective responsibilities, seasonality, ceremony, medicine, and the health and wellbeing of land, waterways, skies and communities. A collective, connected and future-facing, non-transactional approach is central to the ongoing flourishing of environments and communities.

● SPOTLIGHT

First Nations Australians and sustainability

Aboriginal and Torres Strait Islander peoples have been practising sustainability for more than 60 000 years. This is how they have been able to live in one of the most challenging environments on Earth for all that time. They learnt to respect and manage the land in ways that ensured the resources on which they depended would continue to be available for generations to come. They learnt that they should only use what was needed and should not waste anything. They would stay in an area for only a certain time, ensuring that they did not overhunt, overfish or overharvest the area (see Figure 2.4.1). They wanted to make sure there would be a steady supply of food, not just in the moment, but in the future.

2.4.1 A Luritja woman hunting sand goanna, Mount Liebig, NT

In working towards the achievement of UNSDG 2 Zero hunger, UNSDG 3 Good health and wellbeing and UNSDG 15 Life on the land, Indigenous practices and benefit-sharing focus on revitalising agricultural practices and restoring food systems, and educating about the importance of food security and sovereign foods such as sweet potatoes and maize.

In Auckland, New Zealand, the Māori community developed the Papatūānuku Kōkiri Marae, or marae, which is a communal space to recover ancestral knowledge about

sustainable food production to feed communities and support aspirations to become food secure. Seven varieties of sweet potatoes and other vegetables are grown in the marae. All seeds and plants are believed to have spirits and in response to agricultural rituals and cultural lores associated with the Māori lunar calendar, prayers are offered to the spirits to seek permission to work in the marae. The marae acts as a collective agency to support Māori people in restoring their human–nature–spiritual relationship, and to educate the wider community about ways of knowing, being and doing related to food.

A range of community events and meetings are held in the marae, including youth leadership programs, planting of traditional seeds, caring for and harvesting fruit and vegetables, cooking classes and community dinners. Adults and children each have vital roles to play in growing and cooking food and teaching Māori agricultural practices. Physical and spiritual wellbeing develops through community engagement with the land, honouring ancestral traditions and staying grounded in cultural identity.

SPOTLIGHT

Cultural burning

In the land now known as Australia, cultural fire or **cultural burning** is an important practice for protecting and balancing the productivity of **Country** (plants, animals, soil, water and weather) and people (see Figure 2.4.2). Cultural burning is a practice that can work towards the achievement of UNSDG 3 Good health and wellbeing and UNSDG 15 Life on the land.

An understanding of Indigenous cultural burning practice is embedded within knowledge systems about caring for Country and contextualised around the biotic and abiotic features of Country. As such, there are diverse and complex approaches towards implementing cultural fire across landscapes. Therefore, it is important to know the multi-species communities that live on Country and to know how Country functions, to introduce fire in culturally and physically safe and appropriate ways across time and space. Knowledge-holding and knowledge-sharing about the practice of cultural burning is inter-generational and different knowledges exist between women and men.

Among Kuku Thaypan Elders in the Cape York Peninsula of Far North Queensland, cultural burning is implemented to maintain cultural protocols and generate understanding about responsibility for Country. For example, as part of planning for cultural fire, an assessment of Country occurs through seasonal indicators, daily living practices and protocols associated with kinship systems, including the needs of neighbouring clans and language groups. Also, permission is sought from knowledge-holders to enact cultural burning. It is important to remember that a formula does not exist for the practice of cultural burning due to the complex and contextual nature of ecosystems, animal habitats and needing to manage cultural protocols of place.

2.4.2 A Walpiri man burning spinifex to promote growth, Tanami Desert, Northern Territory

Activities

Acquiring and processing geographical information

1 Describe the role of stewardship and community in the approach of indigenous peoples towards sustainability.

2 Define cultural burning.

Applying and communicating geographical understanding

3 Explain how at least one UNSDG relates to food systems and agricultural practice as an example of indigenous peoples' benefit-sharing for a sustainable future.

4 Study the box, Spotlight: Cultural burning. Explain the benefits and implications of cultural burning on the future of environments and communities.

UNIT 2.5

Evaluating sustainability

The goals of being sustainable and achieving sustainable development are procedural and long-term, with no fixed endpoint. To be sustainable implies being responsible and being proactive and innovative with decision-making, which is only possible when data is available, measured and tracked. Evaluating and monitoring sustainability-focused initiatives across environments and communities is required at regular intervals to determine short-term and long-term effects and changes over time, including progress, regression and stability.

Intergovernmental organisations, NGOs, corporations, communities or individuals advocate for and participate in sustainability-focused initiatives (see Unit 2.3). Such groups will also evaluate the success, or otherwise, of sustainability-focused initiatives. Evaluation outcomes are often reported in the public domain for accountability purposes, for example, through citizen science projects, environmental impact statements, or health checks and report cards.

Criteria for evaluating sustainability and economic activities

The four pillars of sustainable development (see Unit 2.1) and principles of ecologically sustainable development (see Unit 2.2) form the usual criteria for evaluating sustainability and economic activities. UNSDGs (see Unit 2.3) can give purpose to the evaluation criteria. An integrated approach towards using evaluation criteria enables a holistic understanding to develop among interested parties so that their actors can suitably plan for future policies and programs to deliver sustainable outcomes for environments and communities.

In Canada, the city of Winnipeg and its metropolitan region (population 855 310 in 2023) has a community-developed indicator system called Peg. The system was created to inspire action and create change among the population around the concept of sustainability. The Peg examines, monitors and reports on environmental, economic and socio-cultural factors to develop a holistic understanding of the wellbeing of Winnipeg's population.

A Peg report is released biennially and provides a snapshot of indicators of the pillars of sustainability, together with explicit links into UNSDGs, so the population can understand the individual and collective roles of community building and contributing to global change. For example, recent data shows the Peg theme of economy has two indicators: unemployment rate and retail sales; both of which are improving, and the theme is linked to UNSDG 8 Decent work and economic growth and UNSDG 9 Industry, innovation and infrastructure. The Peg theme of natural environment also has two indicators: residential waste going to landfill, which is improving, and commuting patterns. This theme is linked to UNSDG 11 Sustainable cities and communities. The Peg theme of social vitality and governance has charitable donations as an indicator, which is improving, and participation in the arts, which is worsening. This theme links into UNSDG 11 Sustainable cities and communities and UNSDG 16 Peace, justice and strong institutions.

SPOTLIGHT

Protecting Far North Queensland's waterways

In Far North Queensland, the Regional Waterways Health Partnerships program arose from the Reef 2050 Long-Term Sustainability Plan. The Wet Tropics Waterways Partnership is one of five partnerships. The partnerships operate in collaboration with government, industry, natural resource management, agriculture, traditional owners, researchers, communities and citizen science organisations. The Wet Tropics Waterways Partnership focuses on monitoring and finding ways to improve the health of waterways in and around the Great Barrier Reef lagoon and across the Wet Tropics region. The partnership regularly brings the community together to raise awareness, share ideas and take appropriate action to improve the waterways.

As part of a monitoring and evaluation strategy across nine freshwater basins and eight estuaries, there are multiple data collection points to assess water quality, coral and seagrass health, fish count and diversity, and habitat health. The data are analysed and integrated from multiple sources, including funded scientific research, voluntary citizen science projects and council reports. The data are then developed into an annual Reef Water Quality Report Card, which provides local communities with an independent, credible, evidence-based assessment of conditions and trends in an easily understood format.

Recent data from the report card reveal that the levels of insecticide across the basins and estuaries are at their lowest since 2016, and that Trinity Inlet is consistently the poorest estuary for dissolved oxygen due to polluted stormwater from nearby urban areas (see Figure 2.5.1).

2.5.1 The water quality at Trinity Inlet, Cairns, is negatively impacted by polluted urban stormwater.

Activities

Acquiring and processing geographical information

1 Summarise why it is important to evaluate and monitor sustainability initiatives. Identify an example of a sustainability initiative and describe how it is evaluated and monitored.

2 Describe the range of criteria used to evaluate and monitor sustainability initiatives.

Applying and communicating geographical understanding

3 Study the box, Spotlight: Protecting Far North Queensland's waterways. Identify a UNSDG of relevance to the Wet Tropics Waterways Partnership and Reef Water Quality Report Card initiative. Justify this initiative's success in response to the pillars of sustainability and principles of ecologically sustainable development.

4 Study the text under the heading, Criteria for evaluating sustainability and economic activities. Explain the impact of Peg and why it is an important tool to evaluate and monitor Winnipeg's progress towards sustainable development.

CHAPTER

3 Global tourism and its sustainability

A passport to international travel is your key to unlocking the wonders the world has to offer. But travel is much more than simply 'going on holidays' or 'visiting places', it's about experiencing different peoples, cultures and environments. It can also be transformative. Travel is, as American novelist Mark Twain once said, 'fatal to prejudice, bigotry and narrow-mindedness'. Travel expands one's mind and enriches the range of perspectives one can draw on when engaging with the world around us. Geographers love to travel!

Tourism is, however, still considered a luxury. Until recently, participation was restricted to the few who could afford both the time and money to travel. Today, most people in the developed world and increasing numbers of people living in developing countries engage in tourism at some time in their lives. Tourism is now an accepted and accustomed, even expected, part of the lifestyle of a large and growing number of people.

By its very nature, tourism is conspicuous. It can also decisively influence living standards and quality of life for those who live in the places visited. It is also one of the most visible pressures that modern civilisation exerts on the environment. This is perhaps understandable given that tourism is now among the world's largest industries.

Today, the challenge for the global tourism industry is to develop and implement strategies to sustainably manage the social and environmental impacts of the vast number of people who engage in tourism.

In this chapter, students study the nature and spatial patterns of global tourism and the biophysical, economic, technological, political and organisational factors influencing it. The text also examines the current trends and future directions of the global tourism industry, and its sustainability challenges and responses.

> **One's destination is never a place, but a new way of seeing things.**
>
> **Henry Miller, US writer and artist**

3.0.1 During the high season, tourists flock to Kyoto's Golden Temple, Japan.

Chapter glossary

adventure travel travel that involves people interacting with a natural environment in a way that has elements of apparent danger; examples include white-water rafting, canyoning, paragliding, skiing, snowboarding, trekking and bungee jumping

cultural tourism travelling to a place to experience its unique culture

domestic tourism travel within the tourist's own country

EIA environmental impact assessment; an assessment of the potential effect on the environment of a proposed development or land use

international tourism travel to a country outside the one in which the tourist normally lives

medical tourism tourism for the purpose of receiving medical procedures, either because the treatments are cheaper at the destination or are not available in the tourist's home country, or the destination has a good reputation for medical expertise

tourism temporary movement of people outside their normal place of work and residence

tourism industry the people and organisations that provide facilities and services for tourists

transnational operating in more than one country; multinational

VFR visiting friends and relatives; a type of tourism that involves staying with or visiting people that the tourist knows

UNIT 3.1

The nature of global tourism

3.1.1 Tourists visiting London. Travel can be transformative.

Nature of tourism

Tourism is a highly complex form of economic activity. It involves the economic interests and investments of large transport undertakings, owners of tourist sites and attractions, various services at the destination, and all levels of government. Each of these serves both the resident population and visitors, and their management must reconcile the needs of tourists with the resident population (see Figure 3.1.1).

In terms of GDP, travel and tourism (domestic and international) together form one of the largest industries in the world. The number of people travelling internationally increased from 25 million in 1950, to 278 million in 1960, and from 674 million in 2000 to 1.46 billion people in 2019. In 2020, due to the COVID-19 pandemic, tourist arrivals dropped 73.9 per cent to just 381 million. Prior to the pandemic, the United Nations World Tourism Organization (UNWTO) had forecast that international tourist arrivals would rise to 1.8 billion by 2030. By 2022, international tourist movements had recovered to 963 million. In 2023, international arrivals reached 1.2 billion, approximately 90 per cent of pre-pandemic arrivals.

Tourism makes a significant contribution to the GDP, employment, investment and foreign exchange earnings of many countries. It is a major catalyst for economic growth and structural change. Being more decentralised than other industries, tourism helps to diversify employment prospects in regional areas and provides opportunities for small business development and community involvement.

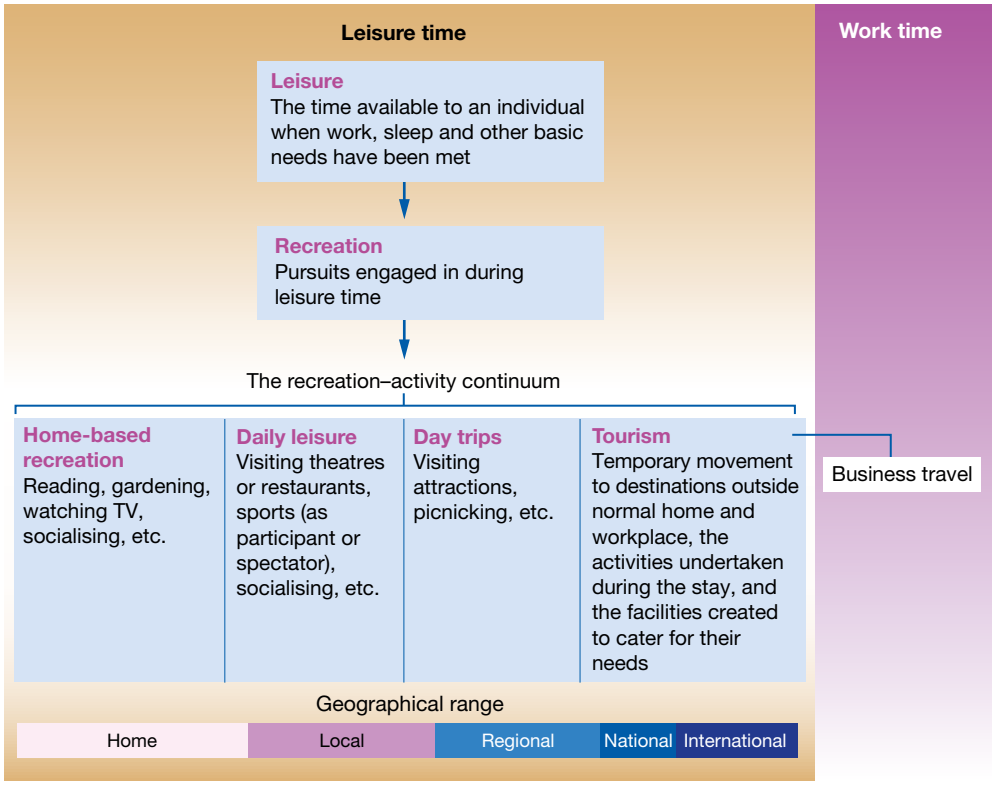
Defining tourism

Tourism is an activity that encompasses human behaviour, use of resources, and interaction with other people, economies and environments. It involves the physical movement of tourists to locations other than their normal place of living.

Most tourism is a form of recreation, undertaken during an individual's discretionary time. However, some tourism is linked with obligations (such as business), to access medical services or education (see Figure 3.1.2).

3.1.2 School students wait to check in to a flight at Narita Airport, Tokyo, Japan.

One of the difficulties in arriving at an adequate definition of tourism is determining how to differentiate between leisure, recreation and tourism. Leisure can be defined as the time not spent working, and recreation as the activities undertaken in discretionary time. Separating recreation and tourism is more problematic. It is useful to consider a continuum with, at one end, recreation based either at home or close to home, and, at the opposite extreme, travel for tourism, where some distance is involved and overnight accommodation is required. This continuum is based on the time needed for the activity and the distance travelled. It places tourism at one extreme of the recreational activity spectrum, as illustrated in Figure 3.1.3.



3.1.3 The definitions of leisure, recreation and tourism

Tourism encompasses all the activities that contribute to a tourist's movements from origin to destination. It involves the consumption of a wide range of goods and services provided by transport, tour operators, accommodation establishments, theme parks and attractions, entertainment and arts venues, museums and historical sites, travel agents, souvenir retailers and restaurants. Tourism generates a mass of economic activity, employment and income.

Tourism's benefits and costs

The growth of global tourism has had pronounced social, environmental and economic effects. Until recently, attention has been concentrated on the economic impacts of tourism. This reflects the early optimism with which tourism was generally viewed. Tourism was widely acclaimed as bringing a multitude of economic benefits—generating wealth and employment.

At the same time, the growth of tourism has prompted more perceptive observers to raise questions concerning the social and environmental desirability of further expansion, especially on the massive scale of contemporary tourism development. Any growth in tourism will place increased demand on the biophysical and built environments and requires large investments in tourism-related infrastructure. The impacts of such expansion must be considered or the very attractiveness that drew tourists to a destination in the first place may be lost. The question becomes: How do we make tourism sustainable?

Did you know?

The word tourism did not appear in the English language until the early nineteenth century, and the word tour was more closely associated with the idea of a voyage or a viewing of the arts than with any idea of being away from home for pleasure, which is a significant feature of tourism today.

Characteristics of mass tourism

The rapid growth of **international tourism**, and the vast number people involved, means that it must now be conceived as 'mass tourism'. The principal characteristics of mass tourism include the following.

- The sheer numbers involved mean that the tourism product has to be offered under conditions of mass production.
- There is little differentiation between mass tourism products: the Mediterranean beach holiday, for example, offers much the same mix of architecture, facilities, food and drink, and entertainment, whether it is in Türkiye, Greece or Spain.
- A few producers dominate particular markets, such as Disney in the world of theme parks, and Carnival Cruises and Royal Caribbean Cruises in the cruise industry.
- Producers take the lead in developing new tourism attractions, whether opening new mass destinations (such as in Vietnam and Peru) or designing new theme parks, such as Royal Carribean Cruise's CocoCay Island day resort in the Bahamas (see Figure 3.1.4).
- There is a growing level of expenditure on consumer goods associated with tourism, such as surfboards for beach holidays, and skis, snowboards and accessories for snow holidays.

3.1.4 CocoCay, an island day resort developed by Royal Caribbean Cruises

By assembling large numbers of tourists in small areas, mass tourism creates intense environmental pressures.

Tourism is highly seasonal. The infrastructure required to cope with a large volume of tourists during the busy season remains underutilised during the rest of the year.

Forms of tourism

Important distinctions can be made between international and **domestic tourism**.

International tourism

International tourism involves travel to a country other than the one in which the tourist normally lives. This is the most economically important market sector of tourism, as international tourists tend to stay longer at their destinations and spend more to cover associated transport and accommodation. They also bring with them foreign currency, which provides revenue to the economy of the countries visited.

Domestic tourism

Domestic tourism is travel within the tourist's own country. Estimates of the size of this sector vary because in many countries, domestic tourism is not adequately measured. In the United States, domestic tourism dominates the overall tourism market, accounting for 96.7 per cent of the 2.3 billion total trips taken in 2019 (before the disruption caused by the COVID-19 pandemic). In the United Kingdom, the figure for domestic tourism is 86 per cent, reflecting the shorter distances travelled to reach the rest of Europe.

Surveys taken in Europe and North America indicate that in most countries, between half and three-quarters of the adult population take holidays in any 12-month period. This covers international and domestic holidays, although the latter is the larger category. Increasing numbers of people take more than one vacation trip a year, which is a factor of great importance for tourism marketing managers.

3.1.5 Tourists on a hop-on hop-off tour bus in Monte Carlo, Monaco

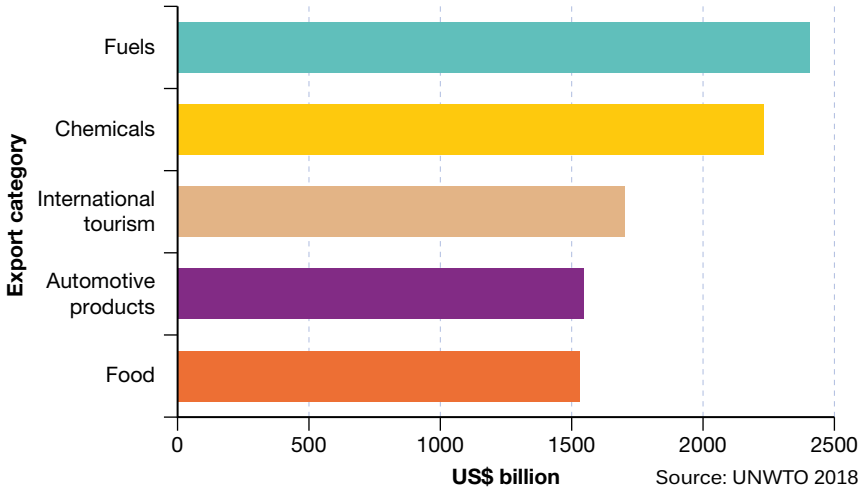
Reasons for travelling

Pre-pandemic (2019), the majority (55%) of international tourist arrivals corresponded with trips for the purpose of leisure, recreation and holidays (see Figure 3.1.5). Business travel accounted for 11 per cent of total travel and another 28 per cent covered travel for other motives, such as visiting friends and relatives (**VFR**), religious purposes/ pilgrimages or **medical tourism**. For the remaining 6 per cent of arrivals, the purpose of their visit was not supplied.

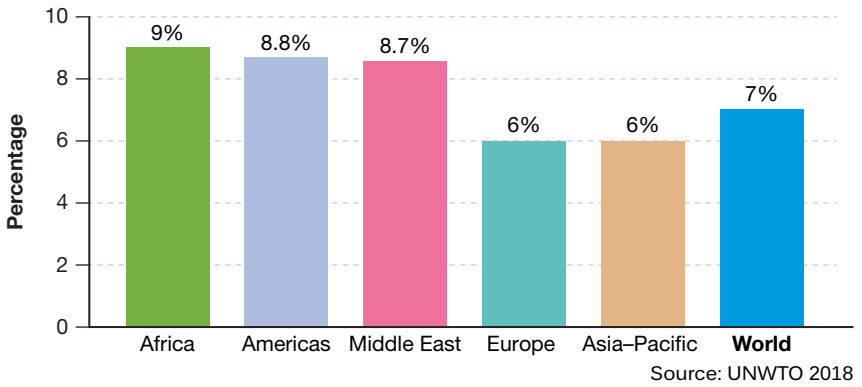
Tourism as an economic activity

Tourism is big business. International tourism receipts have surged from US$2 billion in 1950 to US$104 billion in 1980, to a pre-pandemic high of US$1.5 trillion in 2019. In 2022, tourism receipts were $1 trillion. Given this growth, it's not surprising that international tourism now represents a major category of international trade. As a worldwide export category, pre-pandemic, tourism ranked third after fuels and chemicals and ahead of automotive products and food (see Figure 3.1.6). In many developing countries, tourism ranks as the first export sector. Overall, international tourism represents about 7 per cent of the world's exports in goods and services, up from 6 per cent in 2014, as tourism grew faster than world trade in the years preceding the pandemic. Figure 3.1.7 shows the relative importance of tourism exports by region pre-pandemic, in 2018.

According to the UNWTO, international tourist arrivals and the industry's economic contribution are not expected to exceed pre-pandemic levels until at least 2024.



3.1.6 Tourism was the world's third-largest export category in 2018

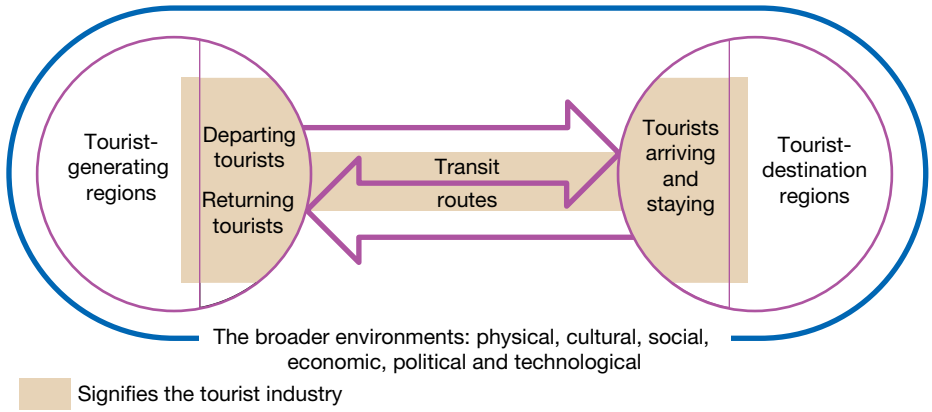


3.1.7 International tourism as a percentage of total exports by region, 2018

Components of tourism

Tourism as an economic activity consists of three major components: the country of origin of the tourists, the tourist destinations themselves and the routes travelled between these locations. Figure 3.1.8 illustrates the place of tourists in the broader environment and Figure 3.1.9 expands on the types of activities involved in tourism.

Tourism destination areas attract tourists by offering what isn't available at home. The activities found in these areas include accommodation, retail and service functions, entertainment and recreation.



3.1.8 The place of tourism as an economic activity in the broader environment

The types of activity involved in tourism

Tourism resources
- Natural resources
- Human resources

General and tourism infrastructure
- Means of communication and travel
- Social installations
- Basic installations
- Telecommunications

Receptive facilities
- Hotels and guesthouses
- Towns and villages
- Condominiums
- Complementary residences
- Staff accommodation
- Food and beverage installations

Entertainment and sports facilities
- Recreational and cultural facilities
- Sports facilities

Tourism reception services
- Travel agencies
- Hotel and local promotional offices
- Information offices
- Car hire
- Guides and interpreters

3.1.9 The types of activities involved in tourism

Transit routes link these two areas (the source and the destination) of economic activity and are key elements, in that their efficiency and characteristics shape the size and direction of tourist flows. Transit routes represent the main transport component of productive activity.

As tourists travel, they acquire an experience made up of many different parts. Some of these are tangible, such as accommodation and souvenirs purchased. Some are intangible, such as the thrill of white-water rafting, the tranquillity of a rainforest and the appreciation of works of fine art. These many activities are, however, extremely interdependent. One cannot have the experience of white-water rafting without having travelled to an appropriate river or having somewhere to eat and stay.

A complex set of industries is involved in the supply of goods and services to tourists. Many small, independent firms tend to operate alongside a few large, multinational corporations.

The nature of production is distinctive, in that the quality of labour at the point of service is vital. Tourism is distinguished from other economic activities, such as agriculture and manufacturing, by the degree to which consumption occurs at the point of production. Tourism services are delivered directly to consumers while on holiday. While souvenirs and other goods may be bought to take home, most of the goods and services demanded by the tourists are consumed in situ, in the places where they are offered or produced. Accommodation, food consumption and entertainment clearly illustrate this. A lot of consumption also takes place en route to the destination area.

Tourism, therefore, depends on many economic activities that cater directly to tourists and produce consumer durables used for tourist activity, such as motor vehicles and recreational equipment. Services provided without direct charge to tourists are also relevant. These include information offices; the maintenance of roads, airports, harbours, railways and national parks; tourism promotion; immigration and customs services; and the large number of amenities provided and maintained by local authorities.

Other characteristics of tourism as an economic activity include the following.

- The **tourism industry** operates 24 hours a day, seven days a week, although it is subject to seasonal fluctuations.
- It is a labour-intensive industry with employment opportunities at all skill levels.
- In most countries, there are few, if any, barriers to entry into the tourism industry.
- Small businesses predominate, despite the growing investment by large **transnational** corporations (TNCs).
- International tourism represents an important medium for educational and cultural exchange and for promoting international understanding and goodwill.
- The impacts of tourism are broad ranging, involving economic, social and environmental considerations.

● SPOTLIGHT

A global tourism catastrophe: The pandemic's impacts

The COVID–19 pandemic of 2020–21 was a disaster for global tourism. The pandemic brought both international and domestic travel and tourism to an abrupt standstill due to government-imposed travel restrictions and lockdowns. Popular tourist sites stood empty (see Figure 3.1.10). The shutdown affected everything from the smallest tourism operator to the massive global hotel chains. The world's airlines grounded thousands of aircraft and the fleets of the cruise industry giants lay idle or were, in some instances, scrapped (see Figures 3.1.11 and 3.1.12).

3.1.10 A worker sanitises a rubbish bin in St. Mark's Square in Venice during the national COVID-19 lockdown, April 2020. Typically packed with tourists, the square sits eerily empty.

Data from the first three months of 2020 highlight the speed and depth of the downturn in global tourism. In the January–March period, international tourist arrivals dropped by 22 per cent. By March they were down by 57 per cent, following the lockdowns, travel bans, and border closures implemented by many countries, including Australia. This represented a global loss of 67 million international arrivals in the first quarter of 2020 compared to the same period in 2019. The global economic impact of this downturn resulted in an US$80 billion loss of export earnings.

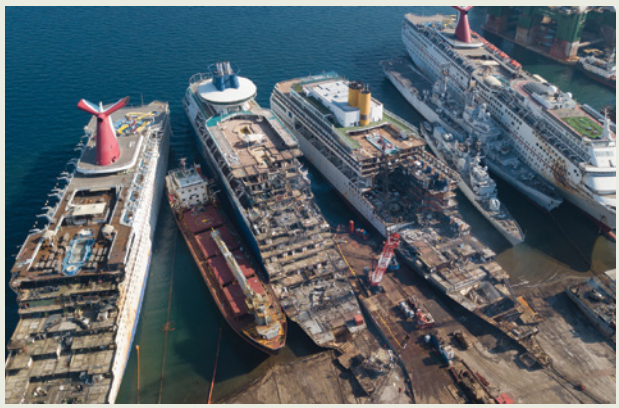
The impacts of the slowdown varied by region. Asia and the Pacific, the first regions to suffer the impact of COVID-19, saw a 35 per cent decrease in tourist arrivals. The second-hardest hit was Europe with a 19 per cent decline, followed by the Americas (–15%), Africa (–12%) and the Middle East (–11%).

The 2020 full-year impact of the pandemic saw a 74 per cent decline in international arrivals compared with 2019, a decline of 1.1 billion arrivals costing US$1.3 trillion in lost export revenue. That compares with a 0.4 per cent decline during the SARS epidemic in 2003 and a 4 per cent drop in 2009 following the global financial crisis.

As a result of the pandemic, between 100 and 120 million tourism jobs were lost in what is one of the most labour-intensive sectors of the global economy. The impact of job losses did, however, vary from country to country depending on how dependent the country was on tourism. Of the world's 20 largest economies, Australia ranks sixth in terms of the industry's contribution to GDP (10.8%).

Worldwide, 44 countries rely on the travel and tourism industry for more than 15 per cent of their total share of employment. Unsurprisingly, many of the countries suffering the most economic damage were island nations, especially those in the Caribbean. In the island nation of Antigua and Barbuda, for example, 95 per cent of its workforce is engaged in the tourism industry.

The COVID-19 pandemic extended well into 2021 and only started to abate when COVID-19 vaccinations became widely available towards the end of that year. Countries slowly relaxed restrictions on international travel, enabling the tourism industry to begin a slow and spatially uneven recovery.



3.1.11 Four cruise ships being broken up for scrap at the Aliaga ship recycling port in Izmir, Türkiye. Older cruise ships we taken out of service early due to the impact of COVID-19.

3.1.12 Qantas planes grounded due to travel bans and closed borders, Avalon Aiport, Victoria, June 2020

Advantages and disadvantages of tourism

Tourism has a range of social and environmental impacts. Some are advantageous, others are detrimental to the ecosystems and communities affected (see Figure 3.1.13).

Advantages of tourism	Disadvantages of tourism
■ Tourism earns foreign income that can be used to pay for imported goods and services. ■ Unique environments are often protected because of their appeal to tourists. ■ Tourism creates jobs and is labour-intensive. ■ Tourism provides opportunities for small operators to establish their own businesses. ■ The production and sale of souvenirs create work for craft-based industries. ■ Local produce can be sold to hotels and restaurants. ■ There is much-needed foreign investment in airports, roads, hotels and other tourism-related infrastructure. ■ Profits can be used to improve housing, schools, hospitals, electricity and water supplies. ■ Local customs and heritage are preserved because tourists want to experience it. ■ Tourism promotes increased understanding between cultures.	■ Only 10–20% of the income received stays in the country; most hotels are foreign-owned; profits go overseas. ■ Lack of planning often results in hotels, airports, roads and golf courses being built in the wrong places, spoiling scenic sites and causing pollution. ■ Much of the employment is seasonal and poorly paid; the better-paid jobs are often taken by foreigners. ■ Traditional craft-based industries may be destroyed as people are encouraged to produce cheap, mass-produced souvenirs. ■ The agricultural systems break down as land is sold off to developers; much of the food eaten by tourists is imported. ■ Locals are often discouraged from using hotel facilities; few can afford the prices charged. ■ Borrowed money can increase the country's debt. Repaying this debt can divert resources from the provision of much-needed social infrastructure, such as schools and hospitals. ■ Local traditions and customs are destroyed by contact with tourists; prostitution, crime, illicit drug use and drunkenness often increase. ■ Tourists may show a lack of respect for local customs and religious beliefs.

3.1.13 Advantages and disadvantages of tourism

Activities

Acquiring and processing geographical information

1 Explain why tourism is described as a highly complex economic activity.
2 Outline the scale of global tourism.
3 Define tourism and explain why it has been difficult to arrive at an adequate definition of tourism.
4 Summarise the benefits and costs of tourism.
5 Summarise the characteristics of mass tourism.
6 Distinguish between international and domestic tourism.
7 List the reasons why people engage in travel.
8 Using data from the text, describe the scale of the global tourism's economic contribution.
9 Summarise tourism's importance as an economic activity.
10 Summarise the nature of the three components of tourism.
11 Explain the importance of transit routes.
12 List the tangible and intangible elements of the tourism experience.
13 Explain what distinguishes tourism from other forms of productive activity.
14 List the range of economic activities associated with tourism.
15 Describe the characteristics of tourism.

Applying and communicating geographical understanding

16 Study Figure 3.1.3 and then write a short-answer response examining the differences between leisure, recreation and tourism.
17 List the key characteristics of mass tourism. Then write a short-answer response comparing the ways in which modern mass tourism differs from travel undertaken in the past.
18 Collect extracts from newspapers, magazines and the internet that address tourism-related issues. Write a 100-word summary of each extract. Share your extracts with others in your class.
19 Study Figure 3.1.6. Using data from the graph, describe the relative importance of tourism in world trade pre-pandemic. Investigate its relative importance today.
20 Study Figure 3.1.7. Identify the region most dependent on tourism exports. Which is the least dependent?
21 Study Figure 3.1.8. Write one or two paragraphs describing the place of tourism as a productive activity in the broader environment.
22 Study Figure 3.1.9. Write a report outlining the range of activities involved in tourism.
23 Study the box, Spotlight box: A global tourism catastrophe: The pandemic's impacts. Then complete the following activities.
   a Describe the impact of COVID-19 on global tourism. Why did it matter?
   b Summarise the state of the global tourism industry before the onset of the pandemic.
   c Describe the impact of the pandemic on employment in the sector.

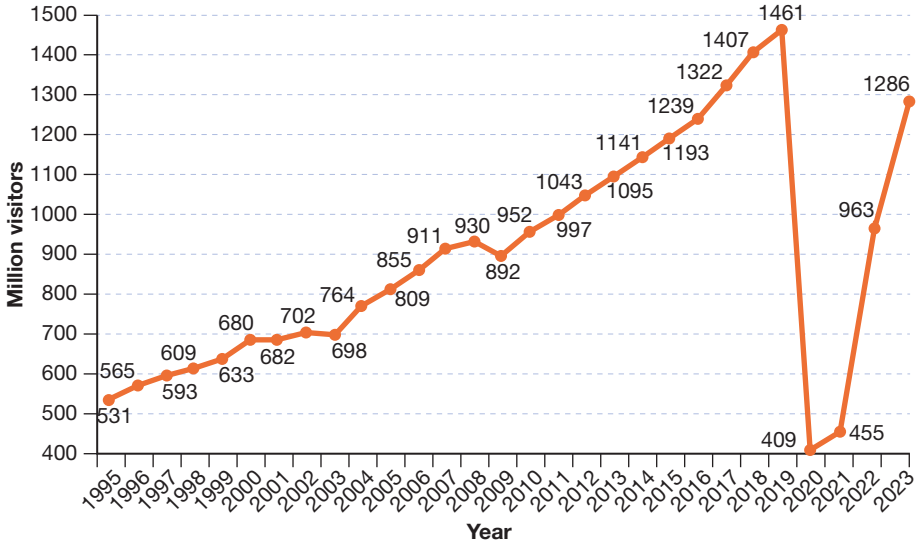
UNIT 3.2

Spatial dimensions of global tourism

All over the world people are travelling more, both within their own countries and abroad. Tourism (domestic and international) is now among the world's largest industries, both in terms of its contribution to global GDP and employment, and it is expected to continue to expand due to rising standards of living, especially in developing countries. Where tourists choose to go is of great significance, especially to governments and those corporations investing in the sector.

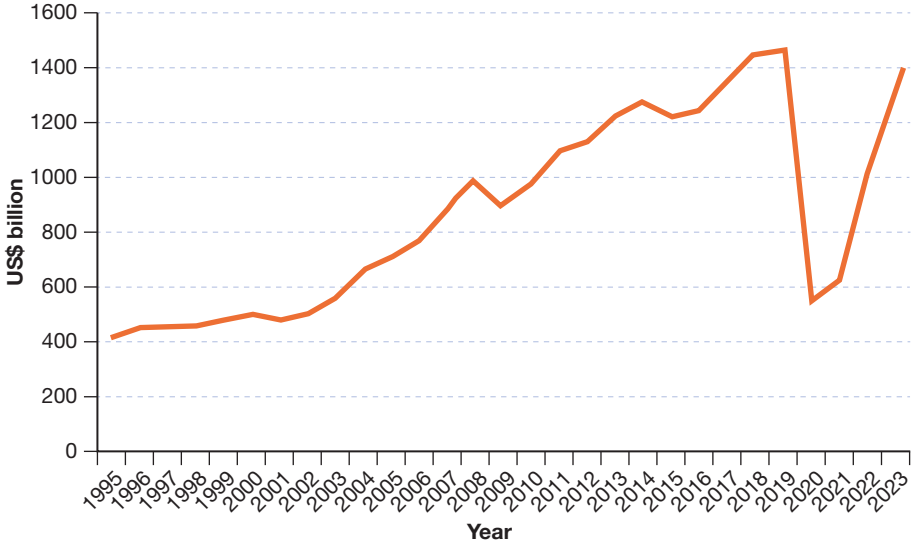
Tourism's growth and spatial distribution

Inbound tourist arrivals and international tourism receipts continued to increase until the onset of the COVID-19 pandemic (see Figures 3.2.1 and 3.2.2). Except for 2009 (the peak of the Global Financial Crisis), international tourism's growth rate averaged 4.2 per cent each year (see Figure 3.2.3). In 2022, post-pandemic tourist arrivals were recovering, but still down -34 per cent on the record numbers in 2019 (see Figure 3.2.4). The UNWTO estimates that arrivals reached 90 per cent of pre-pandemic arrivals in 2023.



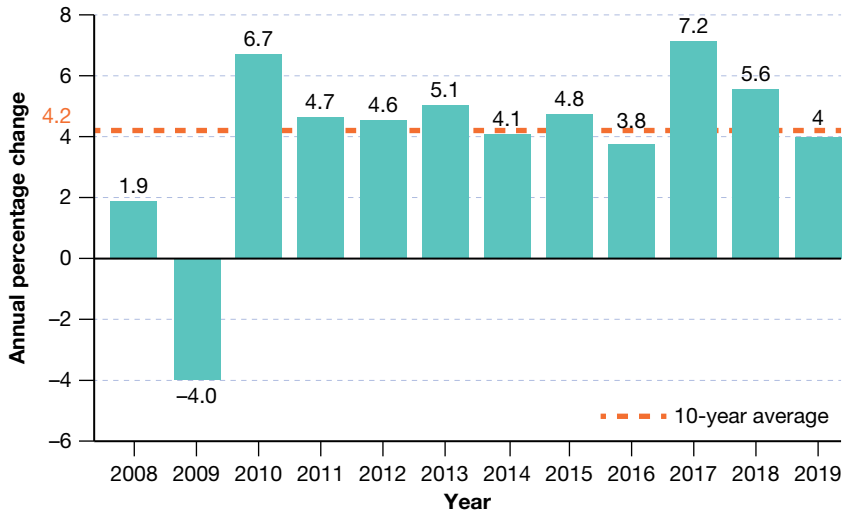
Source: World Tourism Organization (UNWTO)

3.2.1 International tourist arrivals 1995–2023



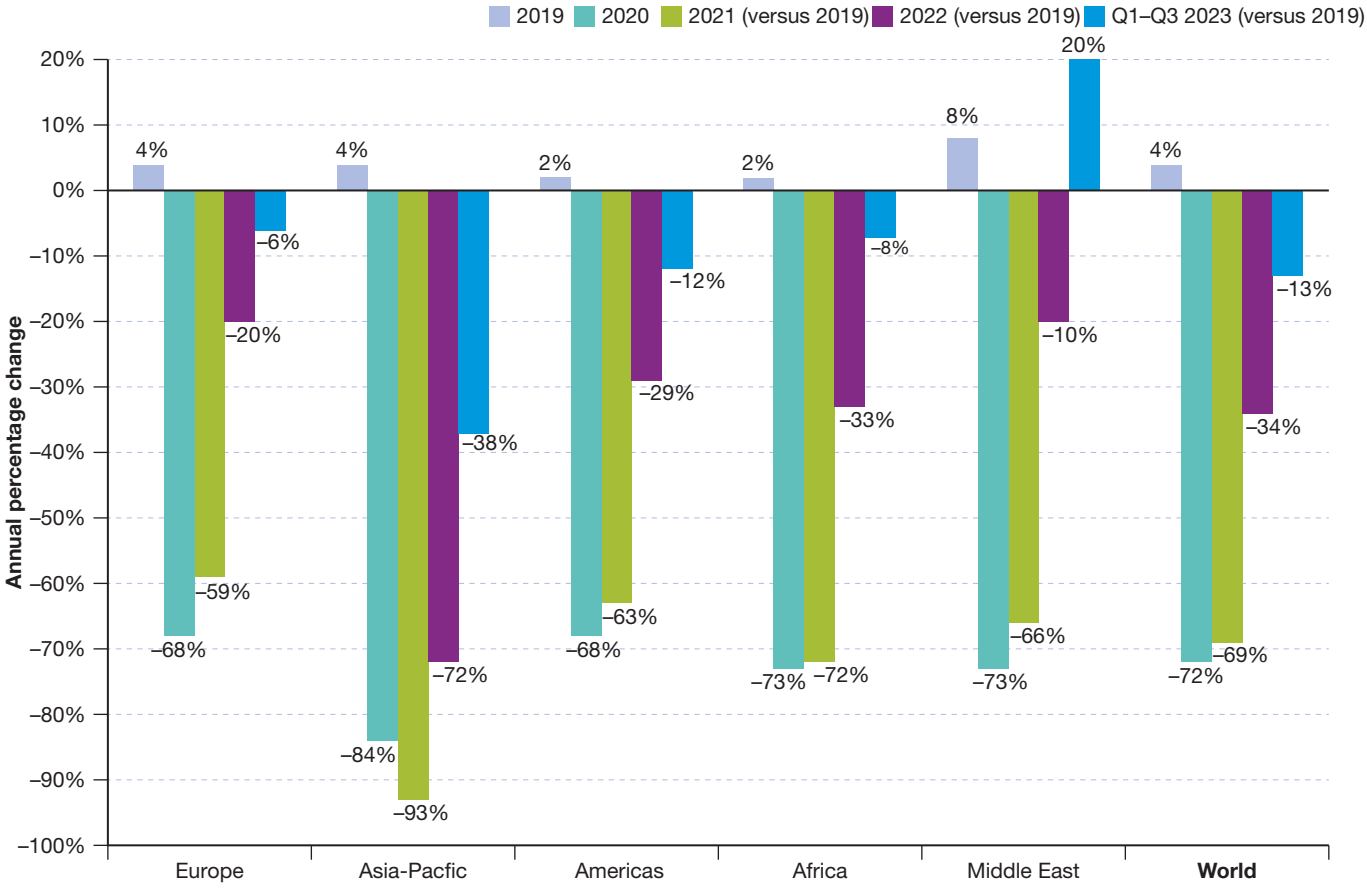
Source: World Tourism Organization (UNWTO)

3.2.2 The growth in international tourism receipts 1995–2023



3.2.3 International tourist arrivals, annual percentage change, 2008–19

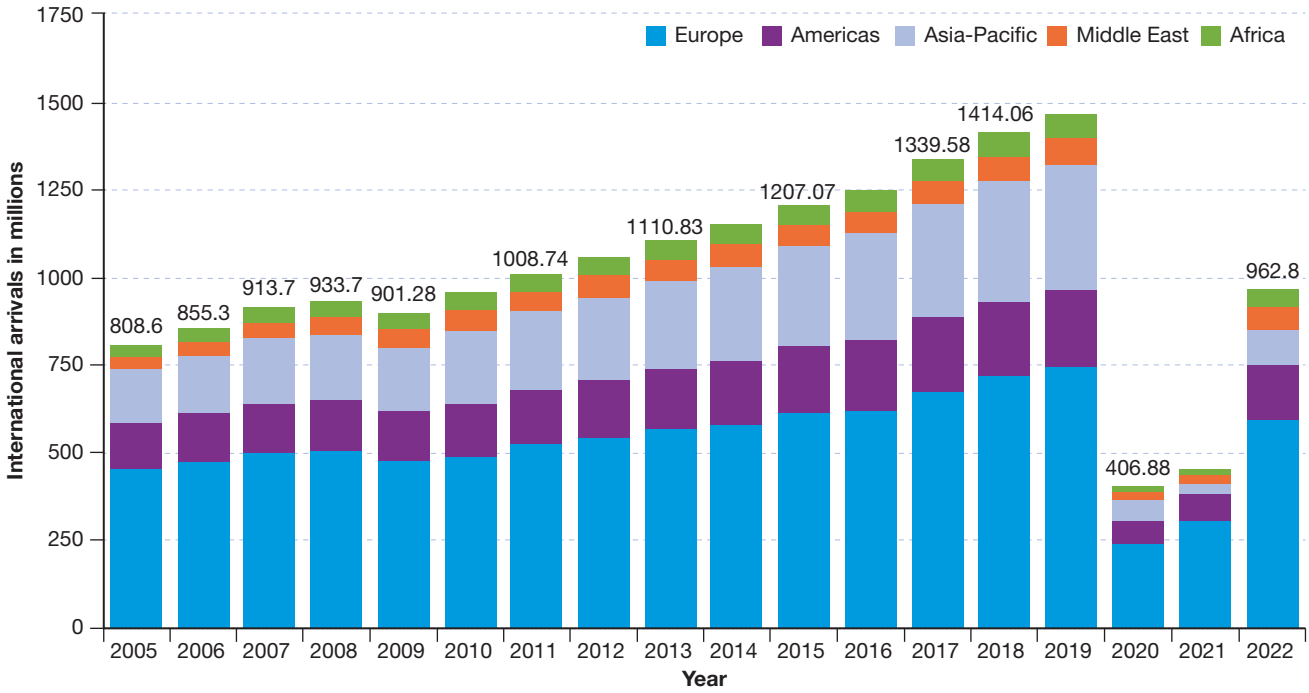
Source: Statista 2023



Source: World Tourism Organization (UNWTO)

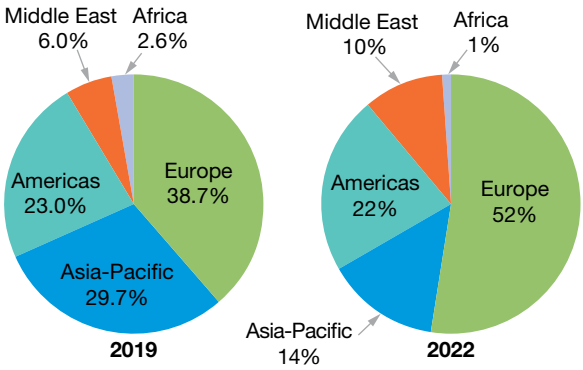
3.2.4 Annual percentage change of international tourist arrivals, by region and worldwide, 2019–Q1–Q3 2023

Europe, Asia-Pacific and the Americas dominated global tourist flow and receipts pre-pandemic (see Figure 3.2.5). Tourists were slower to return to the Asia-Pacific than to Europe and the Americas (see Figure 3.2.6). There was a strong flow of tourists from the United States to Europe throughout the twentieth century, and the level of transatlantic movement in both directions soared in the 1970s as keen competition and technological advances in aviation reduced the real price of travel. Total world tourism (by numbers) grew throughout the 1980s, 1990s and 2000s, at around 4 per cent per annum. The growth of tourism in the Asia-Pacific region is a more recent development (see Figures 3.2.7 to 3.2.10).



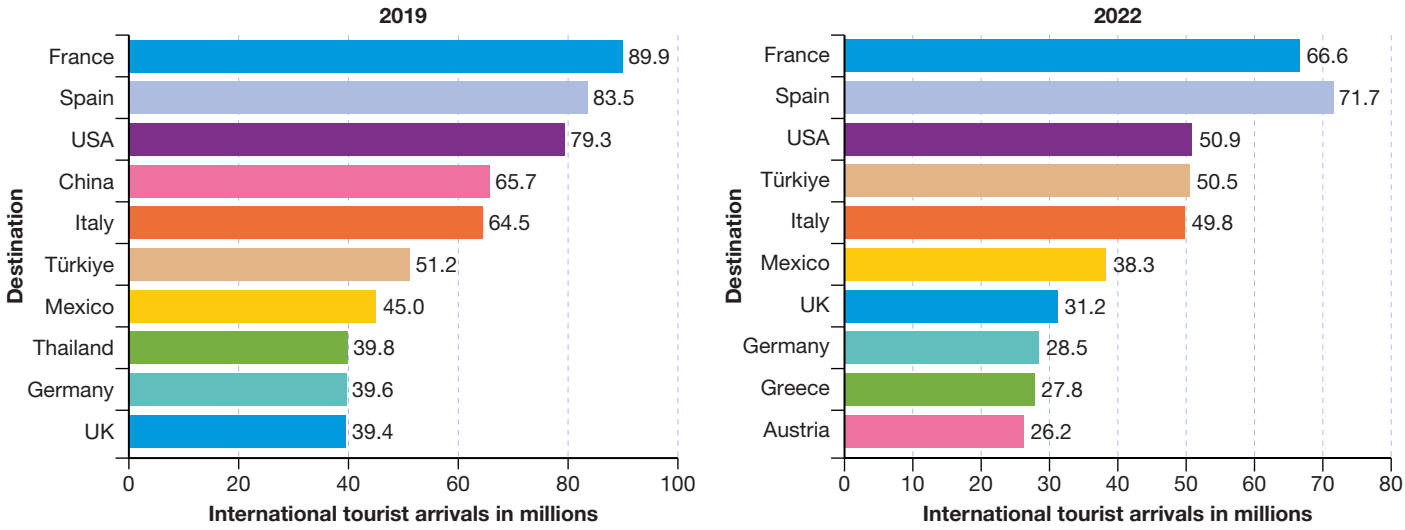
Source: Statista

3.2.5 International tourist arrivals by region, 2005–22



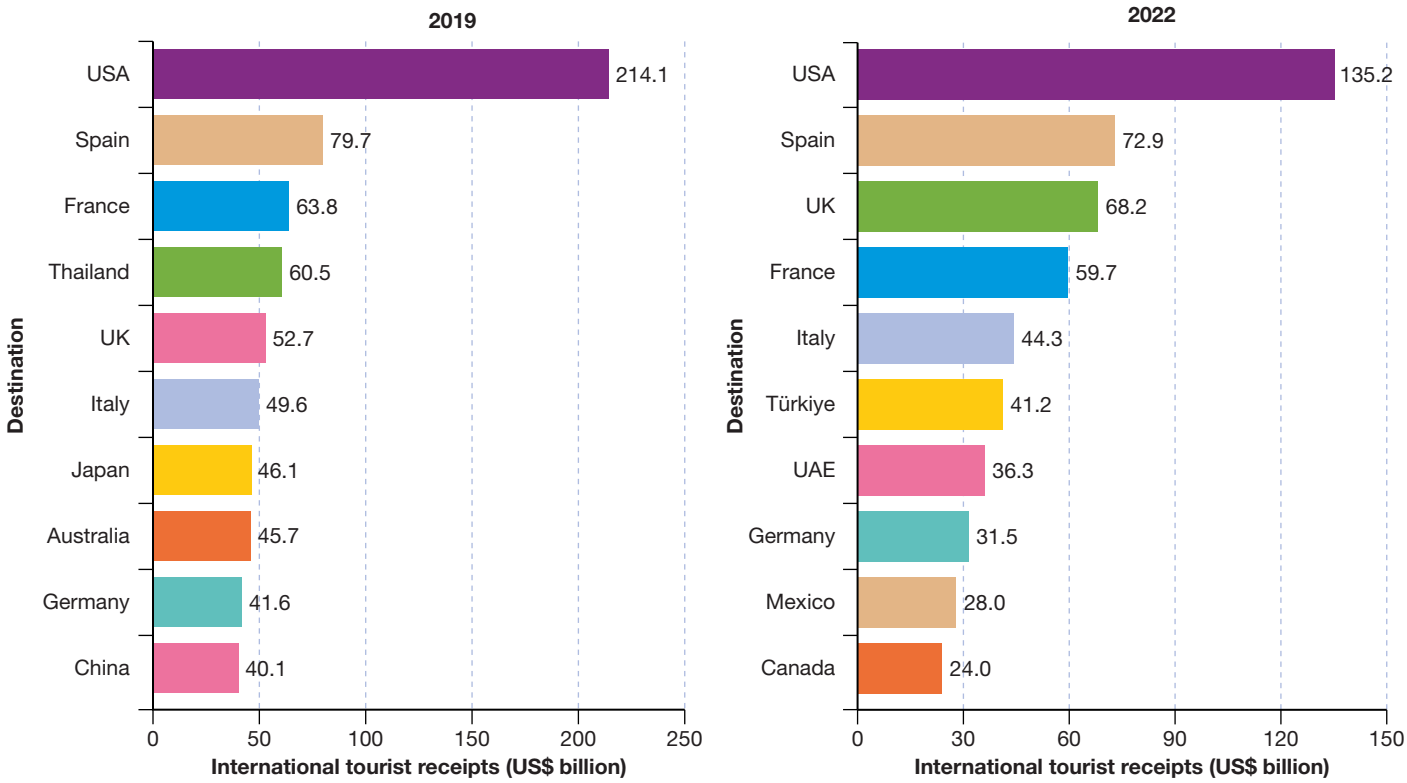
Source: World Tourism Organization (UNTWO)

3.2.6 International tourism receipts by region, 2019 and 2022 (% share)



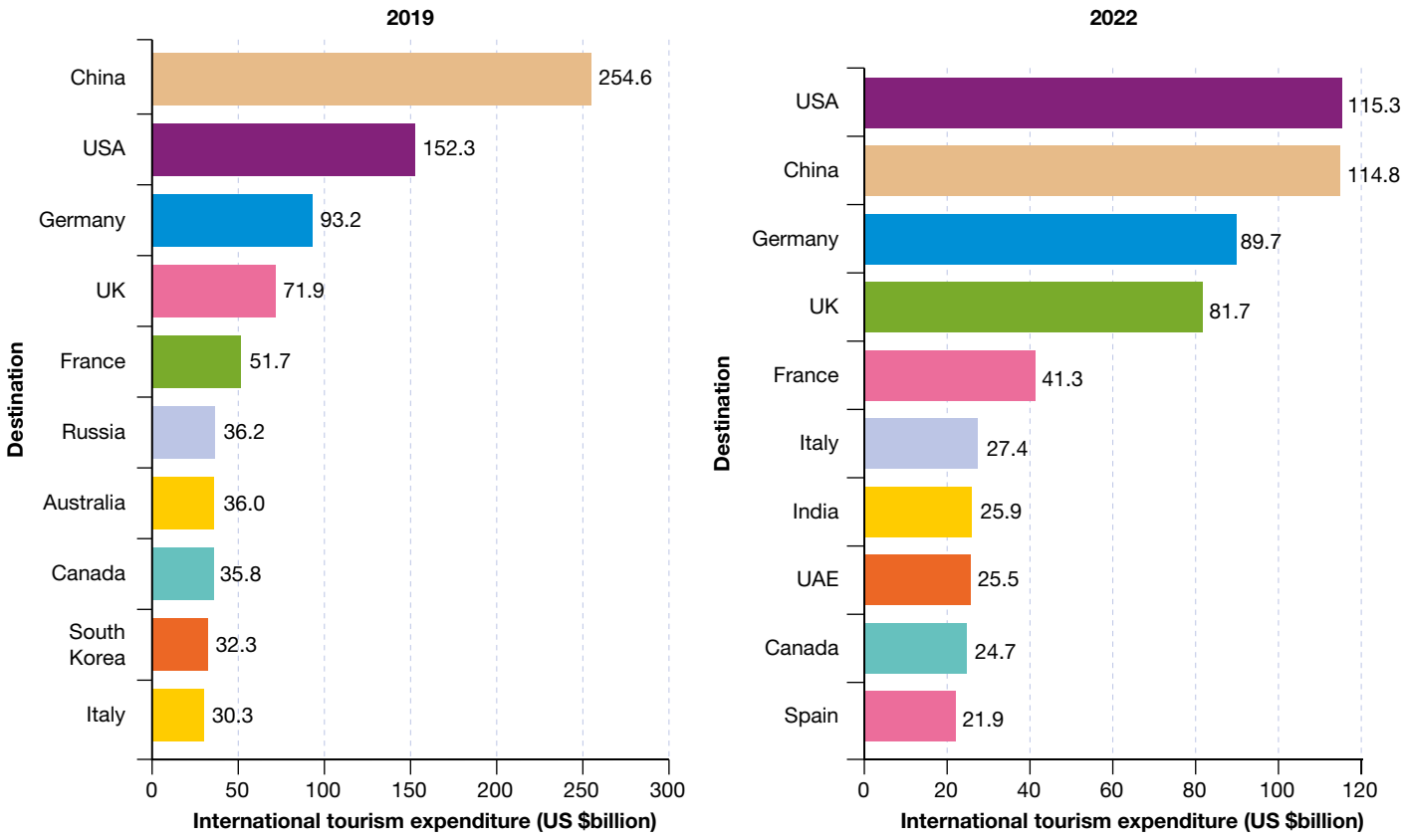
Source: World Tourism Organization (UNWTO)

3.2.7 World's top tourist destinations, 2019 and 2022



Source: World Tourism Organization (UNWTO)

3.2.8 World's top recipients of tourism receipts, 2019 and 2022



Source: World Tourism Organization (UNWTO)

3.2.9 International tourism expenditure by country, 2019 and 2022

More and more countries are destinations for international travel, and the relative importance of the various tourism segments has changed. The range of destinations now encompasses almost all countries and all regions in the developed world and many of those in the developing world.

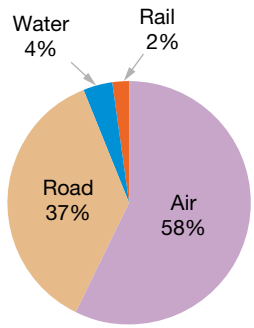
Driven by the relative affluence of the industrialised countries of Western Europe, North America and, over the last 10 years, China, tourism has also expanded significantly in Eastern Europe and is becoming an important sector in many developing countries in Asia, Africa, Latin America, the South Pacific and the Caribbean.

Tourism has developed both in the liberal Western democracies and under centrally planned socialist regimes, and has become an important economic sector in many developing countries. Likewise, tourism has developed in a wide variety of physical environments: on low-lying islands of the Indian Ocean, at great heights in the Himalayas, in the countryside of Tuscany, Italy, on the savanna plains of Africa and along the Australian coastline.

There has also been spectacular growth in the Asia-Pacific region: Oceania and Asia have had far higher growth rates than other world regions (see Figure 3.2.10). In part, this reflects the focus on these regions by the tour companies and tourists of developed countries. It also reflects the rising real incomes in countries such as China and India where an emerging middle class is keen to travel.

Region	2000	2019	Absolute change	Percentage change
Africa	27.9 million	68.8 million	40.9 million	+146.6%
Americas	128.2 million	219.3 million	91.1 million	+71.0%
Asia–Pacific	110.6 million	359.6 million	249.0 million	+225.0%
Europe	391.0 million	744.5 million	353.5 million	+90.4%
Middle East	24.4 million	73.0 million	48.6 million	+199.0%

3.2.10 Pre-pandemic growth in international tourism by region, 2000–19.



Source: UNWTO

3.2.11 Pre-pandemic mode of transport, 2019 (% share)

Much of the growth in global tourism can be accounted for by the decline in the real cost of travel and the rise of a global middle class with enough discretionary income to engage in travel. Lower costs have largely been driven by developments in aviation technologies, especially the introduction of high-capacity aircraft beginning with the Boeing 747 in 1969 (see Figure 3.2.11).

The world's middle class continues to grow rapidly. By 2020, half of the world's population were part of the middle class, or lived in wealthy households. Specifically, out of a total of 7.6 billion people in the world, 3.6 billion now belong to the middle class. This is a significant figure, especially when you consider that only 10 years earlier the number of people making up the middle class was just half that number (around 1.8 billion).

After reaching the first 1 billion people at the end of the 1980s, the middle class took more than 20 years to add another 1 billion. It took just eight years to add the last 1.6 billion.

Looking ahead, the growth of the middle class shows no signs of slowing down. Indeed, the latest estimates place the total population of the middle class at around 5.2 billion by 2030 (around 1.6 billion more than today), which will represent some two-thirds of the world's population.

Since 2009, around 700 million people in China have entered the ranks of the global middle class: 40 per cent of all new entrants. Combined, China and India account for around 60 per cent of the new global middle class, around 1 billion people.

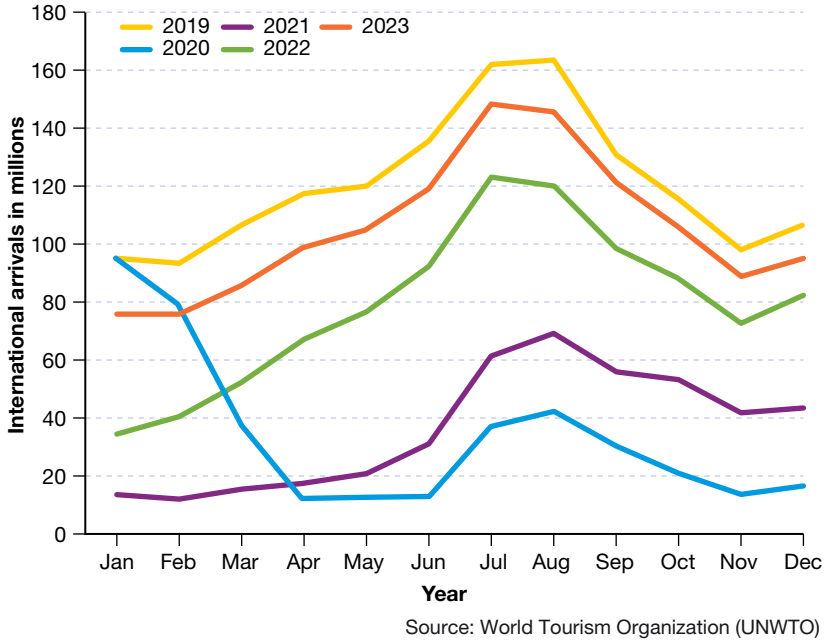
So why does this matter? The purchasing power of the middle class is projected to increase from $35 trillion in 2019 to $64 trillion in 2030. Households entering the middle class increase the demand for both consumer durables and services, including tourism, entertainment, health, education and transport. The middle class also tend to

Investigating tourism

Access the most recent data and resources relating to issues in tourism at the following organisations' websites:

- Australian Bureau of Statistics
- Tourism Research Australia
- Bureau of Infrastructure, Transport and Regional Economics
- Department of Industry, Tourism and Resources
- Tourism Australia (see the corporate website section)
- World Tourism Organization.

take holidays at the same time—during the Northern Hemisphere summer—adding to the seasonality of travel (see Figure 3.2.12). The lifestyle aspirations of the middle class are central to the tourism industry's future (see Figures 3.2.13 and 3.2.14).



3.2.12 Seasonal pattern of international arrivals, 2019–22

Before the onset of the COVID-19 pandemic, the UNWTO projected that the number of Chinese tourists would reach 400 million by 2030 (that's nearly a quarter of all international travellers). Of the increase in total international movements between 2019 and 2030 (from 1.3 billion to 1.8 billion), almost half are projected to originate from China.

Even at 400 million, there is still potential for further growth. Significantly, China's outbound tourists represent less than 28 per cent of the country's total population. This suggests the existence of a huge potential to grow the number of Chinese engaged in international tourism.

3.2.13 Chinese tourists visiting Segovia, Spain.

3.2.14 Prior to the COVID-19 pandemic, 1.3 million Chinese tourists visited Australia in 2019 alone.

Activities

Acquiring and processing geographical information

1 Summarise the trend in international visitor arrivals and receipts since 1995.

2 What are the destinations that continue to dominate global tourism, both in terms of visitor arrivals and receipts?

3 Summarise the changing trends in tourist destination choices that occurred in conjunction with the rapid growth in global tourism. What have been the drivers of these changes?

4 Describe the factors accounting for the growth and changing spatial distribution of global tourism.

Applying and communicating geographical understanding

5 Study Figures 3.2.1 and 3.2.2. Using data from the graphs, write a paragraph or two summarising the trends apparent in international visitor arrivals and receipts since 1995.

6 Study Figure 3.2.3. Describe the trends in the annual percentage change in tourist arrivals since 2008. In which year did growth peak? What has been the average rate of increase over this time?

7 Study Figure 3.2.4. Summarise the trend in international tourist arrivals in terms of annual percentage change, 2020–Q1–Q3 2023, using 2019 as a basis.

8 Study Figures 3.2.5 and 3.2.6. Using data from the graphs, describe the spatial distribution of international visitor arrivals and receipts in 2019 and 2022. Describe the uneven nature of the post-COVID-19 recovery.

9 Study Figures 3.2.7 and 3.2.8. Identify the world's top tourist destinations in terms of both arrivals and receipts in 2019 and 2022. Have there been any significant changes?

10 Study Figure 3.2.9. What does this data suggest about the spatial distribution of global tourism and the economic activity it generates?

11 Study Figure 3.2.10. Explain what this data tells us about the changing spatial distribution of tourism in 2000–19.

12 Study Figure 3.2.12. Write a paragraph outlining the seasonal nature of tourism. Account for this pattern.

UNIT 3.3

Factors influencing global tourism

3.3.1 Crowds of tourists descend on Rome's historic Trevi Fountain (Fontana di Trevi)

3.3.2 Busloads of tourists at Iguacu Falls (Foz do Iguaçu), Brazil

A place's unique biophysical environment, cultural heritage and artistic life frequently represent integral components of its tourism industry. Scenic sites, comfortable climates and unique cultural and natural landscapes have an significant impacts on travel to specific localities, regions or countries (see Figures 3.3.1 and 3.3.2).

Various types of tourism have differing requirements for favourable development, and certain sites, regions or countries will be more favourable for development than others. Different types of tourists place different demands on resources at and on their way to a destination.

The factors influencing global tourism include the processes and natural cycles of the biophysical environment, economic, cultural and social factors, technology and political/organisational considerations. Together these constitute the human–environment interactions that are central to geographical inquiry.

Biophysical factors

The tourism industry is located according to the spatial distribution of attractions and access to them, which is largely determined by environmental factors. The environment of a host region offers things that the tourist is seeking and needs, and which are not always available at home. The importance of biophysical factors can be seen at all points in the tourism process.

Environmental conditions

Tourist behaviour patterns are not necessarily motivated only by environmental conditions, but are clearly influenced by them through choice of destination and length of stay. Environmental conditions may influence tourists' loyalty to or substitution of tourist destinations.

Environmental conditions may also place constraints on types of developments. Destinations lacking suitable climates, unique geological/topographical features or exotic plant or animal life are seldom chosen for tourist development. Some complementary natural characteristics are highly desirable, even if a place has a rich history or is unique historically. The construction of amenities and infrastructure alone is usually insufficient for the development of tourism.

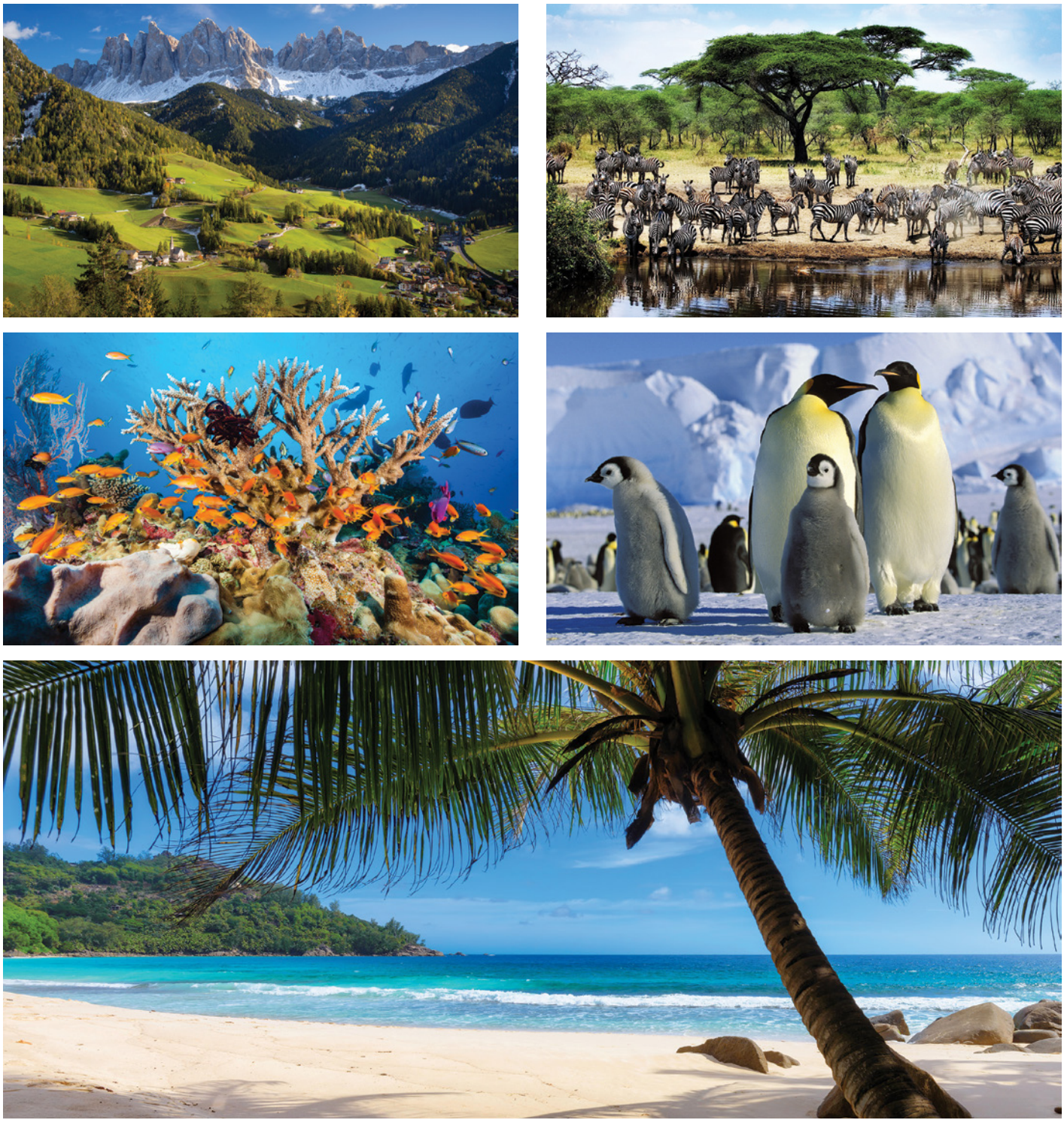
Climate conditions

Climatic conditions are perhaps the most important of the environmental factors. Most outdoor recreational pursuits depend on favourable weather conditions. Air travellers need accurate information on weather conditions, as only a limited range of clothing can normally be taken. A knowledge of the land and sea breezes of coastal areas is essential for the sailor, while a hang-glider is interested in the forecast of mountain winds. An appreciation of potential environmental hazards is basic to the safety of many recreational pursuits, especially in extreme conditions.

For each tourist activity, there is an optimal climate that allows comfortable participation for a maximum number of days each year. This depends on a combination of temperature, humidity, solar radiation, windspeed and visibility. The Mediterranean climate is arguably the most agreeable. The tropical zone has great potential, although health hazards pose a major constraint in those regions where living conditions are substandard.

Climate often determines the length and profitability of the holiday season at a destination. For example, in the popular ski resorts of the Australian Alps the limited amount of adequate snow cover strictly limits the peak tourist season. However, these resorts also cater for bushwalkers in the off-peak season, and, in the case of Thredbo, mountain biking.

Coasts, mountains and inland waterways offer the most popular physical environments for tourist development (see Figure 3.3.3).



3.3.3 (clockwise from top left) the Dolomites Mountains, Italy; the Serengeti National Park, Tanzania; Antarctica; Hawaii, USA; Great Barrier Reef, Australia

The seasonal movements of tourists, as shown in Figure 3.2.12 on page 47, highlights the importance of climate to global tourism. International arrivals peak in the Northern Hemisphere's summer months. The cultural contributor, in this instance, is the scheduling of long summer vacations in North America and Europe.

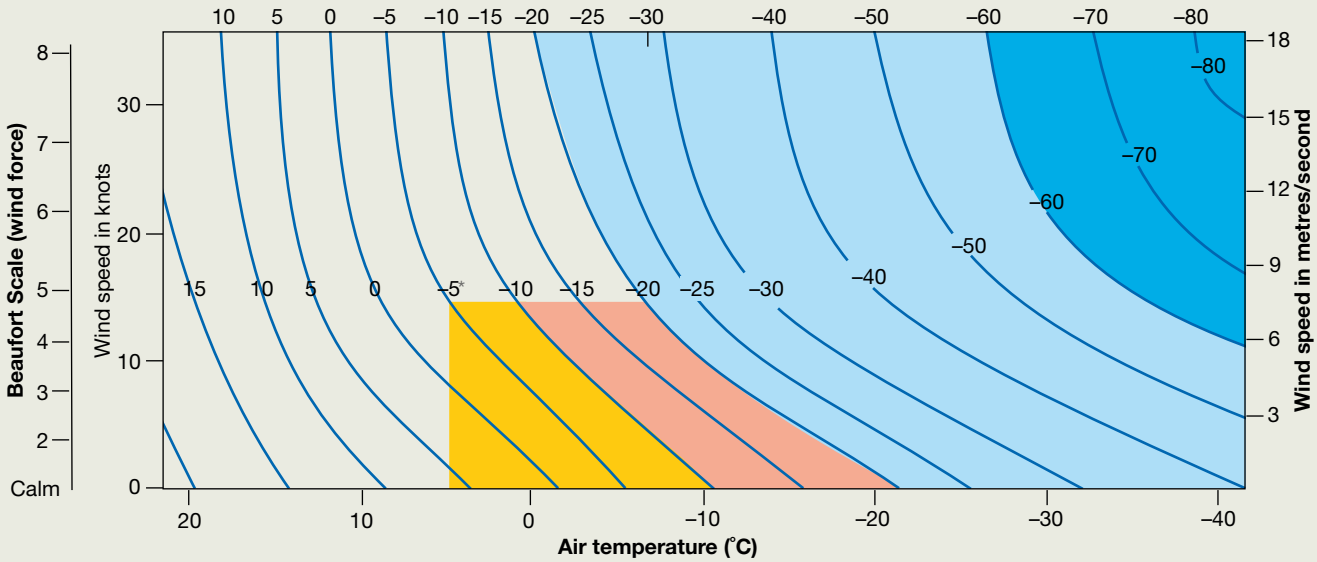
● SPOTLIGHT

Winter sports tourism

Winter sports tourism has quite specific climatic requirements, as it involves either watching or participating in a sporting event or engaging in a snow- or ice-based recreational activity. Temperatures need to be low enough to support the retention of snow and ice, but not so cold that outdoor activities become impractical or even dangerous. The windchill factor is also a decisive factor when undertaking outdoor activity in cold climates (see Figure 3.3.4).

Winter sports or recreational activities are typically variations of skiing, snowboarding, ice skating and sledding (see Figure 3.3.5). Traditionally, such pursuits were confined to cold areas during winter, but artificial snow and artificial ice technologies now allow more flexibility.

While many alpine resorts are focused on providing the infrastructure required by winter sports and recreational activities, many practise seasonal diversification. Mountain biking and hiking are increasingly popular summer pastimes in alpine resorts.



*Port Stanley, Falkland Islands in July: Average daytime temperature 4°C. Wind speed 16.5 knots. Equivalent temperature = −7°C

Comfortable for skiing on sunny days—bright sunshine reduces the windchill

Comfortable for skiing on overcast days

Risk of frostbite

Great danger of frostbite (exposed flesh freezes in less than 1 minute)

3.3.4 Windchill chart showing equivalent temperatures and when it's comfortable to ski or snowboard

3.3.5 Snowboarding is one of the most popular winter sports.

Economic factors

The tourism industry is a multidimensional economic activity and a geographically complex one. There is no single tourist product, commodity or service by which the output of tourism can be effectively measured. Rather, tourists demand different services at different stages, from their point of origin to their destination, and many components of tourism are inextricably bound to other economic sectors, such as airlines to transportation, souvenir shops and restaurants to retail or service, and hotels and other forms of accommodation (See Figure 3.3.6 overleaf).

Generally, however, tourism has been seen as an important instrument for facilitating economic growth because of the wider multiplier effects it has throughout the rest of the economy. As a result, most governments now actively seek to promote tourism to and within their countries and take steps to coordinate both public and private tourism-related activities and foster the industry's growth. For many countries, tourism is by far the biggest source of foreign exchange.

Consumer demand: While consumer behaviour can be influenced by advertising and the attention given to tourist destinations and experiences in the media, and popular culture more generally, it is the decisions people make that determine the economic wellbeing of a tourism destination or experience. Some will prosper while others will struggle and even fail. Some consumers are more price-sensitive than others. As a result, the products offered will range from budget offerings through to ultra-luxury experiences. Hotel groups such as the French multinational, Accor, operate brands ranging from budget properties, such as Ibis, to 5-star luxury hotel chains, such as Sofitel, Raffles and Fairmont. The same market segmentation is evident in the cruise industry, with operators such as Royal Caribbean, Carnival, Costa, Disney, MSC and P&O targeting the mass tourism market, while operators such as Silversea, Seabourn and Regent cater for a more affluent market.

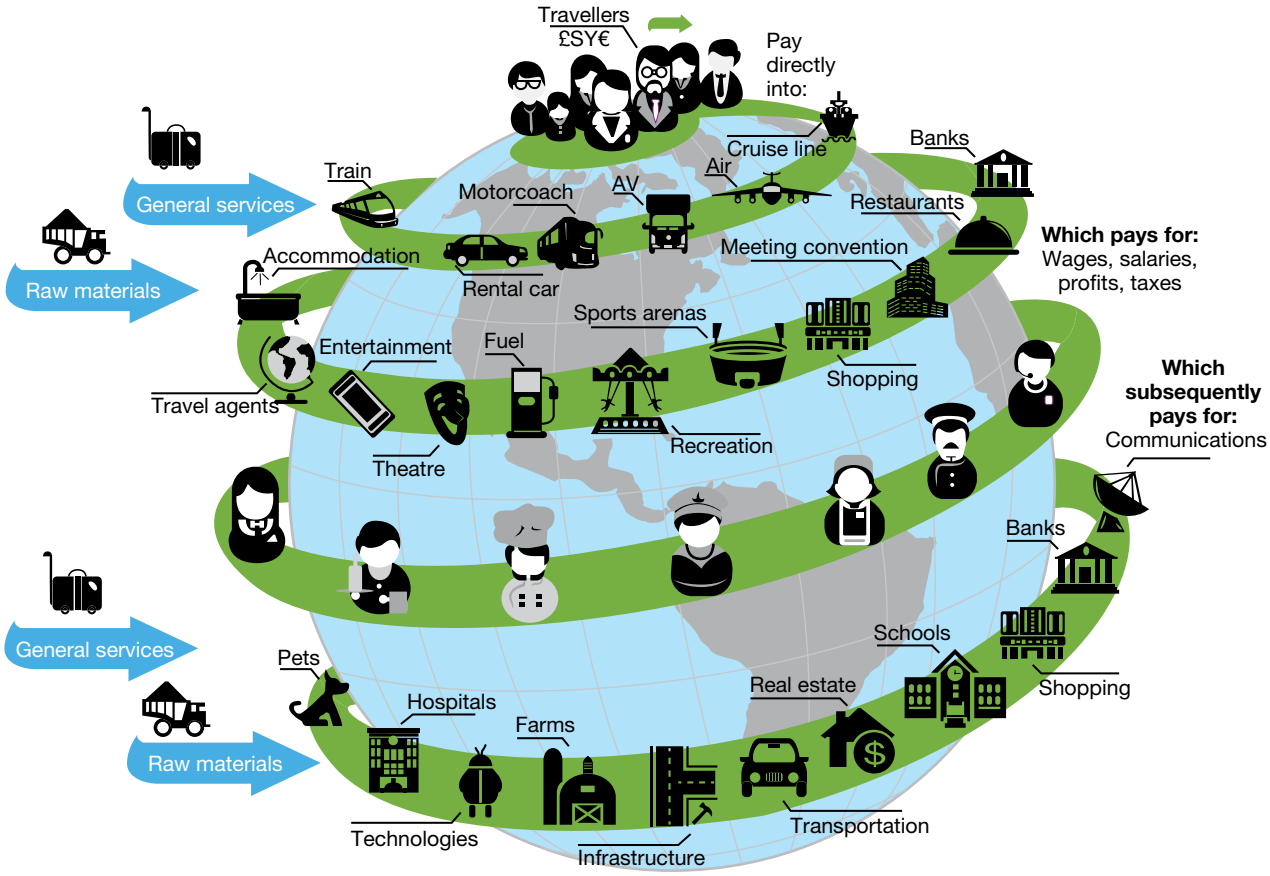
Global supply chains: Given the multidimensional nature of tourism's economic activity, it is not surprising that the global supply chains, critical to its operation, are incredibly complex. The supply chains comprise the suppliers of all the goods and services that go into the delivery of the tourism product. They include not only accommodation, transport and excursion providers, but also bars and restaurants, handicrafts, food production, waste disposal and the infrastructure that supports tourism in destinations. Take, for example, a cruise ship. Cruise ships typically traverse the world's oceans almost continuously with only a periodic refit interrupting their operation. Supplying the diverse needs of thousands of passengers and crew is a major logistical exercise, as is the routine rotation of the crew and entertainers. Commodities sourced from around the world need to be available for loading when the ship docks in a port on a specific date for just a few hours.

Mobility of labour: Tourism is a major source of employment, with large numbers of people working in the provision of accommodation, catering, transport, entertainment, other service industries and the souvenir trade. There is also an enormous amount of employment generated indirectly by tourism, especially in the enterprises servicing the sector. Some tourist-related enterprises have a heavy reliance on guest workers. The managerial staff of hotels are often drawn from a range of nationalities and are regularly redeployed within the company's international operations. Cruise ship operators rely heavily on guest workers from the Philippines, the Indian subcontinent and Eastern Europe. In Australia, elements of the hospitality sector rely on backpackers and foreign student labour.

Development levels and capital flows: In developing countries, tourism is seen as the most viable and sustainable way of fostering economic development. Tourists bring with them a ready supply of much-needed foreign currency. As the popularity of a particular tourist destination grows, these countries become increasingly attractive as investment opportunities for the transnational developers of hotels and resorts. Jobs are also created, as it is a labour-intensive industry. Many of the jobs available require relatively few skills and little investment, and therefore increase the employment prospects of the poor.

Did you know?

In 2018–2019 (prior to the COVID-19 pandemic), tourism was Australia's fifth-largest export. Only iron ore, coal, natural gas and education generated more income. Annualised tourism exports of A$33.5 billion were greater than Australia's principal rural exports (beef, other meats, wool and wheat), at A$22.1 billion.



3.3.6 Money travels with tourists around the world and contributes significantly to the economy.

Did you know?

The Hajj is an annual pilgrimage made to the Ka'ba, the 'House of God'. It is one of the Five Pillars of Islam (see Figure 3.3.7). The Hajj is a mandatory duty for Muslims that must be carried out at least once in their lifetime by all adult Muslims who are physically and financially capable of undertaking the journey. Religious pilgrimages are an important element of cultural tourism.

Cultural factors

Features of historical or cultural interest exert a powerful attraction for many tourists.

Many Americans, Canadians and Australians visit Europe because of its historical heritage. Visitors to Paris, London and Rome are drawn by the historical associations and traditions, the pageantry and entertainment, and many cultural attractions.

Three major forms of culture have been identified as attracting visitors.

- Forms of culture that are inanimate: these include unique architecturally significant and historical buildings and monuments.
- Forms of culture that are reflected in the normal daily life of a destination: this involves visiting other people to observe their social, economic and leisure activities to understand their religion, ideologies, customs and lifestyle.
- Forms of culture that are animated and may involve particular events: examples include music festivals, festivals reflecting old traditions and behaviour, re-enactments of old battles and displays of old cars or machinery.

Contacts of this kind can have beneficial effects, but they may also have negative impacts on locals and their culture. Indigenous cultures and traditional ways of life may be weakened or even destroyed by the impact of tourism. The commercialisation of cultural artefacts, identity and performance may result in undesirable cultural change.

Social factors

Tourism for many people is a 'pressure valve' for modern life—used simply to restore physical and mental wellbeing. For other travellers, replacing the known with the unknown and seeing different places, people and cultures may be a means of self-realisation and learning.

An important reason for the explosion in global tourism is the world's changing demographics. Increasing life expectancy means that there is a growing proportion of the population over retirement age (see Figure 3.3.8). Growing affluence, especially in countries of the developing world, is also an important driver of global tourism.

3.3.7 The Great Mosque of Mecca, Saudi Arabia, site of the annual Hajj pilgrimage

Technological factors

Historically, the most important factor affecting tourism is technological change, particularly in transport and in consumer choice and experience.

Transport technologies

Advanced industrial technology was the prerequisite for tourism in the nineteenth century, providing steam power for mass transport by road, rail and sea. In the twentieth century, transport technology for air, road and off-road vehicles allowed the spread of mass tourism to destinations more widespread than those that could be reached by rail or ship.

The capabilities of different transport modes, in terms of their size, seat capacity, speed, range, fuel efficiency, noise level and passenger comfort, have all made great advances and continue to do so. Such developments not only impact profitability, but can also influence consumer choice. Developments in transport will continue to determine which destinations can be reached within acceptable time and cost constraints.

The development of wide-bodied, long-haul jets was a major impetus to the growth of tourism. When the first generation of Boeing 747s appeared in the early 1970s, they greatly reduced the real cost of travel, making long-haul travel a realistic aspiration for a greater number of people. It made possible the rapid expansion of tourism in parts of the world that were previously too far removed from the wealthy tourist-generating countries of the developed world. The next generation of super large planes, such as the Airbus A380, proved economical only if they were full and used on long-haul flights. The trend now is in favour of smaller, more fuel-efficient planes, such as the Airbus A350-900 and A320neo, and the Boeing 787 Dreamliner.

3.3.8 Longer life expectancy is one demographic factor underpinning the growth in global tourism. Cruising is a popular option for older people with mobility restraints. The growth of the cruise ship industry has, at least in part, been underpinned by this demographic change.

Governments that recognise the enormous economic potential of tourism are investing billions of dollars into transport development projects. Considerable investment in infrastructure has made surface transport faster and more competitive over longer trips.

High-speed rail uses an integrated system of dedicated track and specially designed trains that travel considerably faster than traditional rolling stock. The Shinkansen bullet train in Japan, for example, can reach speeds of 320 kilometres per hour (see Figure 3.3.9). Japan continues to upgrade and expand its high-speed rail network across the country. The first bullet train service to the northern island of Hokkaido was opened in 2016 at a cost of US$6.6 billion to connect Tokyo with ski areas and regions famed for their cherry blossoms on Hokkaido. Trains on this line travel through the Seikan Tunnel, which is one of the longest tunnels in the world. An extension of the line to Sapporo, the biggest city in Hokkaido, is expected to be completed by 2030. High-speed rail is also a major facilitating factor in European and Chinese tourism.

3.3.9 A bullet train (Shinkansen) operates at high speed near Mount Fuji, Japan

Consumer technologies

The internet has empowered travellers in many ways. They can now exercise greater control over the key elements of the tourism-related experience—transport and accommodation bookings and the planning of the experiences they will engage in. The development of sophisticated travel apps and specialist travel websites supports people in these activities. Tourists can record and share their holiday experiences on social media via their smartphones and rate their holiday experiences on the internet in real-time.

Political and organisational factors

Some countries have a long history of active intervention in tourism. This has certainly been the case in France. The French government has, for example, made a large investment in the development of the coast of Languedoc-Roussillon, which is one of the largest tourism projects in the world.

There has been less government support in other parts of the developed world. Agriculture and manufacturing have often received a level of government support not offered to service-related industries such as tourism because those employed in tourism lacked political influence. This was certainly evident in the United States, where successive governments have been preoccupied with protecting its product-oriented industries. In 2017, the Trump administration announced plans to remove protection for some national parks and cuts to their size to allow resource extraction, such as mining and logging. President Biden (Trump's successor) reinstated the protections.

Generally, however, governments at all levels and of all political persuasions have recognised that while tourism is basically a private sector activity, its impact on local communities, regional and national economies, and international relationships requires government involvement. It can be a lucrative source of revenue.

The extent to which a government becomes involved in tourism depends on its philosophical approach, the role of planning in the economy, and the breadth of its economy and dependence on certain industries. It also depends on the accumulated impact of development on the physical and cultural environment.

Whatever the extent of their involvement, governments profoundly influence the economic climate in which tourism operates. Governments largely determine expenditure on the infrastructure that travellers utilise, such as roads, railways and airports. Political factors directly affect the business side of tourism. Generally, this occurs through labour regulation, taxation policies, foreign investment policy, visitor entry requirements, land zoning and consumer protections. Increasingly, governments formulate national strategies for tourist development or incorporate tourism into broader development policies.

In Western democracies, the government's principal role in tourism is to foster the development of an environment in which the industry can prosper, consistent with its broad economic, social and environmental considerations. This involves promoting the development of a dynamic and competitive industry that contributes to economic wellbeing, an enhanced quality of life and a sustainable natural and cultural heritage.

The role of government in tourism is diverse and can be both direct and indirect. It includes tourism promotion, facilitating visitor entry, the provision of transport infrastructure, regulation and control, and general economic policy.

Tourism promotion and support

The most direct means by which governments seek to promote tourism is the establishment of national and regional tourism organisations designed to facilitate tourism development. These organisations may focus on the promotion of domestic tourism and/or engage in international marketing and promotion.

Tourism Australia, for example, is the Australian Government's statutory authority responsible for international and domestic tourism. Its mission is to promote Australia as a desirable destination, and it is active in fifteen key international markets, promoting the

country's unique attributes to entice people to come here (see Figure 3.3.10). Its activities include advertising and promotions, media and industry programs, trade shows, online communications and consumer research.

The tourism industry and governments, for the most part, rely on the tourism data compiled and published by the UNWTO. The role of the UNWTO is to promote tourism as a driver of economic growth, inclusive development and environmental sustainability. It serves as a global forum for tourism policy development and a source of tourism research and data collection.

3.3.10 Terri and Robert Irwin attend a Tourism Australia campaign launch in Sydney, October 2019

Facilitating visitor entry

Ease of access to a country or region is a key factor in attracting tourists. Governments are responsible for matters such as visa processing and customs clearance. If visitor entry formalities are unduly complicated and time-consuming, tourism will suffer. The border closures, quarantine requirements and vaccination mandates enacted during the COVID-19 pandemic illustrate the important role that borders play in facilitating or restraining international travellers.

To encourage tourism, some countries have introduced visa-free entry or selective visa-free arrangements with other selected countries. The removal of border controls between the countries of the European Union is seen as a major stimulus to tourism in Europe.

Transport policy

The availability, pricing and ease of using transport dictate the flow of tourists both within and between countries. The distribution of transport capacity within a country also influences the level of dispersal of tourists and hence affects regional development. Governments are generally responsible for the provision of transportation infrastructure and equipment and the maintenance of safety standards, particularly airline security.

Regulation, control and tourist wellbeing

Government regulations are usually introduced for reasons of safety, zoning, consumer or environmental protection, price or quality control, or to ensure that services are available in remote locations. While such regulations are necessary, they incur costs. Too many regulations can cause conflict and become a deterrent to attracting investment.

Smartraveller.gov.au is the Australian Government's travel advisory service. It provides daily updates on the risks that travellers may face at different destinations. Australian consular services and assistance are provided to travellers who need help overseas. Travellers are often advised not to travel to places that are experiencing the impacts of conflict (war and civil unrest), criminal activity and natural disasters.

General economic policy

Government economic policies have direct and indirect implications. For example, restrictive policies, imposed when governments are grappling with high rates of inflation or current account deficits, can reduce disposable incomes. This limits the amount available for discretionary spending on travel and tourism. High interest rates can mean lower investments in tourism infrastructure. This, in turn, limits the industry's capacity to provide adequate services to potential visitors. Government taxes, charges and levies, which increase costs to inbound tourists, can adversely impact visitor numbers.

SPOTLIGHT

Tourism in Vietnam

Tourism plays an increasingly important role in the economy of Vietnam, contributing 7.5 per cent of the country's GDP. In 2019, Vietnam attracted 13 million visitors, of which 10 million came from other Asian countries. Tourists from China, South Korea and Japan make up about half of all arrivals. In 2023, 12.6 million people visited Vietnam (see Figure 3.3.11).

The Communist government of Vietnam has actively promoted the growth of the tourism industry by relaxing visa requirements and encouraging foreign investment in the sector. Despite this, challenges remain. Vietnam's tourism industry faces a shortage in both the quality and quantity of human resources. While many government-run training programs have been established, demand for skilled workers has still not been met. This is particularly true for hotels, which struggle to find suitable staff for housekeeping, maintenance, customer service and more. Foreign language and customer service skills are important in the hospitality industry. Such skills can only be learnt through education and training.

Deficiencies in tourism-related infrastructure also hinder the sector's development. Overcapacity in all of Vietnam's major airports is another obstacle for its tourism industry to achieve sustainable growth. Long-term measures include the government-funded construction of new airports in key tourist areas to alleviate the burden on infrastructure in big cities.

3.3.11 After Ho Chi Min City and Hanoi, the World Heritage-listed limestone landscape of Ha Long Bay is Vietnam's third-most visited attraction.

Activities

Acquiring and processing geographical information

1 Explain how biophysical factors influence the spatial pattern of tourism.
2 Summarise the economic importance of tourism.
3 Explain why tourism is described as multidimensional and geographically complex.
4 Explain why tourism has been seen as important in terms of promoting economic growth.
5 Summarise the economic significance of consumer demand, global supply chains, development, the mobility and labour, and capital flows in reference to the global tourism industry.
6 Explain the role of culture as a motivation for travel. List the three forms of culture that attract tourists.
7 Summarise the social factors affecting global tourism.
8 Summarise how the developments in transport technology have shaped the growth of tourism.
9 Summarise the ways in which political/organisational factors influence tourism.

Applying and communicating geographical understanding

10 Study Figure 3.3.3. List the features of the biophysical environment that tourists may find attractive in each place.
11 Study the box, Spotlight: Winter sports tourism. Complete the following activities.
   a Summarise the diversity of winter sports and recreational activities.
   b Describe the climatic conditions that are regarded as comfortable for skiing and snowboarding on overcast days and on sunny days. Under which climatic conditions is there a great risk of frostbite?
12 Study Figure 3.3.6. Describe the scope of the economic contribution of global tourism.
13 Access the Tourism Australia corporate website. Summarise the nature of the organisation's current tourism promotions.
14 Access the Australian Government's Smartraveller website. List the places that currently carry travel warnings. Note the basis of these advisories.
15 Study the box, Spotlight: Tourism in Vietnam. Summarise the economic importance of tourism to Vietnam. How has the government facilitated the growth of tourism?

UNIT 3.4

Current trends and future directions in global tourism

Internationalisation of tourism

As with other forms of economic activity, tourism has become globalised. Technological advances have made travel safer, more comfortable and more accessible (i.e. cheaper in real terms). Global transportation infrastructure is rapidly becoming a seamless, interconnected pathway to all parts of the world.

As the level of economic and cultural integration has increased, more and more countries have started to participate in the sector. While tourists from Japan, Europe, North America, China, Australia and New Zealand dominate the sector, tourism from all sources is increasing, driven principally by the rapid growth of the middle class in developing countries. At the same time, the range of destinations of mass tourism has increased and now encompasses almost all countries in the developed world and many in the developing world. The collapse of Communism in Eastern Europe and the former USSR in the late 1980s also made the borders of nation-states more porous. The most significant development of the past last decade has been the emergence of China as the number one source market for outbound tourists since 2012.

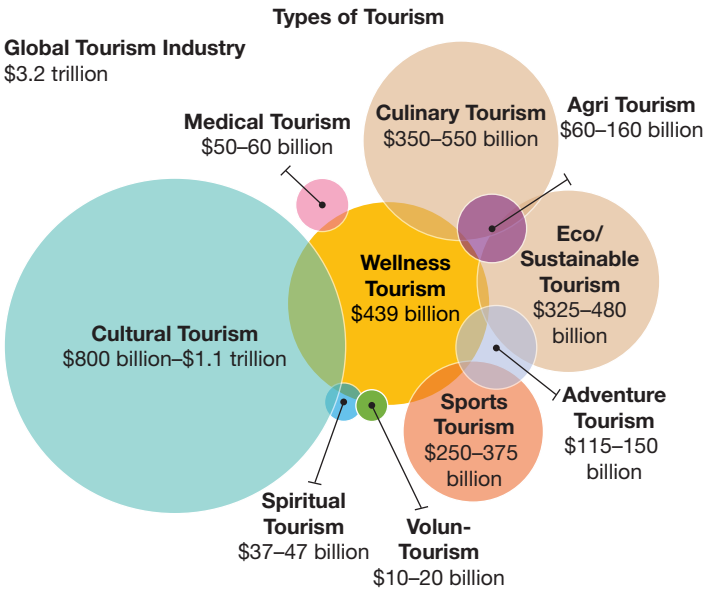
In the future, the process of internationalisation is expected to increase as experienced travellers seek new destinations, and an increasing number of those in living developing countries seek to engage in tourism.

Changing consumption patterns

Many of today's tourists have travelled before and, as a result, are increasingly sophisticated consumers. They know where they want to go, how they will get there and what they want to do once they arrive. The pre-packaged tour is no longer the preferred option for most tourists. Experienced travellers now seek to fulfil specific desires rather than absorb as much as possible in the available time. Travellers to Europe, for example, are now less inclined to engage in a 'whirlwind' tour of as many countries as possible on a single, extended holiday. Instead, they are opting for shorter holidays in individual regions or countries, giving them more time to experience their destination.
These changes reflect the travellers' increasing desires for new and different experiences. The changing demands of the experienced traveller have created an enormous demand for more specialised forms of tourism experiences. Tourism as an economic activity has responded. Figure 3.4.1 illustrates the increasingly diverse nature of tourism.

In the future, changing consumer tastes and preferences will profoundly influence the evolving tourist product and the directions this global economic activity will take. Many cruise enthusiasts, for example, have exhausted the traditional cruise destinations, such as the Mediterranean and Caribbean, and now seek new destinations. The growth in demand for expedition-style travel experiences to destinations such as Antarctica, the Arctic, the Kimberly region of WA, the Galápagos Islands and the Amazon River, is one outcome of this process and has prompted companies engaged in the sector to expand their fleets of expedition ships, which tend to be much smaller than the ships built for the mass cruise market.

An examination of just some of the emerging forms of tourism illustrates this growing diversity.



3.4.1 Diversification within the global tourism industry (in US$)

● SPOTLIGHT

A rise in Chinese tourists

An important trend in global tourism is the increased number of Chinese tourists travelling overseas (see Figure 3.4.2). Rising incomes in China and fewer obstacles for Chinese passport holders to travel abroad are the main drivers of this trend.

3.4.2 Chinese tourists in Venice

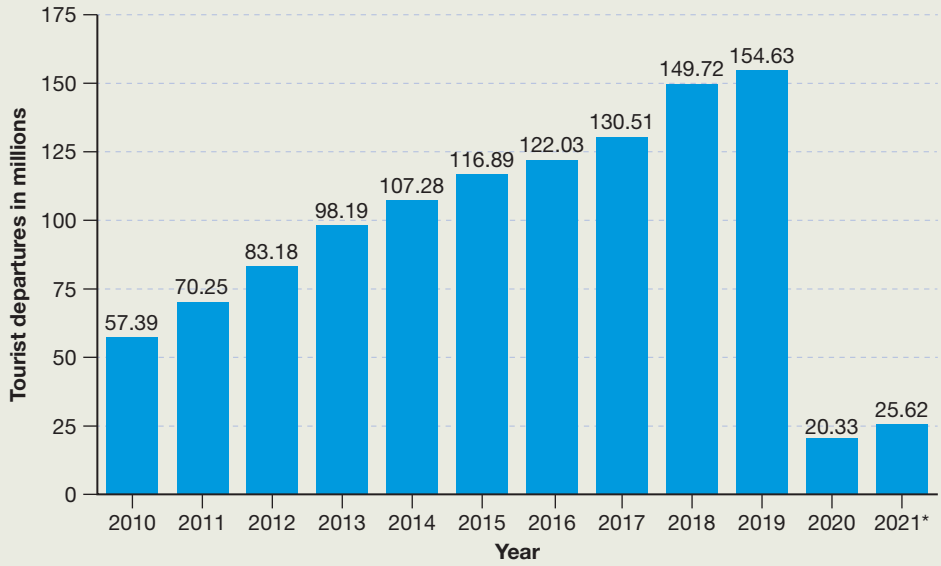
China maintained its position as the source of the world's largest number of outbound tourists from 2012 to the onset of the COVID-19 pandemic (see Figure 3.4.3). In 2019, the number of outbound tourists in China reached 154.6 million people before dropping to below 26 million a year in 2020 and 2021. Chinese visitors spent US$127.5 billion in overseas destinations in 2019. The rebound in outbound Chinese tourism post-pandemic has been relatively slow, numbering just 8.5 million in 2022, with most outbound Chinese tourists heading to Macau. In the first six months of 2023, 40 million Chinese nationals travelled abroad. In 2023, the Chinese government expanded the list of countries that organised group tours were permitted to travel to 78.

The top destinations visited by Chinese tourists pre-pandemic were Vietnam, Thailand, Japan, Indonesia, Singapore, Malaysia, Hong Kong, Philippines, Cambodia and Macau.

With China's notoriously bad air pollution, it is perhaps not surprising that clean air and a natural environment have become important considerations in choosing travel destinations. Sunny beaches with fresh air have attracted increasing numbers of Chinese visitors. In 2019, island travel accounted for 30 per cent of the total Chinese outbound travellers. Popular island destinations included Phuket, Thailand and Bali, Indonesia.

Family vacations are also popular with Chinese tourists. Universal Studios, Singapore; the London Eye, UK; and Universal Studios, Los Angeles, USA, were among the top family attractions. The Metropolitan Museum of Art, New York, USA; Musée du Louvre, Paris, France; the Vatican Museums, Vatican City; and the British Museum, London, UK, were the most popular foreign museums. Medical tourism has also become more popular among Chinese tourists, with huge sums of money spent on it Top medical destinations were Japan, South Korea and the USA.

Given that less than 10 per cent of the Chinese population holds a passport, there is huge potential for even more growth in China's outbound travel.



3.4.3 Growth in Chinese outbound tourism, 2010–2021 (*2021 numbers estimated)

Adventure and expedition travel

Adventure travel has emerged as a popular reason to travel. Authentic adventure experiences, often with elements of real or apparent danger, are becoming increasingly popular, especially with millennials and Generation Z. These experiences range from trekking, scuba diving, white-water rafting (see Figure 3.4.4), and jet boating to paragliding, parachuting, bungee jumping from bridges or helicopters, and swimming with sharks. There is a variety of explanations for the growing popularity of adventure tourism, including the idea that many people just want to have fun.

Expedition travel experiences, which generally lack the physical activity of adventure travel, are better suited to the experienced, older (and typically more affluent) traveller (see Figure 3.4.5).

Cultural and environmental travel

An increasing number of tourists choose to stay longer in a destination and immerse themselves in local customs and routines. They then take away with them memories of a shared experience, not just photographs. Environmental tourism is typically defined as travel to destinations where the flora, fauna and cultural heritage are the primary attractions. Responsible ecotourism includes programs that minimise the adverse effects of traditional tourism on the natural environment and enhance the cultural integrity of local people. **Cultural tourism** includes educational tours, performing arts events, festivals, pilgrimages, visits to monuments, and the study of nature, folklore and art. The cultural tourist is likely to be someone who enjoys meeting local people and learning about their lifestyle, seeks educational experiences and uses travel for personal growth and a genuine appreciation of others.

Developing culturally geared tourism programs encourages destinations to celebrate and promote the elements that distinguish their communities. In doing so, they provide opportunities for authentic cultural exchange between locals and visitors. In response to the growing demands by tourists to experience Asian history and culture, Singapore has spent more than US$1 billion to preserve the city's remaining architectural and cultural heritage.

Food tourism

Food tourism is a growing trend. Food has always been closely tied to the culture of a place, but it has become much more than simply dining out when on holidays. Food experiences have evolved into authentic cultural experiences and have even become the motivator to visit a particular place. Cooking classes and visits to local markets and farms to source ingredients are sought by tourists as a way of immersing themselves in the local way of life. Food tourism is closely bound to the growing trend of experiential travel (see Figure 3.4.6).

Wellness tourism

There is increasing interest in wellness tourism, where the focus is on holistic wellbeing, from yoga retreats to destination spas (see Figure 3.4.7). Its focus is the promotion of personal health and wellbeing, through physical, psychological or spiritual activities. Wellness tourism aims to reduce stress levels and promote a healthy lifestyle. In 2021, the global wellness tourism industry was valued at $850.6 billion and is expected to grow to $2.1 trillion by 2030.

3.4.4 White-water rafting is popular with millennials seeking adventure.

3.4.5 Expedition tourists observing the northern lights in Norway.

3.4.6 Participating in cooking classes in an exotic destination to sample and learn how to cook the local food is becoming an increasingly popular tourist activity, such as this one in Luang Prabang, Laos.

3.4.7 Scandinave Thermal Spa, Whistler, Canada

Organisational developments

Organisation is the framework within which tourism operates. It is concerned with the structures, issues and approaches that relate to this type of economic activity. The organisation of tourism comes from two sources: the government or 'official' organisation, and the private sector.

Government

Governments at all levels and of all political persuasions have recognised that while tourism is fundamentally a private-sector activity, its impact on local communities, regional and national economies, and international relations requires government involvement. In recognition of the contribution that tourism makes towards a country's economic and social wellbeing, nearly all governments have established national tourism organisations to promote tourism within their countries. The extent of their responsibilities varies, with some geared only towards international promotion and marketing, while others become involved in regulation and promotion of the industry domestically.

Private sector

Tourism in the private sector is characterised not only by a wide variety of economic activities supplying passenger carriage (or travel), accommodation, amenities and attractions, but also a range of different types of enterprises. The opportunities that exist in tourism give rise to a mix of large-scale and small-scale operations. These range from individuals renting out their lodgings to guests through Airbnb and sole proprietorships selling souvenirs or handicrafts to tourists, to large transnational corporations catering to all tourist needs from origin to destination. There has also been significant growth in corporate involvement in tourism.

Activities that are less demanding in terms of capital, know-how and entrepreneurial skill can be handled by small businesses. Capital-intensive, large-scale operations have a relatively long payback period (a return for the capital invested) and require high levels of technical and managerial expertise. In the accommodation sector, camping grounds, bed-and-breakfast establishments and motels lend themselves readily to individual owner operation, while large hotel chains usually have corporate ownership. Airline operations are the preserve of major companies or governments, while transportation at destinations

is often handled by small-scale owner-operators. Much of the growth in large tourism companies arises from the very competitive nature of many tourist markets and destinations and a drive for a greater market share and economies of scale.

● SPOTLIGHT

Concentration of ownership and control

The level of concentration achieved in the tourism industry in the future will depend on the relative strength of two opposing forces.

First, the demands of increasingly sophisticated travellers for new experiences and travel products provide opportunities for innovative operators to enter the industry. This could lead to a reduction in the concentration of ownership.

Second, there is the market strength of the big operators. They have the capital to invest in the latest technology and greater market share to guarantee its efficient use. Their control of the market is especially evident in supply-led tourism. Increasingly, producers can generate a market by introducing and promoting a specific tourist product. It is common practice for large airlines to advertise a 'lead-in special', offering cheap airfares to a specific location with accompanying savings on accommodation. The touring arm of the corporation gives special rates to its accommodation wholesaler, effectively creating its own market. Such practices will undoubtedly lead to more concentration in ownership, control and decision-making in tourism.

Overall, there is a polarisation evident within the industry and a diversification of the tourism market.

Tensions between globalisation and localisation (global tourism)

Global	Local
Transnational corporations	Local (independent) enterprises
Profit-driven	Often life-style driven (financial viability remains a consideration)
Generic experiences	Innovative, differentiated products/experiences
Economic factors dominate	Cultural/social influences strong + economic considerations
Brands dominate	Brands not widely known

3.4.8 The polarisation evident in the global tourism industry is exemplified in the tensions between the forces of globalisation and localisation.

The polarisation taking place within the industry is especially evident in the tensions between globalisation and localisation (see Figure 3.4.8). At one end of the continuum are the TNCs—the global travel companies, airlines, cruise lines, and multi-brand hotel corporations (see Figure 3.4.9). At the other end of the continuum are local entrepreneurs—the entertainers, tour guides, stallholders, restaurant and bar owners, operators of local attractions and the owners of small hotels, B&Bs and Airbnb accommodation (see Figure 3.4.10). Local entrepreneurs typically take advantage of the economic opportunities stemming from the flow of tourists generated by tourism-focused TNCs. These trends are likely to accelerate in the future.

3.4.9 InterContinental Da Nang Sun Peninsula Resort, Da Nang, Vietnam. The resort is operated by the British-based IHG, which operates more than 6000 hotels and resorts worldwide, across 18 brands.

3.4.10 Locally owned and operated budget resort, Phu Quoc, Vietnam

Horizontal and vertical integration

Growth in the scale of operation and increases in the concentration of ownership and control have generally come about through horizontal and vertical integration.

Horizontal integration involves expansion within a given sector of the productive activity, thereby removing competition between each other. They can take advantage of economies of scale with centralised management, finance acquisition and purchasing. The greatest value of horizontal integration is in marketing. Consumers can be referred to other hotels within the chain, rather than turning to a competitor. The existence of a familiar, reputable brand hotel in an exotic destination offers customers security—a base from which the unknown can be confidently explored.

The hotel sector is a good example of horizontal integration. The multi-brand hotel group IHG, for example, controls brands that extend across mid- to high price points, from the Holiday Inn to the Intercontinental and Regent brands. Accor, the French TNC, spans all price points, from the budget Ibis to the luxury Fairmont, Raffles and Sofitel brands.

Vertical integration, on the other hand, is where a company takes over one or more other companies that are at different levels in the distribution chain. Many companies opt for integration to allow for total control of all aspects of their business. Major package tour operators have been especially attracted to the corporate practice of vertical integration. In seeking to gain a competitive advantage and keep prices down, they have become progressively and increasingly involved in all sectors of tourism, from the market (retail outlets), through the transport sector (investments in airlines), to the destination (acquiring hotels and tour bus operators).

Trends to watch

In addition to the trends outlined above, it is possible to identify several changes that will shape the nature of the tourism product in the future.

- The ageing of the population and the growing middle class in developing countries will continue to grow the market.
- Post-COVID-19-pandemic there is an industrywide focus on safety and hygiene. This is likely to remain a focus well into the future.
- Solo travel is growing. Leisure travel used to be a family affair or something that couples undertook together. While that's still the case for many, people are increasingly choosing to strike out on their own.
- There is a recognition of benefits to be gained by tailoring tourism experiences to the interests of the LGBTIQA+ community.
- Through online web-based virtual reality tours, customers can experience hotel interiors, restaurant interiors, outdoor tourist attractions and more, all from their home.
- The eco travel sector is growing in importance, reflecting a growing interest in ethical and sustainable tourism options.
- Blended travel is growing, where consumers are redefining their work-life balance, whether through 'workations', becoming 'digital nomads' or taking advantage of work-from-anywhere policies.
- There is a growing awareness of, and, in some notable instances, a revolt against, the social and environmental impacts of mass tourism. See, for example, the box, Spotlight: Venice and its quest for sustainable tourism on pages 72–75.

Activities

Acquiring and processing geographical information

1 List the factors driving the internationalisation of global tourism.

2 Summarise the ways in which today's tourists are becoming more sophisticated. How has this impacted on tourism?

3 Distinguish between adventure and expedition travel. What types of activities does each include?

4 Define environmental, responsible and cultural tourism.

5 Summarise the cultural motivations for travel.

6 Explain why there is a growing interest in food and wellness tourism. What types of experiences are available?

7 Explain why governments have become involved in the tourism industry.

8 Describe the nature of the private sector's engagement in global tourism.

9 Describe the nature of the forces affecting the level of concentration evident in the tourism private sector.

10 Account for the polarisation evident in the tourism private sector.

11 Distinguish between vertical and horizontal integration in the tourism industry.

Applying and communicating geographical understanding

12 Study the box, Spotlight: A rise in Chinese tourists. Explain the rapid increase in Chinese tourism. What are the most popular destinations for Chinese tourists? What types of tourism experiences are popular with Chinese travellers?

13 Study Figure 3.4.1. Prepare a report describing each type of tourism shown in the diagram, indicating the people who are inclined to undertake it and the destinations that are popular for it.

14 Using travel brochures or advertisements from newspapers and the internet, collect examples of adventure travel, cultural and environmental travel, food tourism and/or wellness tourism.

15 Undertake research to identify examples of vertical and horizontal integration within the tourism industry.

16 Select one of the hotel groups listed below. Access the group's website. Write a brief report summarising the group's history, size and geographical spread, the market sector or sectors that the group targets, and the number and location of hotels that the group operates in Australia.

- Marriott International
- IHG
- Hilton Worldwide
- Accor

UNIT 3.5

Sustainability strategies in global tourism

The tourism industry is at the forefront of global efforts to promote a more sustainable future. This is driven, at least in part, by the increasing environmental awareness of those engaged in tourism—a consumer-driven response to the challenges facing planet Earth. There is also a growing awareness of the social impacts of tourism and its implications for the sustainability in the industry. Being able to critically analyse or assess the strategies adopted by providers within the sector is an important geographical skill.

Impacts of tourism

Environmental impacts

Tourism developments tend to be located near attractive or unique features of the biophysical environment. Unfortunately, tourism often places a heavy strain on such natural resources. The greatest threat exists to those environments considered to be the most fragile; that is, most vulnerable to natural or human-induced stress. Without careful management, intensive tourism development can contribute to a deterioration of the environment, notably air and water quality.

Tourism can also lead to the destruction of the natural environment. Vegetation can be damaged by trampling, fire and the removal of species. Wildlife can be driven to the brink of extinction by hunting and disruptions to feeding and breeding, as well as restrictions on movement and the loss of natural habitat.

Tourists may be unaware of the impact that their presence has on the natural environment, and others may start to question the wisdom of visiting in the first place when their very presence may damage what they have travelled to appreciate.

The link between tourism development and environmental protection is critical for the future success of this economic activity. Uncontrolled development in environmentally fragile areas could well destroy the natural attraction that draws the visitors. With adequate planning by governments and adherence to environmental codes by tourism operators, the threat of environmental degradation posed by global tourism can be overcome.

The challenge is to develop procedures to assess the potential environmental impacts of tourism-related developments. Australia's Environmental Impact Assessment (**EIA**) process is designed to identify the likely consequences of a development for the biophysical environment at a stage when it can influence the decision of the officials responsible for approving a proposal. Other mechanisms available for governments to address the impact of tourism are regulations, the establishment and management of national parks, the preservation of significant heritage sites, and the enactment of legislation that helps to conserve our unique and precious cultural and natural resources.

A more detailed reference system from which potential tourism impacts can be identified and assessed is presented in Figure 3.5.1.

The biophysical environment	The constructed environment
Changes in floral and faunal species composition ■ Disruption of breeding habits ■ Killing of animals through hunting ■ Killing of animals to supply goods for the souvenir trade ■ Inward or outward migration of animals ■ Destruction of vegetation through the gathering of wood or plants ■ Change in extent and/or nature of vegetation cover through clearing or planting to accommodate tourist facilities ■ Creation of a wildlife reserve or sanctuary **Erosion** ■ Compaction of soils, causing increased surface run-off and erosion ■ Increased risk of occurrence of landslips or landslides ■ Increased risk of avalanche occurrence ■ Damage to geological features, such as tors and caves ■ Damage to riverbanks **Pollution** ■ Water pollution through discharges of sewage and spillages of oil or petrol ■ Air pollution from vehicle emissions ■ Noise pollution from tourist transportation and activities ■ Natural resources ■ Depletion of ground and surface water supplies ■ Depletion of fossil fuels to generate energy for tourist activity ■ Increased risk of fire **Visual impact** ■ Facilities, such as buildings, chairlifts and car parks ■ Litter	**Urban environment** ■ Land taken out of primary production ■ Change of hydrological patterns **Restoration** ■ Reuse of disused buildings **Infrastructure** ■ Overload of infrastructure, such as roads, railways, car parking, electricity grids, communications systems, waste disposal facilities and water supplies ■ Provision of new infrastructure ■ Environmental management to adapt areas for tourist use, such as sea walls and land reclamation **Urban form** ■ Changes in residential, retail or industrial land uses, such as the move from houses to hotels and boarding houses ■ Changes to the urban fabric, such as roads and pavements ■ Emergence of contrasts between urban areas developed for the tourist population and those for the host population **Visual impact** ■ Growth of the built-up area ■ New architectural styles ■ People and belongings ■ Tourism-related advertising

3.5.1 Potential impacts tourism on the environment

SPOTLIGHT

Golf tourism and its environmental impacts

The game of golf generates US$100 billion in travel worldwide and a world-class golf course can support an entire local economy, as it can bring in tourist dollars from all around the world. Lush green golf courses (see Figure 3.5.2) come at a cost. Most courses use non-native grasses and large quantities of fertilisers, weed-killers, pesticides and other chemicals to achieve the look that is attractive in tourist brochures. These chemicals can have negative impacts on surrounding ecosystems, which may eventually cost more to remediate than the economic boost provided by the resorts

Slowly, this issue is being addressed. Golf course designers are now more focused on course layouts that don't require major alterations to the local terrain and provide better water and soil management. By more effectively controlling water flow and run-off, designers can create courses that are more self-sustaining and require less intervention from greenkeepers.

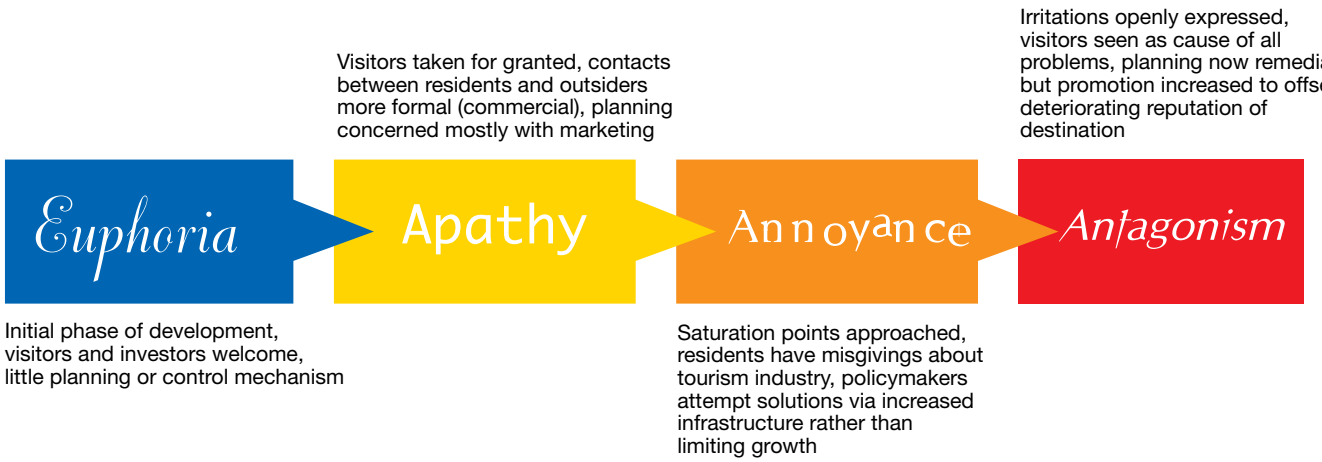
Natural wildlife habitats are also being retained and are now presented as features of courses. This helps minimise the displacement of local flora and fauna and makes for a better experience for golfers.

3.5.2 Phoenix Gold Golf and Country Club, Pattaya, Chonburi, Thailand

Social impacts

Social contact between tourists and residents can be mutually beneficial. The resident population can gain a greater understanding of visitors' customs, values and culture, as well as enjoying an increased demand for traditional entertainments, crafts and music, thereby preserving parts of the national heritage. Tourists' patronage of museums, art galleries and theatres brings revenue and maintains these facilities for local use as well. The tourists themselves may go home with a better understanding of the host country and its culture and traditions.

Critics of the industry often suggest that the transient social relationships inherent in tourism are incapable of producing any meaningful contact between visitors and residents. Increasing numbers of tourists can mean a shift in attitude from initial euphoria by the resident population to growing hostility (see Figures 3.5.3 and 3.5.4).



3.5.3 Index of irritation

Tourism development may result in mutual misunderstanding, hostility and social tension as residents' lifestyles are affected by the demands of tourists. One of the most significant and least desirable impacts of tourism is the growth of prostitution, crime and gambling in the host population.

Such serious social impacts indicate that social policy and the provision of community services must become an integral part of tourism planning by both tourism operators and the host government. Where such planning is lacking and the problems are not addressed, resentment develops, especially if money is drained from the host country because of foreign ownership of tourist resorts. Outright hostility towards visitors may emerge, which could reduce tourist flows and threaten the viability of tourism operations. These tensions are likely to re-emerge as the post-COVID-19 recovery gains pace.

3.5.4 Environmental protesters from the group Comitato No Grandi Navi, demonstrate against excessive tourism and the presence of cruise ships in the Venetian lagoon, Venice, Italy.

Sustainable tourism

The UNWTO defines sustainable tourism as 'tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities'. It further states that 'Sustainable tourism development guidelines and management practices are applicable to all forms of tourism in all types of destinations, including mass tourism and the various niche tourism segments'. It also notes that 'Sustainability principles refer to the environmental, economic, and socio-cultural aspects of tourism development, and a suitable balance must be established between these three dimensions to guarantee its long-term sustainability.'

These principles require that sustainable tourism should:

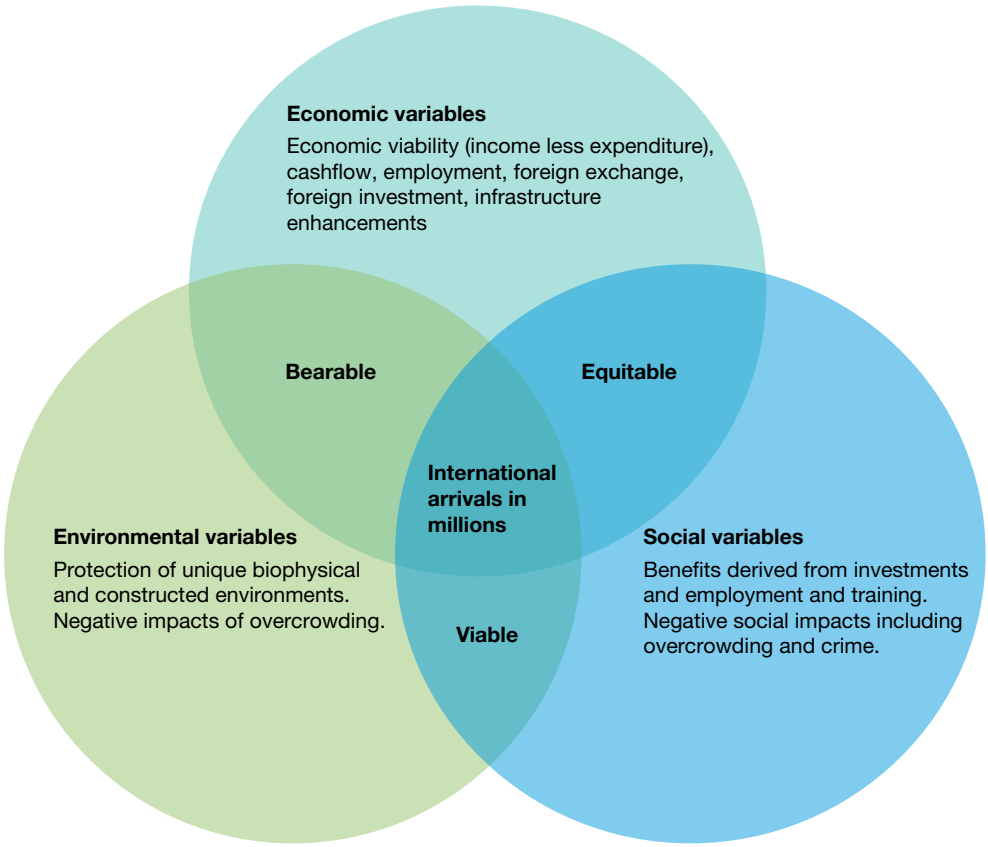
- make the best use of the environmental resources that represent a key element in tourism development, maintaining essential ecological processes and protecting a place's natural heritage and biodiversity
- respect the socio-cultural authenticity of host communities, conserve their built and living cultural heritage and traditional values, and contribute to inter-cultural understanding and tolerance
- ensure viable, long-term, fairly distributed socio-economic benefits for all stakeholders, including stable employment and income-earning opportunities, the provision of social services to host communities and a contribution to the alleviation of poverty.

The objective of sustainable tourism is to retain the economic and social advantages of tourism development while reducing or mitigating any undesirable effects on the natural, historic, cultural or social environment. This is achieved by balancing the needs of tourists with those of the destination (see Figure 3.5.5).

Sustainable tourism should aim to maintain a high level of visitor satisfaction and ensure a meaningful experience for tourists, raising their awareness about sustainability issues and promoting sustainable tourism practices among them.

Did you know?

In the 2030 Agenda for Sustainable Development, UNSDG target 8.9 aims to, 'by 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products'. The importance of sustainable tourism is also highlighted in UNSDG target 12.b, which aims to 'develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products'.



3.5.5 Elements of sustainable tourism

Sustainability strategies in global tourism

In this course, students are encouraged to find and analyse their own examples of strategies used to achieve environmental or social sustainability in the tourism industry. The rest of this unit explores several sector-specific examples, including a case study of Venice's efforts to achieve environmental and social sustainability. The criteria that can be used to analyse such initiatives are also provided in Figure 3.5.10 on page 71.

HOSPITALITY SECTOR

The hospitality sector is increasingly focused on reducing its environmental footprint. Hotels chains, for example, are becoming conscious of the need to cater for the environmentally aware traveller. Strategies used to reduce their footprint include:

- installing furniture made from wood sourced from sustainably managed forests
- supplying guests with eco-certified soap, shower gel and shampoo in refillable dispensers instead of single-use plastic containers
- waste reduction and recycling programs
- using environmentally friendly, eco-certified cleaning products
- encouraging guests to reuse towels and introducing an at-will linen washing policy when guests occupy the same room over multiple days
- the installation of water and energy saving technologies, for example, LED lighting, light sensors and timers and the use of water stations rather than supplying bottled water
- using compostable plastics
- engaging in carbon offset initiatives.

The issue to consider when thinking about sustainability is whether these are substantive strategies or tokenistic attempts to create an impression that businesses are being proactive in protecting the environment.

SPOTLIGHT

IHG's Green Engage initiative

Each of the world's major hotel chains has developed programs that showcase their environmental awareness. InterContinental Hotels Group's (IHG) Green Engage system is one such hotel chain-based program (see Figure 3.5.6). The system provides hotels within the group with the means to measure and manage their impact on the environment. The hotels can choose from over 200 'Green Solutions, which are designed to help them reduce their energy, water and waste, and improve their impact on the environment. The IHG Green Engage system has four levels of certification that hotels can achieve. Those achieving Level 3 certification or above can reduce energy use by up to 25 per cent. The rating system assists guests in choosing a hotel that meets their own environmental values.

3.5.6 InterContinental Hotel, Chicago, USA

TRANSPORT SECTOR

Transportation is one of largest contributors to global greenhouse gas emissions (14% of all emissions). Transport-based emission primarily come from the burning of fossil fuels by cars, trucks, ships, trains and planes. Strategies to reduce the tourism industry's emissions include incentives encouraging the uptake of electric vehicles, the electrification of rail networks and the development of Sustainable Marine Fuels (SMF) and Sustainable Aviation Fuel (SAF).

3.5.7 Qantas has committed to achieving net zero emissions by 2050

Qantas, for example, has committed to reducing its carbon emissions by 25 per cent by 2030 (from 2019 levels) and has endorsed the industry's aim of achieving net zero emissions by 2050 (see Figure 3.5.7). It has also initiated several carbon offset programs, minimised the use of single-use plastics and is investing in more sustainable aircraft and aviation fuel. Qantas is working with Airbus to accelerate the development of an SAF industry in Australia. The scale of the challenge for the aviation sector is, however, daunting given that the projected increase in demand for air travel could increase aviation's greenhouse gas emissions by over 300 per cent of 2005 levels by 2050.

The issue to consider when thinking about sustainability is whether it is realistic for the industry to substantially reduce its emissions, given the projected increase in air travel.

DESTINATION-BASED INITIATIVES

Tourist destinations and providers are increasingly aware of the need to reduce their environmental footprint. In some instances, this is in response to government-legislated requirements. In other instances, it is seen as a commercial imperative with consumers becoming more aware of the environmental consequences of their travels.

SPOTLIGHT

Thredbo's sustainability initiatives

Thredbo Alpine Resort, located within the Snowy Mountain National Park, is committed to preserving and protecting its unique alpine environment (see Figure 3.5.8). In doing so, it has embraced an extensive range of environmental initiatives which have resulted in it receiving gold certification through EarthCheck, an Australian-based certification, consulting and advisory group for sustainable destinations and tourism organisations. Specific initiatives include:

- the powering of resort operations by renewable energy
- the use of a closed-loop organics recycling machine to reduce the volume of waste being sent to landfill and producing a useable compost product that puts nutrients back into the soil
- the removal all single-use plastic products and the introduction of certified compostable and sustainable sugar cane pulp food packaging
- the use of SNOWsat technology to map snow depths more accurately across the resort, which makes snow grooming and snowmaking more efficient, saving fuel and energy
- a partnership with Greenfleet (an Australian not-for-profit environmental organisation focused on protecting the climate by restoring native forests) to offset the resort's vehicle emissions. In total, Thredbo has offset over 12 619 tonnes of carbon emissions by planting approximately 46 500 native trees.

The issue to consider when thinking about sustainability is the extent to which such actions can effectively reduce the resort's environmental footprint in the fragile alpine environment.

3.5.8 Thredbo Alpine Resort is one of many tourist destinations focused on sustainability.

SPOTLIGHT

Antarctic tourism

Minimising the environmental impact of tourism in the global commons of Antarctica is a tricky issue because no individual government has the power to set the rules, and the challenge is becoming more complex as Antarctica's popularity as a tourism destination grows (see Figure 3.5.9). More than 56 000 tourists visited Antarctica during the 2018–2019 season. The figure for the 2023–2024 season is expected to rise to more than 78 000. Most visitors come by cruise ship, setting sail from ports in South America.

The International Association of Antarctica Tour Operators (IAATO) is key to managing tourism in such a fragile part of the world. IAATO members agree to abide by the organisation's guidelines, as well as the rules set out by the Antarctic Treaty system. These govern things like the number of passengers allowed ashore during site visits, staff-to-visitor ratios, and the amount of experience required of expedition crews.

The IAATO rules also stipulate that vessels carrying more than 500 people are not allowed to make landings, they can only cruise off the coast. Smaller vessels offering expedition cruises are allowed to make landings with their passengers having the opportunity to have guided walks and engage in activities such as kayaking and snowshoeing.

While membership in IAATO remains voluntary, all Antarctic tour operators must obtain a permit to travel in Antarctica from one of the 12 governments party to the Antarctic Treaty.

3.5.9 The rapidly growing number of tourists visiting Antarctica presents a range of challenges.

Greenwashing

Greenwashing is a communication strategy adopted by businesses whereby they misrepresent the extent to which their enterprise is environmentally friendly, sustainable or ethical. Companies that take up greenwashing communication strategies often do so to conceal their environmental shortcomings.

When analysing the effectiveness of any sustainable tourism strategy it is important to consider whether the provider is genuine in addressing the environmental footprint of its activities or simply engaged in greenwashing.

Evaluating the sustainability of a tourism-based activity

As part of their studies, students are required to evaluate the sustainability of a selected tourism-based activity using specific criteria. In doing so, they examine the range of strategies used to achieve sustainability and critically analyse one of these strategies. Figure 3.5.10 features a sample sustainability analysis checklist.

Students should note that analysing something involves identifying its key components and the relationship that exists between them and then drawing out and communicating their implications. Evaluating something involves making a judgement based on criteria to determine its value.

Sample sustainability strategy analysis checklist

- ☐ Has the selected sustainability strategy been developed with the input of the relevant environmental and social stakeholders?
- ☐ Is the sustainability strategy making use of the smallest possible number of resources?
- ☐ Is the sustainable strategy employing green procurement standards for all required goods, materials and services being used?
- ☐ Has the strategy considered potential negative environmental and social impacts in medium- and long-term timeframes?
- ☐ Will the strategy support or ensure the continued provision of environmental services in the affected area?
- ☐ Will the strategy be beneficial in terms of its impacts on climate change?
- ☐ Will the strategy result in a decrease in greenhouse gas emissions?
- ☐ Has the strategy assessed the risks of water, air or soil contamination?
- ☐ Does the strategy have a negative impact on a protected site, a vulnerable site or a highly valuable ecosystem?

3.5.10 Sample sustainability analysis checklist

Activities

Acquiring and processing geographical information

1. Summarise the environmental and social impacts of tourism.
2. Define sustainable tourism. What should it seek to achieve? What is its objective and aims?
3. Summarise the strategies the hospitality sector has embraced to promote sustainable tourism.
4. Describe how the transport sector is seeking to reduce its environmental footprint.

Applying and communicating geographical understanding

5. Study Figure 3.5.1. Write an extended response outlining the potential impacts of tourism on the biophysical and constructed environments.
6. Study Figure 3.5.3. Explain the irritation index in your own words.
7. Study the box, Spotlight: Golf tourism and its environmental impacts.
8. Study Figure 3.5.5. Write a report outlining the key elements of sustainable tourism.
9. Study the box, Spotlight: Thredbo's sustainability initiatives. As a class, critically assess whether Thredbo's initiatives, focused on reducing its environmental footprint, are a genuine attempt at promoting sustainability or an example of greenwashing.
10. Study the box, Spotlight: Antarctic tourism. Why is minimising the environmental impact of tourism in Antarctica problematic? How is tourism managed? As a class, discuss what additional measures could be taken to protect Antarctica's fragile ecosystem.
11. Investigate tourism in the Antarctic. Access the IAATO website. Outline the mission of the association and its aims. What are the stated benefits of tourism in Antarctica? How does it seek to protect the fragile Antarctic environment?

■ CASE STUDY

Venice and its quest for sustainable tourism

The growth of global tourism is not without its consequences. Before the onset of COVID-19, overcrowding was the most pressing issue facing the industry, as the surge in visitor numbers alienated residents of popular destinations, overwhelmed local infrastructure and degraded environments.

Venice is one of the most visited places on Earth. The greatest tourism-related challenge facing the iconic Italian city is how to cope with the sheer number of tourists crowding its squares, canals and narrow laneways (see Figures 3.5.11 and 3.5.12). Added to this are the environmental challenges facing the lagoon on which Venice is located—rising sea levels, erosion, the increased frequency and severity of extreme weather events and pollution.

3.5.11 Aerial photograph of Venice

3.5.12 Venice summer tourist surge. The iconic Italian city is in danger of depopulation due to crowding and the high cost of living.

Sadly, Venice has become a victim of its own popularity. Over-tourism, driven by the low cost of air travel and the growth of the cruise ship industry, has led to the departure of residents unsettled by the tourist invasion. Many have simply relocated to the mainland, driven out by the crowds, high prices and rising rents, as property owners have found the short-term Airbnb market more lucrative.

Post-pandemic, many locals were not keen for the city to resume 'business as usual'. The non-profit group, We Are Here Venice, for example, has been fighting for authorities to recognise the advantages of sustainable tourism. Of note, is its campaign to keep massive cruise ships out of Venice.

Prior to the pandemic, as many as 25 million tourists from all over the world descended on the city each year. Of these, 19 million were daytrippers who, on average, spent just €5–€20 each. The 20 per cent of tourists who spent at least one night in Venice contribute more than two-thirds of all tourist revenue—an estimated US$5 billion in 2019.

Socio-economic challenges

The socio-economic challenges facing Venice include its population decline and the associated loss of the public goods on which people depend, the lack of affordable housing and the high cost of living.

In 2021, the number of residents in the historical centre of Venice was just above 50 500. In the early 1950s, it was more than 175 000. The reasons for the decline are complex, but include the refusal of authorities to guarantee even the most basic services for those living in the city—schools, groceries and healthcare. Then there is the shortage of rental accommodation, with property owners increasingly attracted to the short-term holiday rental market (e.g. Airbnb). Rents for the homes that are still available have increased well beyond the financial means of the service sector workers, who are critical to the city's tourism industry. Shops that once met the daily needs of the city's residents have closed or been replaced by souvenir shops or high-end boutiques targeting the tourist trade. Residents see shops, craftspeople, barbers, pharmacies and other service providers closing to make room for bars, restaurants and hotels.

The cost of living is high, even by European standards. Restaurant prices are more than 50 per cent higher than on the adjacent mainland. Congestion, and the need to deliver almost all goods by boat or barge, increases delivery costs which are recouped through higher charges for goods and services.

Tourism has also contributed to what is termed the 'artificialisation' of the city—a loss of authenticity. Residents cite the city's growing impersonality, its superficiality, the lack of quality and genuineness in all things. Some simply dismiss the city as an architectural 'Disneyland'.

Environmental challenges

As noted above, Venice is one of the world's urban treasures and one of its most unique cities. Built on little more than a large sand bar in the middle of a coastal lagoon, the city's centuries-old palazzi (palaces), churches and shops rest on wooden piles driven into the lagoon's soft sand.

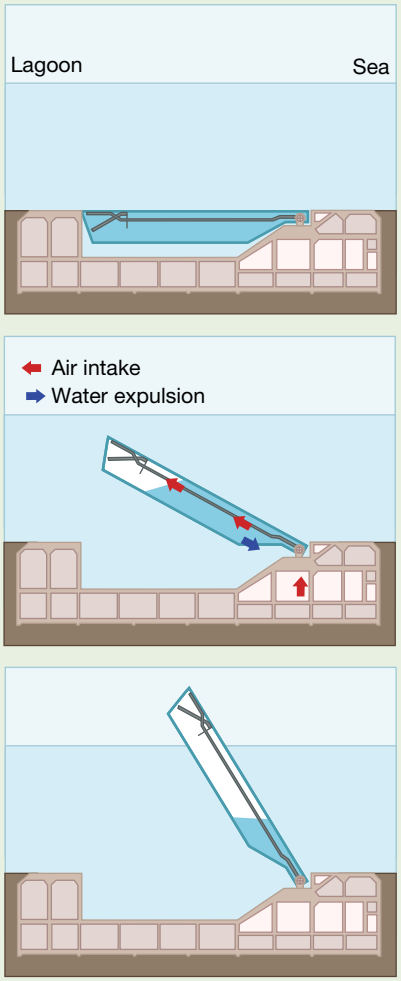
The city's best-known environmental problems are its apparent sinking, its regular flooding and its polluted waterways. Not all of these are tourism-related.

The gradual sinking of the city (about 23 cm over the past century) has been attributed to the lowering of the lagoon's bed caused by mainland industries pumping freshwater from the watertable beneath the lagoon. This practice was stopped in 1970, allowing the lagoon bed to rise a little in the decades since. However, the threat of serious flooding has not abated as global warming has resulted in rising sea levels in the Adriatic Sea and within the lagoon. The construction of the MOSE barrage promises some relief.

MOSE (*Modulo Sperimentale Elettromeccanico*, or Experimental Electromechanical Module) has been built, at a cost of US$8 billion, to protect the city and the Venetian Lagoon from flooding. The project is an integrated system consisting of rows of mobile gates (see Figure 3.5.13) installed at the Lido, Malamocco and Chioggia inlets, which can temporarily isolate the Venetian Lagoon from the Adriatic Sea during *acqua alta* (high tides). MOSE is designed to protect Venice and the lagoon from tides of up to 3 metres.

In addition to the construction of MOSE, the Venice Water Authority and Venice Local Authority are raising quaysides and paving in the city to protect the city from medium-high tides (below 110 cm, the height at which the mobile barriers will be activated).

Other environmental issues include pollution from heavy industries on the nearby mainland, the congestion caused by unregulated boat traffic, and the damage to buildings that line the city's canals from boat wakes slapping against their foundations (see Figure 3.5.13).



3.5.13 The MOSE barrage working principle

3.5.14 Congestion on Venice's Grand Canal

Strategies to promote sustainable tourism

Activists argue that the COVID-19 pandemic gave Venice the opportunity to rethink mass tourism and to try to create a new type of sustainable visitor experience. Proposed and enacted strategies include:

- the banning of cruise ships, which until late 2021 decanted thousands of tourists into the city each day (see Figure 3.5.15)
- the designation of the lagoon as a national monument by the Italian government, a move designed to protect its fragile ecosystem
- strategies to boost the number of permanent residents by 12 000 and new jobs by 20 000. Keys to this initiative are increasing the number of long-term rental apartments, incentives for new commercial start-ups and greater controls over land-use zoning to protect Venetian artisans
- policies aimed at controlling arrivals of daytrippers. This includes the imposition of a daytripper tax on visitors who sleep elsewhere—80 per cent of all tourists. Daytrippers will be required to pre-book their visits. The entry ticket will cost between €3 to €10 depending on the season. It's proposed that the profits from the entry fees will go towards services that benefit Venice's residents, including maintenance, cleaning and reducing living costs
- the promotion of Venice as a place of education with tourist apartments housing students instead of tourists, thus bringing new energy to the city

The central questions for analysis are, will the measures implemented and/or planned reduce crowding, reverse the city's population decline and enhance its liveability? Will these measures assist the tourism industry in the city to become sustainable?

Did you know?

In 2019, the Italian government approved the Venice municipal government's proposal for the introduction of an entrance contribution fee of €5 for daytrippers. The fee is aimed at better managing the crowds that visit the city.

With its implementation delayed by the pandemic, authorities plan to trial the initiative in the spring of 2024. Daytrippers will need to register on a soon-to-be-launched portal and pay the €5 fee. The portal will generate a downloadable QR code that will certify that the fee has been paid and it will be enforced by local authorities, who will randomly check people and ask to see the code. During the trial, people will also be allowed to pay on the spot if they are found not to have the code. Those visitors staying one of more nights in the city will not be required to pay the fee.

3.5.15 A cruise ship traversing Venice's canale della Giudecca, dwarfing the city's landmarks

Activities

Acquiring and processing geographical understanding

1. Study the Case study: Venice and its quest for sustainable tourism.
2. Outline the principal challenges impacting the sustainability of tourism in Venice.
3. What have been the impacts of overcrowding?
4. Why are daytrippers and cruise ships of particular concern?
5. What are the socio-economic challenges facing Venice? What strategies are being implemented to mitigate the impacts of excessive tourism?
6. What are the environmental challenges facing Venice? What strategies are being implemented to mitigate the impacts of excessive tourism?

Applying and communicating geographical understanding

7. Critically assess the strategies being implemented. Are they likely to be effective? What alternatives are there?
8. Use the sustainability analysis checklist in Figure 3.5.10, on page 71, and any additional investigations you have undertaken on the tourism-related challenges facing Venice to critically assess the strategies being implemented to address the social and environmental impacts of tourism in Venice. What else could be done?
9. Investigate an example other than Venice of the environmental and/or social impacts of global tourism and critically assess the strategies being used to promote sustainability. Present your findings as an oral report.

CHAPTER

4 Global winemaking and its sustainability

Wine has been produced and consumed for thousands of years. Indeed, wine has been firmly established at the very heart of civilisation since ancient times. Wine became a reflection of the lands and cultures of Europe, intrinsically woven into everyday life. So as Europeans ventured into the New World on their voyages of exploration and quest for colonisation, they carried vines with them. Subsequently, the tradition and culture of winemaking spread to the Americas, Australia, New Zealand and South Africa.

Today, the winemaking industry is global in its character and extent. More than ever, wine is consumed throughout the world as a celebratory drink and an accompaniment to food. Wine continues to fascinate, as unlike any other beverage it is linked to the land, the people and the culture that crafted it. It has become an established part of global culture.

Winemaking is a lucrative economic activity, and it has become a fiercely competitive one. The traditional dominance of Europe's longer-established wine regions is being challenged by well-marketed, quality wines from New World countries such as Australia and Chile.

This chapter investigates the global economic activity of winemaking and its sustainability, through an exploration of its nature, spatial patterns, the biophysical, economic, technological, political and organisational influences on the industry, and its current trends and future directions.

> **Wine is bottled poetry.**
>
> **Robert Louis Stevenson, Scottish writer**

4.0.1 Rows of grapevines in Montagne de Reims, part of the Champagne wine region, France

Chapter glossary

appellation a wine or food classification system based on geographical location

aspect the direction a slope faces

blended wines created by combining or mixing varietals from different vineyards to achieve a consistent quality

budburst the first sign of the annual growth of the grapevine in spring

cloning where an exact genetic replica of another organism is made

estate wine quality wine made in small quantities from a single vineyard

fermentation the process whereby yeast converts sugars into alcohol

marketed a product that has had a the set of techniques used on it to attract and persuade consumers to buy it

Mediterranean climate a climate with wet winters that provide subsoil moisture for early spring growth and hot, dry, sunny summers that promote ripening

microclimate the climate within a small, defined area (different from the area directly surrounding this area) that can dramatically affect the character of the wine produced there

New World wines wines from the New World countries, particularly Australia, New Zealand and the Americas

oenology the science and study of winemaking

Old World wines wines from Europe

pruned where grape canes have been cut back in winter when the vines are dormant, to promote new growth in the spring

rootstock a base plant of a different species of grape, onto which a wine grape cutting is grafted; this practice can increase the hardiness and pest and disease resistance of the vines

sustainable viticulture grape growing and wine production that embraces the principles of ecological sustainability

terroir a French term that describes the site-specific differences in wine that result from factors such as soil types, drainage, local microclimate and sun exposure

vintage the year in which the grapes for a given wine were harvested

viticulturalists agriculturalists that manage vineyards where grapes are grown

viticulture the cultivation and harvesting of grapes, especially for use in the production of wine

Vitis vinifera the most commonly used grape species in winemaking

winemaking the production of wine via the crushing and fermentation of grapes

UNIT 4.1

The nature and spatial patterns of global winemaking

4.1.1 *Vitis vinifera*: *vitis* meaning to twist, the vines cling and climb as their tendrils curl around the wires on trellises; *vinifera* meaning wine bearing

The global wine industry involves two distinct activities: **viticulture** (the cultivation and harvesting of grapes, which occurs in a vineyard) and **winemaking** (the production of an alcoholic beverage via the crushing and **fermentation** of grapes, which occurs in a winery). **Viticulturalists** work closely with winemakers because vineyard management, and the resulting grape characteristics, provide the distinctive product with which the winemaker must work.

The winemaking grape

Wine is produced from the juice of grapes which grow on vines. The grape species ***Vitis vinifera*** is the most commonly used species in winemaking (see Figure 4.1.1). There are 1000 grape varieties that are used to make wine. They are selected based on the desired wine characteristics and the location of the vineyard. These characteristics can be optimised by the right growing conditions, so that the chardonnays from Burgundy, France, are considered superior, as are the semillons from the Hunter Valley, Australia. Another factor that determines the quality of wine is the huge array of production techniques from across different regions and countries. Such considerations result in the great range of wines created by the global wine industry.

Viticulture

It can take up to five years for a grapevine to develop and produce its first crop. **Budburst** is the first sign of the annual growth of the vine in spring. The buds swell and open, allowing the new green shoots to break through. As the vine grows, the canes are trained along trellises to promote the development and ripening of the grapes. Grapes are harvested when ripe in mid- to late summer. The vines are **pruned** during winter when they lay dormant.

4.1.2 Grape juice is clear. Red wines gain their colour from contact with grape skins during fermentation.

Winemaking

A winery may be adjacent to the vineyard where the grapes are grown, or it may be in a separate state, or even another country. In New World countries, such as Australia, grapes from one region are often **blended** with those from another. This creates a wine dominated by varietal characteristics, for example, a chardonnay may be made with grapes from Coonawarra, South Australia, and the Yarra Valley, Victoria. In Old World countries, such as France, the best quality wines are usually made from grapes grown in a single vineyard.

Winemaking involves several distinct stages. After being harvested, the grapes are crushed and allowed to ferment (see Figure 4.1.2). This primary fermentation stage lasts about a week, during which time yeast converts most of the sugars in the grape juice into alcohol. In the next stage, the liquid is transferred into vessels for the secondary fermentation. Here, the remaining sugars are slowly converted into alcohol and the wine is filtered or 'cleared'. Some wine is then aged in oak barrels (which gives the wine a distinctive taste) before bottling, while others are bottled directly. The time from harvest to drinking can vary from a few months to many years. Most wine is now produced for consumption one to three years after the harvest.

This is not, however, the end of the production chain. Wines must be **marketed**, just like any other product. This final stage often determines the commercial success of the company producing the wine.

SPOTLIGHT

All you need is a healthy bunch of grapes

Wine has the advantage of being a mono-ingredient product—all you need to make wine is a healthy bunch of grapes. If the bunch is healthy, it does not require any other components. Any interventions are best described as 'corrections'. To intervene as little as possible, it is necessary to draw on generations of knowledge, at all levels, including soil and its microbiology, plant physiology and vineyard management. This knowledge is **oenology**—the science of wine and winemaking.

Estate versus blended wines

Wine can be made in many different styles and at many different quality levels. Techniques in the wine industry are now so advanced that a winemaker can create almost whatever they choose, using the right grapes.

A few dozen bottles of carefully crafted prestige **estate wine** can be made from a single top-quality vineyard, or skilfully blended from many vineyards in greater, more commercial quantities (see Figure 4.1.3).

Estate wines	Blended wines
■ These wines are a true reflection of their land and culture. ■ Made on a smaller scale, these wines are more difficult to obtain and can be significantly more expensive than standard wines. ■ These are wines that evoke passionate discussion, fervent opinions and genuine loyalty. ■ They are also the wines that undergo miraculous flavour transformations when laid down to age for a few years.	■ Many of these blended wines have become world brands. ■ The reputation of branded wines is to make each batch and each **vintage** the same as the last. For these wines, reliability comes first. ■ As they are made in bulk, they are more affordable and widely available.

4.1.3 Estate and blended wines

Did you know?

The Wine Intelligence Global Wine Brand Power Index 2022 reported that Australia's Yellow Tail is the world's most powerful wine brand, with Chile's Casillero del Diablo coming second. The index is designed around measurements of awareness, purchasing and connectivity.

A history of wine

Modern grapevines originated as wild vines. Winemaking started around 7000 years ago. Ancient Greek and Roman civilisations celebrated with wine, bringing it firmly into the Mediterranean way of life. The Greeks and Romans introduced grape growing and winemaking to the rest of Europe. As the Roman Empire expanded across Europe, so too did the growing of grapes and the production of wine. All the major wine-producing regions of Western Europe, including the Mosel and Rhine valleys of France and Germany, and the Danube Valley in Austria, were established by the Romans. When the Roman Empire fell, around 500 CE, Europe descended into a period of conflict known as the Dark Ages. The Catholic Church protected grape growing and winemaking expertise during this time (see Figure 4.1.4).

4.1.4 Wine became an important part of the Christian religion, with European monasteries doing much to improve winemaking techniques.

Viticulture then spread from Europe to the Americas, Australia, New Zealand and South Africa This commenced during the Age of Exploration from the early fifteenth century and continued during the period of colonialism, which extended to the first half of the twentieth century. Today, wine is produced on every continent, except Antarctica.

Did you know?

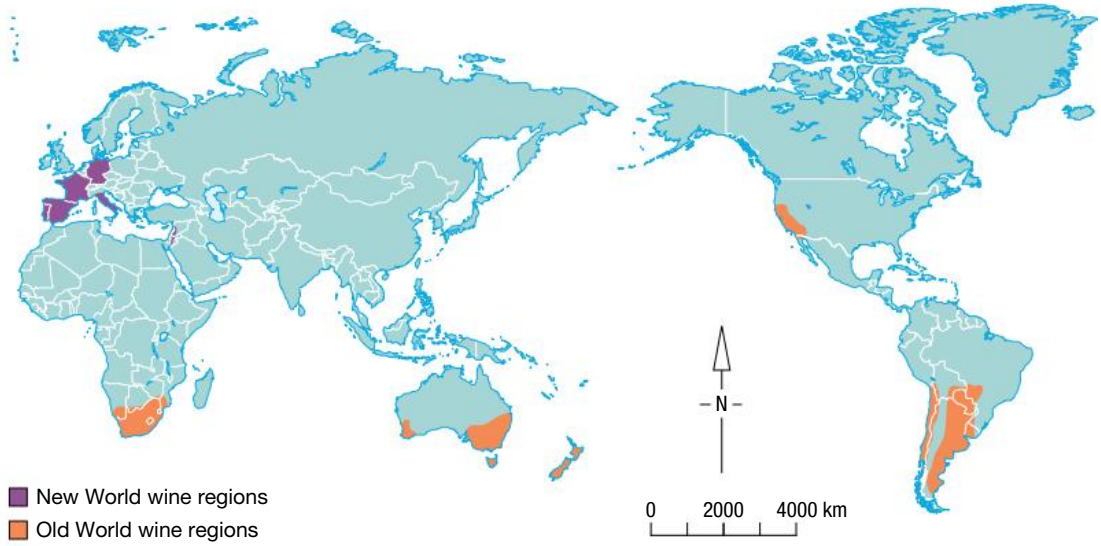
When Europeans ventured into the New World, their religion and their vine cuttings went with them. Wine was part of their religious tradition and daily life for quenching thirst. At that time, wine was often cleaner and safer to drink than water.

Spatial distribution of viticultural and winemaking

As with any agriculture, viticulture is reliant on its environment. Most major grape-growing regions in the world are located between 30° and 50° north and south of the equator. The most suitable climate is a **Mediterranean climate** with mean temperatures between 10°C and 20°C and rainfall of 700 millimetres per annum, with most rain falling in winter. The wet winter provides subsoil moisture for early spring growth and the hot, dry, sunny summers promote ripening.

Old and New World wines

Given the long history of viticulture and winemaking in the Mediterranean region, Europe has historically dominated wine production. Some of the world's most famous wine regions are found in Europe, including Tuscany, Italy; Bordeaux, France; La Rioja, Spain; the Douro Valley, Portugal; and Mosel, Germany, and are known as Old World producers (see Figure 4.1.5). Their wines are considered sophisticated and reflect the local **terroir**. Terroir describes the entire environment in which the vine grows—a unique combination of climate, topography and soil type that shapes the character of the grapes on the vines.



4.1.5 Old and New World wine regions

Old World winemakers rely heavily on tradition with little intervention in altering the wine. This tradition is so deeply entrenched that strict regulations are in place governing what takes place in the vineyard and the winery, to protect the exclusivity of **Old World wines** (see Figure 4.1.6). Wines are labelled by their place of production claiming their exclusivity.

New World wine producers are found outside the traditional wine-producing regions of Europe. As the Mediterranean climate also occurs in southern and south-western Australia, Central Chile, coastal California and the Western Cape of South Africa, viticulture has also been established in these places (see Figure 4.1.7). Many of these countries were colonised by the Old World winemaking nations.

New World producers are not bound by regulations and tradition, so they have been able to manipulate undesirable qualities of the biophysical environment and have developed innovative winemaking practices. They are now recognised for producing some of the boldest, most interesting and elegant wines in the world.

New World wines are commonly labelled by their varietal (e.g. riesling, chardonnay, merlot) and marketed for their consistency. Many have moved into bulk wine production with mechanical harvesting of grapes and modern super-wineries churning out millions of bottles a day.

4.1.6 Vineyards in Carcassonne, France

4.1.7 Vineyards of the Cape Winelands, near Stellenbosch, South Africa

4.1.8 Vineyards in the Ningxia region on the edge of the Gobi Desert, China

Did you know?

Within a few decades, the edge of the Gobi Desert has been transformed, as vineyards have been extended, irrigated with water from the Yellow River (see Figure 4.1.8). Located between 37° and 39° north, it is within the 'golden zone' for growing quality wine grapes, in terms of temperature requirements.

Activities:

Acquiring and processing geographical information

1 Distinguish between the activities of viticulture and winemaking.

2 How did winemaking begin in Europe?

3 Describe the spread of grape cultivation into the New World.

4 Explain the link between viticulture and wine quality.

5 Outline the distinct stages in winemaking.

6 Describe the world's most famous wine-growing regions.

7 Demonstrate how the use of technology varies between Old World and New World producers.

Applying and communicating geographical understanding

8 Study the text under the heading Estate versus blended wines and Figure 4.1.3. Conduct a class discussion on the qualities of each type of wine and which is likely to become more favoured by consumers in the future.

9 Study Figures 4.1.6, 4.1.7 and 4.1.8. Compare the environment of each region and account for any differences or similarities.

UNIT 4.2

Factors influencing global winemaking

Viticulture is a sophisticated and complex economic activity because it is the product of the interrelationships between the many factors influencing it. The industry depends on both biophysical and economic factors because if grapes cannot be grown then there can be no winemaking, and if the wine cannot be sold then there is no point in harvesting the grapes. In the competitive global market, technological and organisational factors are also increasingly influential.

Biophysical factors

The combination of biophysical factors determines whether grapes can be successfully grown, and if so, what character the wine produced will have. In contrast to other crops, grapes can be grown in diverse climates and soils. The same vine species planted in different regions can produce quite different wines, due to terroir.

Climate

Climate determines the length of the grape-growing season, the rate of plant growth and the quantity and quality of the fruit. The Mediterranean climate is ideal for growing wine grapes. Within the range of suitable climates, particular varietals will flourish in specific climates. The ideal average temperature is 19°C for white grapes and 21°C for red grapes.

Vines generally need an average rainfall of approximately 700 millimetres a year. A reliable supply of water is, therefore, crucial to the viability of vines. Although scientifically unproven, environmental stress is believed to enhance the sensory characteristics of the grapes, which may result in a better vintage. In a drought, the vines will produce smaller berries, concentrating their flavour. When heavy rainfall occurs, especially if accompanied by hail in summer storms, the leaves can be shredded, and ripening fruit stripped from the vines. Hot humid weather that follows such rain events is conducive to fungal diseases, such as powdery mildew, infecting grapes.

Soils

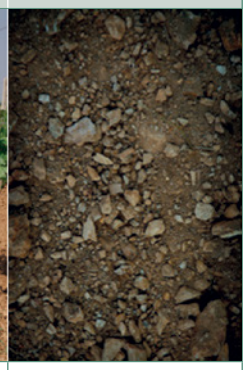
Soil characteristics are a major biophysical factor affecting global viticulture. In fact, many Old World producers regard soil as paramount in determining wine quality, as terroir is the greatest contributor to the art of winemaking. They hold that it is the mineral composition and organic content of the soil that nourishes vines and determines the flavour of the wine. New World producers can manipulate soils with the addition of fertilisers to boost nutrient content if necessary. So, they consider soil structure and texture more influential in determining the quality of wine that comes from a vineyard. These soil properties determine the water-holding capacity of a soil and its ability to retain heat.

The nature of a soil depends on several factors, including the parent material and the physical, chemical and biological processes of weathering. The composition of the parent material (e.g. granite, limestone or slate) will influence the properties of the soil and thus the character of the wine (see Figure 4.2.1).

Soils suitable for viticulture, particularly the growing of premium quality grapes, are generally not fertile nor especially deep. In bulk wine production, a deeper soil structure is considered beneficial as it can hold water reserves. However, a shallower and drier soil is generally better for producing quality wines.

Did you know?

The earliest known reference to terroir is in the medieval writings of the Cistercian monks of Burgundy. The monks tasted the dirt to understand its influence on wine production.

Limestone	Granite	Slate	Clay	Loam	Gravel
					
Limestone produces soils that are not very fertile, which limits the vigour of vines and produces grapes packed with flavour. The limestone base of the Chalone Vineyard in California, USA, produces quality chardonnay.	Granite produces acidic crystalline soils. Granite country suits the syrah (shiraz) grape and has made Hermitage in northern Rhône, France, famous for its wine.	Soil derived from slate retains heat and drains well. It also adds flavour and mineral character to a wine. The cool climate wine region of the Mosel Valley, in Germany has dark mineral-rich slate soil, which is an ideal growing medium for riesling.	Clay soils tend to stay cooler and retain water, which is advantageous in hot, dry regions. These soils are renowned for producing the boldest red wines. The great shiraz vineyards of the Barossa Valley, in South Australia, are found on clay soils.	Loam is equal parts clay, sand and silt, as well as humus (organic matter). It is very fertile, resulting in vine growth being overvigorous. The wines from these vineyards often lack flavour and colour, unless the vines are heavily pruned. The Napa Valley, California, USA, has sandy loam soil, and it is the sand content that keeps the soil poor enough to produce quality wines.	Gravel soils are warm and drain easily, which is beneficial in cool, wet regions. Cabernet sauvignon is a late ripening grape and in Bordeaux, France, it is grown on the top or south-facing slopes where gravel is dominant.

4.2.1 Typical soil types suitable for viticulture

Topography

The elevation, **aspect** and incline of the slope in a vineyard must all be considered. Many vineyards are located on undulating to steeply sloping land, which helps to prevent erosion. This is evident in the Mosel Valley in Germany (see Figure 4.2.2). Over 2000 years ago the suitability of the unique geology (slate), topography, aspect and **microclimate** for grape growing was recognised and plantings commenced on the south-facing steep slopes of the river valley. Since the late nineteenth century, riesling has been the predominant grape variety that has given the Mosel Valley region prominence.

The direction the vines are facing on the slope, the slope's aspect, can also affect the growth rate and the quality of the fruit produced. A slope can provide shelter or warmth and can affect drainage patterns. In the Southern Hemisphere, a north-facing slope is favoured in cooler climates and vice versa in warmer climates. The opposite holds for the Northern Hemisphere.

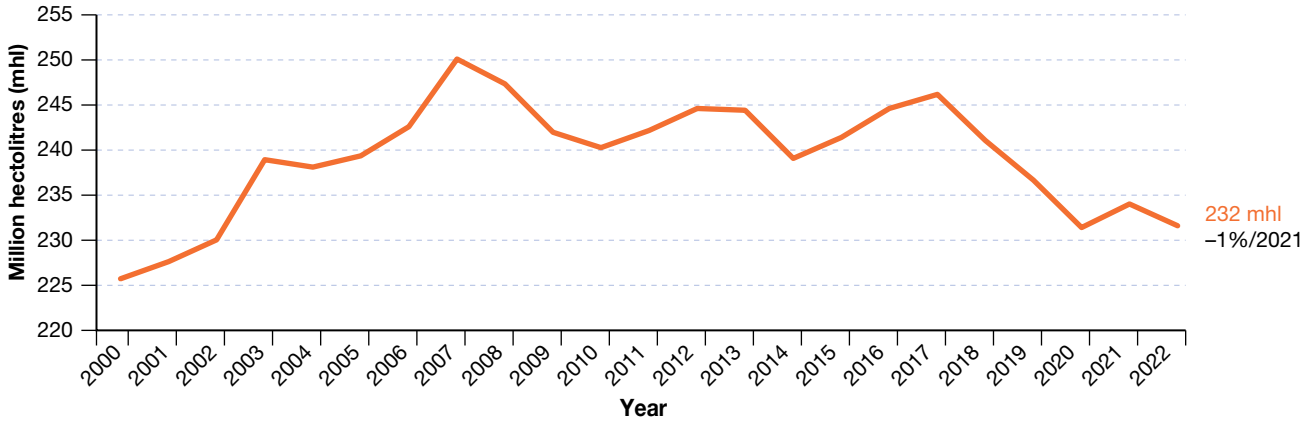
4.2.2 The vineyards along the sides of the Mosel Valley represent the largest continuous steep-slope viticulture in the world.

Economic factors

Wine was one of the first products to be traded in early civilisations. Then, as now, the most successful wine producers were those who grasped the economic factors: the market forces of supply and demand, and whose wine met the prevailing expectations of those purchasing it.

Demand: The amount of wine consumed

Global per capita wine consumption has been declining for nearly two decades (see Figure 4.2.3). Much of the decline can be linked to the French and Italians, whose wine consumption went down in 2022 to 47.4 and 44.4 litres respectively, from 73 and 62 litres in 1990. The tradition of farm and factory workers having wine with lunch and dinner is fading. Generations have changed and drink-driving laws and occupational safety regulations have become stricter. Europeans are drinking less, but they are drinking better quality wine.



4.2.3 Global wine consumption, 2022

In most places outside Europe, wine-drinking has only established itself as part of the social experience since the 1970s. The combined effects of increasing affluence and an interest in wine in countries such as the United States and Australia, have established wine drinking as part of social events. Americans are drinking more wine than ever, and the United States has established itself as the top wine-consuming country in the world.

Consumption of wine in Asia has been increasing for some time, with China leading the increase globally since 2010. The level and rate of income growth in the emerging middle class of China has been accompanied by a westernisation of culture and the prestige of giving expensive wine as a gift. The International Organisation of Vine and Wine (*Organisation Internationale de la Vigne et du Vin*—OIV) attributes much of the downward trend in global wine consumption since 2018 to falling demand in China. The volume of wine consumed in China dropped when COVID-19 lockdowns were imposed, with social interactions curtailed and traditional gifting events, such as Lunar New Year, cancelled. This was mirrored around the world, as people's incomes dropped during the COVID-19 crisis. At the same time, there were disruptions to global supply chains, leading to a spike in costs in production and distribution, which increased wine prices.

There is also increasing competition from other alcoholic beverages, which appeal to younger drinkers. Craft beers, cider and spirits such whisky and gin, which are handcrafted by small producers, are increasingly sought after. RTDs, or ready-to-drink beverages, have increased their market share since 2018. Consumers enjoy the convenience of pre-made cocktails, spirits and spritzes. There is also increasing competition from low- and non-alcoholic wines.

● **SPOTLIGHT**

No- or low-alcohol wines—threat or opportunity?

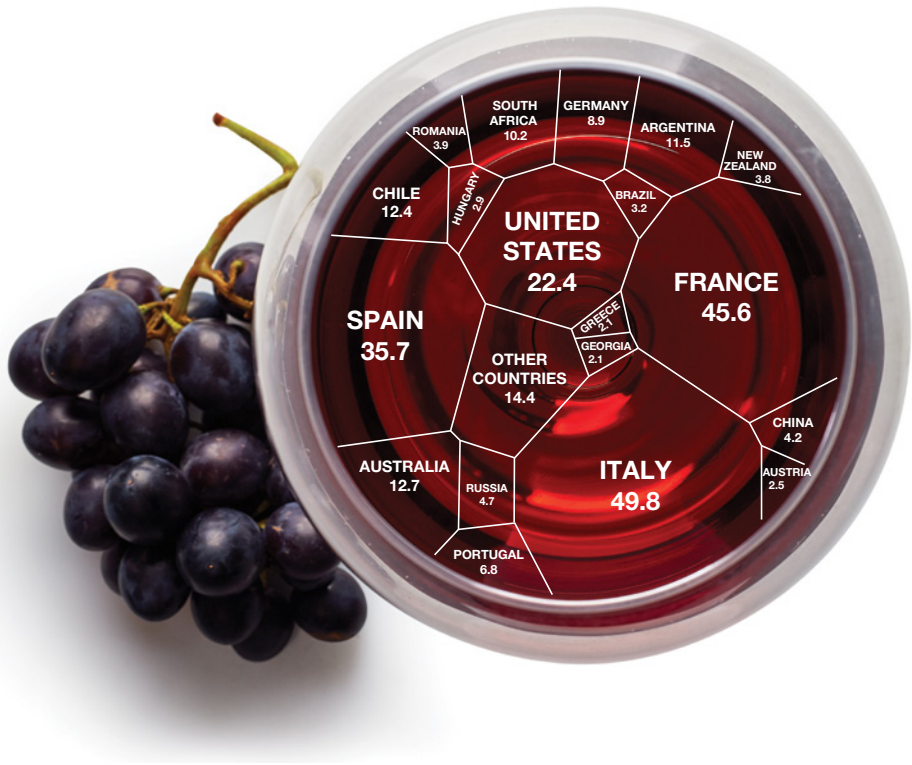
First it was beer, now wines with a lowered or no alcohol content proving to be increasingly popular with health-conscious consumers. As such, they represent a disrupting influence within the industry. France is one of the fastest-growing markets in the global alcohol-free drinks boom. The rush of start-ups creating alcohol-free spirits, wines, cocktails and beers marks a departure in a country with a vast alcohol industry. In Australia, the trend is most evident on the shelves of our local supermarkets. Banned from selling alcoholic beverages, supermarkets now devote greater shelf space to non-alcoholic wines, beers and mocktails.

Supply: the amount of wine produced

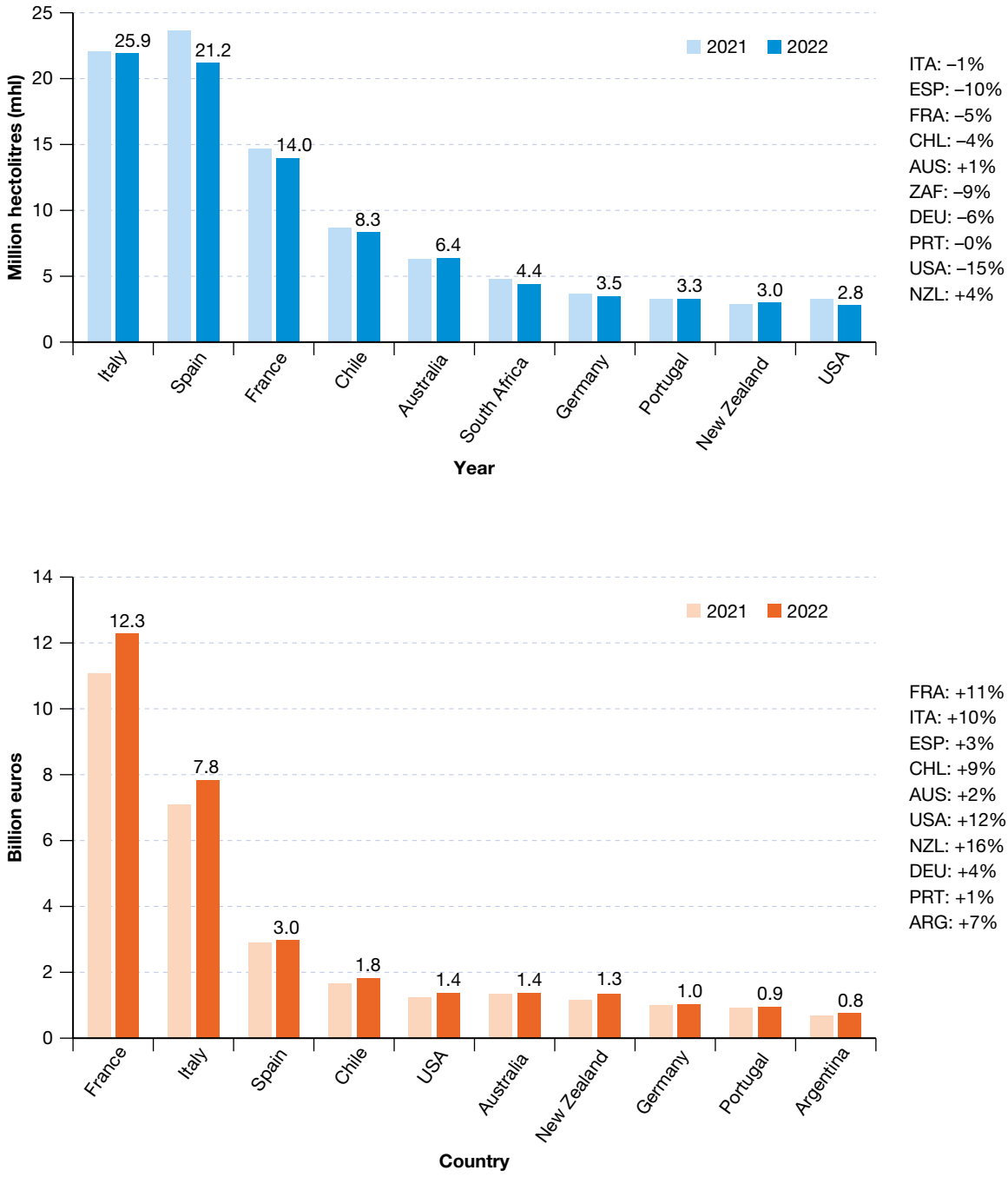
Historically the Old World has dominated wine production. Over the last 20 years, trends in the global wine market have clearly reflected the imbalances between supply and demand. Global production of wine has continued to exceed consumption, leading to a wine glut that has subsequently driven down prices. There was a global oversupply of wine after 2004 when production peaked at 298 million hectolitres (mhL) (see Figure 4.2.4). It prompted a downward trend in production, particularly in the main wine-producing countries of the Old World.

Of the top 10 wine-producing countries in the world, the most sustained increase in production has occurred in Argentina, China, South Africa and Chile. The Old World's dominance of the global wine industry risks being challenged by well-marketed, consistent quality wine from these New World countries, whose share of global production and exports is soaring.

The growth of international trade is just one aspect of the complex evolution of the global viticulture and winemaking industry. Of all commodities traded, wine possesses among the greatest variations in price, and its markets are as varied as the wine varieties themselves. With the global oversupply of wine, this industry has become fiercely competitive. The main exporters of wine are shown in Figure 4.2.5.



4.2.4 Global wine production over time and global wine producers in 2022 per billion hectolitres.



4.2.5 The top 10 wine exporters by volume and value, 2022

Technological factors

Technology is the main area of contention between Old and New World producers, as it represents widely different philosophies. New World producers often use technology to overcome or manipulate undesirable biophysical constraints. If there is a rainfall deficit, viticulturists will apply irrigation water. Machinery is also used to harvest the grapes, thereby cutting costs and prices. Likewise, many innovative practices have been developed in winemaking, such as large stainless-steel vats that moderate temperatures to enable wines to undergo a controlled fermentation.

Spatial technologies

Geospatial technologies, such as geographic information systems (GIS), assist in site selection of a vineyard in terms of microclimate variables, slope, aspect, soil drainage and composition. Advanced technologies, such as drones and sensors, are used to collect environmental data in the vineyard (see Figure 4.2.6).

4.2.6 Smart farming and precision agriculture using drones to spray a vineyard. They can be used at night when the air is still, and spray drift is less likely.

Water storage and management

Irrigation technologies use soil moisture probes to monitor water availability to the vines and automatically adjust the output irrigation systems. Drip irrigation is widely used in Northern Californian vineyards, and careful monitoring of these systems can yield significant water savings.

Biotechnology

Geneticists are directing their efforts to gene mapping and genomics, to develop *Vitus vinifera* grapes that do not need pesticides and have more resistant **rootstock**. **Cloning** is used to achieve consistent grape quality. A cloned plant is an exact genetic replica of another organism. Sensory scientists are joining forces with neurobiologists to develop wines that enhance the health benefits of wine.

Transportation and communication technologies

In the competitive global market, new technologies enable more efficient distribution of wine to the point of sale and assist producers in maintaining the consistency of their product. Databases are used to meticulously record every aspect of a wine's production from the vineyard to the point of sale, such as weather conditions and how the wine was blended and stored. Such systems will enable winemakers to track and reproduce high quality wine.

SPOTLIGHT

Digital trends in the wine and vine sector

In the final stages of the supply chain, the use of robots is common in many warehouses. For some logistics centres, this technology helps to efficiently track inventory within many warehouses in different locations, which increases productivity at the distribution stage. Through smart storage—the automation of warehouses through robotics and artificial intelligence (AI), and smart shops—the final stage of the wine lifecycle is improved. Distribution and sales are more efficient due to time savings and automation, making tasks run autonomously through integration with AI. Inventory (stock) control can also be improved with digital tools. Digital labels can help to simplify traceability, enhance sustainability initiatives and seek consumer engagement.

Political and organisational factors

Traditionally, the very nature of the viticulture and winemaking industry made it a fragmented industry. Historically, it was dominated by small, often family-owned and operated estate-based enterprises. This remains common in Europe today. Italy has over one million growers and there are over 12 000 producers in Bordeaux, France. Generations of winemakers have built the reputations of the various regions of France.

The nature of ownership and control in the global wine industry has been changing over recent decades. Through corporate takeovers and mergers, globalisation has led to the emergence of large, international wine corporations, particularly in the New World. Constellation Wines, a division of the New York-based Constellation Brands, is the world's largest wine business. In 2022, it had 10 700 employees and more than 120 wine brands.

International trade and politics

With the global oversupply of wine, the industry has become fiercely competitive. National governments often assist their own producers by providing financial support in the form of subsidies, or protect them from overseas competition by imposing tariffs and quotas.

The World Trade Organization (WTO) has promoted trade liberalisation, with the removal or reduction of barriers or restrictions on free exchange of wine between countries. Nations seek trade agreements with other countries, giving them favoured trading status. The Australian Government has secured free trade agreements with Japan, Korea, the United States and China. However, politics is fickle and in 2021 the Chinese Government imposed tariffs of up to 212 per cent on Australian wine imports. This punitive measure was the result of a diplomatic dispute over the investigation into the origins of COVID-19, which escalated into a trade war. This effectively slashed the $1.2 billion trade by 99 per cent. The Chinese wine trade recommenced in 2024 when the Chinese government lifted tariffs.

Did you know?

The term **appellation** d'origine contrôlée (AOC) means 'controlled designation of origin'. The AOC seal was created in 1950 to guarantee that wine produced in a designated geographical region used vines and traditional production methods and met a rigorous set of clearly defined standards. This certification process is based on the concept of terroir. There are currently over 300 French wines authorised to have an AOC designation on their label.

Organisation of Vine and Wine

The institutional or regulatory framework in which the industry operates includes a variety of intergovernmental organisations and government agencies. At a global scale, the OIV is the peak international wine industry body. This Paris-based organisation was established in 1927 and has 47 members, including almost all the world's major wine-producing and wine-consuming countries. The OIV makes recommendations on viticulture, winemaking and other regulatory matters that form the basis of wine-related laws in many countries.

Activities

Acquiring and processing geographical information

1 Summarise the ways in which the various elements of climate impact viticulture and the style of wine produced.

2 Explain the relationship between soils and the quality and character of wine produced.

3 Describe the ways in which topography influences the growth of grapes and the character of wine.

4 Describe and account for the changing amount of wine consumed in the last two decades.

5 Explain how wine producers in both the Old World and New World have responded to changing consumption levels.

6 Identify the differing attitudes towards technology held by Old World and New World producers.

7 Give examples of how new technologies are transforming the wine industry.

8 Describe the nature of ownership and control of the viticulture and winemaking industry.

Applying and communicating geographical understanding

9 Conduct a class discussion on the topic, 'The best quality wine comes from a region with deep, fertile soils and high rainfall'.

10 Study Figure 4.2.2. Explain the suitability of the steep slopes of the Mosel Valley in Germany for viticulture.

11 Study Figure 4.2.3. Describe the trend in wine consumption since 2007.

12 Study Figure 4.2.4. Calculate the percentage share of both Old World and New World wine production.

13 Study Figure 4.2.5. Compare the rankings of Italy, France and Spain for both the volume and value of wine produced in 2021 and 2022.

UNIT 4.3

Current trends and future directions in global winemaking

As with any economic activity, the wine industry is dependent on the global economic situation, which has been quite volatile in the last decade and worsened by the COVID-19 pandemic. Several challenges continue to arise related to high inflation, the energy crisis caused by Russia's invasion of Ukraine and supply-chain disruptions that have significantly disrupted sea freight. While winemakers must contend with such economic forces, which are out of their control, one of their greatest challenges is global warming. In time, this may well bring about the most significant changes of all and alter the global map of viticulture.

A competitive market

Uncertainty promotes fierce competition between suppliers. While the decline in Old World production has eased, New World producers, especially Chile, New Zealand and South Africa, are experiencing substantial growth. This is expected to continue, along with their reputations as suppliers of quality wines. The big players will continue to focus on high-end quality wines. While the volume of wine exports has dropped because of supply chain problems, the value of wine exports reached a record high of $41 billion in 2022 due to much higher prices, and this is expected to continue.

China is no longer considered likely to become a top wine-consuming nation of high-quality wine. Since 2018, China's consumption has dropped on average two million hectolitres each year. There are other rising players in the market though, with the OIV predicting that the strongest surge in consumption will be in India. Admittedly, the country is starting from a very low base.

Climate change

According to estimates by the IPCC, temperatures will increase between 2°C and 2.5°C by the end of the century, with the worst-case scenario an increase of 3°C to 3.5°C. While rising surface temperatures are significant, global warming is expected to shift major climate belts and this will impact viticulture. Depending on the region and the amount of change, this may have positive or negative implications on wine yields.

With temperatures increasing worldwide, many regions will become exposed to water deficits more frequently, which will lower yields by reducing budburst, vine growth and the flowering that produces grapes. These processes are also temperature-dependent. If grapes ripen too quickly, they don't develop flavour and may even shrivel on the vine in the heat (see Figure 4.3.1).

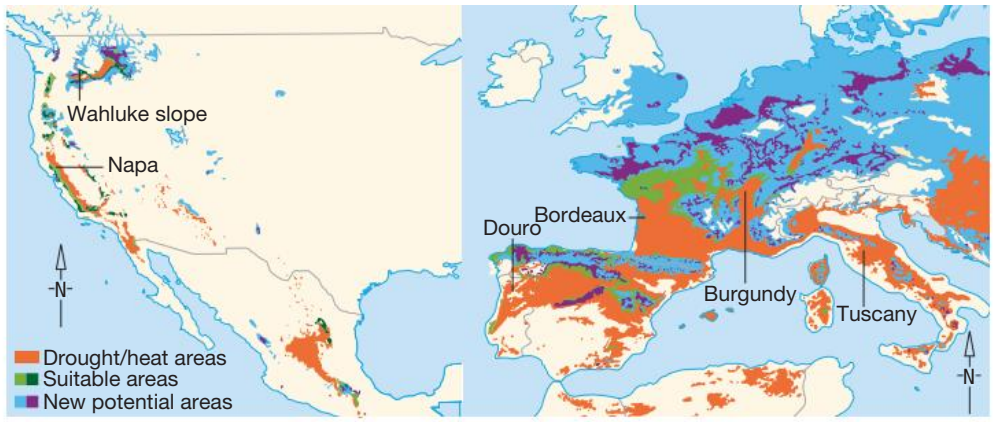
Other regions, especially those sitting in the higher latitudes or at higher elevations, will probably benefit from a milder climate and new varietals may become viable. In some cases, grapes may be able to be grown in these areas for the first time. So, region by region, climate change could shift wine production, especially in terms of grape selection and wine types produced. Red grapes handle the heat much better, so producers of white wine are being forced to look towards higher latitudes and altitudes, where conditions are more suitable for white grapes.

Premium grapes suitable for winemaking are grown within narrow climate ranges. To gain optimum productivity and quality for some individual varieties, such as pinot noir, this range is even narrower as it is most suited to cooler climates, such as the Burgundy region of France. Gradually increasing temperatures will lead premium wine-grape growing regions to shift poleward. It is estimated that the northern boundary of European viticulture will shift north 20 to 60 kilometres per decade between 2020 and 2050. Globally there will be winners and losers. Viticulture may become viable in climates that were previously too cold, whereas warm climates heating up may result in conditions that no longer suit *Vitis vinifera* (see Figures 4.3.2 and 4.3.3).

4.3.1 Heat stress can damage vines and cause their grapes to shrivel.

Did you know?

Unlike most other crops, grapevines retain 'memories' of past weather events. New grapevine shoots begin to grow in buds in the year before budburst occurs. If an early autumn frost, strong winds or hailstones damage the buds, the vines will not produce as many grapes the in next season, which may lower a vineyard's yield.



4.3.2 The changing map of the world's wine-producing region

EUROPE

Winners

- England was once not considered suitable for viticulture, but in recent years the number of vineyards has grown to over 300. The South Downs region now has weather like the Chamtpagne region of France, with the added advantage of sitting on chalky, clay soils. In the future, it could well become a renowned producer of sparkling wine.
- Denmark is an emerging wine producer due to a milder climate that now makes viticulture possible. There are now 1400 wine growers, of which 80 are commercial producers.

Losers

- Large sections of Mediterranean-bordering countries, especially wine-producing areas of Greece, Italy and France, may become completely inhospitable to viticulture by 2050 due to rising global temperatures.
- Burgundy is famous for its pinot noir, but the variety is beginning to lose its viability in the region due to rising temperatures.
- Soaring temperatures and less rain in Spain's interior may render it unsuitable for viticulture.
- Italy's Tuscany region is already finding that grapes are ripening far too early, forcing a change to different grape varieties.

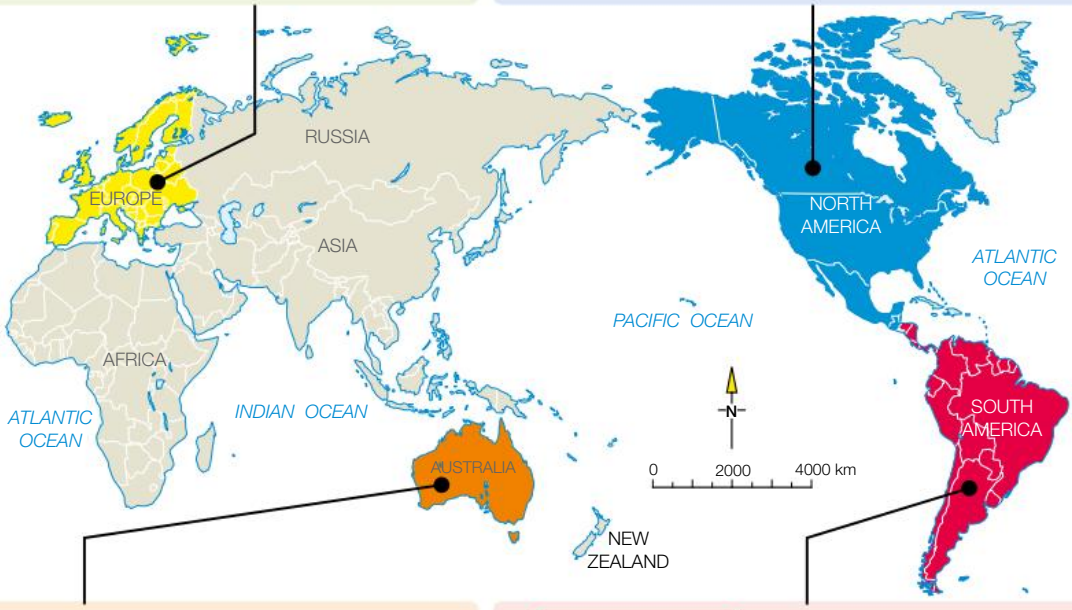
NORTH AMERICA

Winners

- Wine-producing regions located in the cooler climates of the northwest states, such as Washington, Oregon and British Columbia, could result in a move awayfrom white to red varietals.
- The northern states of Montana, Wyoming and Michigan will benefit from warming conditions. In Michigan, for example, wine production has scaled up as the climate has warmed. The number of wineries has increased from 16 to 130 in the last decade.

Losers

- Scientists predict that with warming temperatures, it is possible that by 2100, the United States could lose up to 81 per cent of its premium wine grape acreage. California would be hardest hit and a reduction in fresh water supply over the next 50 years may result in an enormous loss of land suitable for premium viticulture, especially in the Napa and Santa Barbara counties. Only the better watered narrow coastal bands and cooler the Sierra Nevada may remain suitable for viticulture.



AUSTRALIA

Winners

- Wine producers in Tasmania will become more competitive with their weather benefiting from climate change. They are already offering quality dry rieslings and sauvignon blancs.
- With vineyards sitting up to 1100 metres above sea level, the cool climate region of Orange, NSW, is well placed to continue the successful production of wines such as chardonnay, merlot and pinot noir.

Losers

- A study by the University of Adelaide concluded that by 2060, South Australia ought to experience an increase in temperatures by 2°C and a 30% decrease in available fresh water. To continue production, viticulturalists may have to switch to varietals that suit hot, dry conditions.
- The Hunter Valley is already at the northernmost limit for growing quality semillon. Any further warming will mean switching to red varietals.

SOUTH AMERICA

Winners

- A new wine frontier is opening up in southern Chile in forested regions such as the Araucania. The climate is cooler and there is just enough rainfall to support the vines without irrigation.
- By the end of the century there could well be a significant shift of the viticulture in western Argentina towards higher altitudes closer to the foothills of the Andes Mountains.

Losers

- Northern Chile will suffer the most with more intense sunlight and a hotter ripening season. As a result, the grapes won't mature enough to give complexity to the wine, especially in red varietals. This is compounded by a reduction in rainfall and reduced river flows.
- Efforts to grow the current grape varieties and improve wine quality will become more challenging in both Chile and Argentina.

4.3.3 Climate change will improve suitability in regions that are currently restricted by low summer temperatures (due to high latitude or altitude) and decrease suitability in warm and dry areas.

New vineyards in the Himalayan foothills of China

The French champagne, wine and spirit maker Moët Hennessy, part of the French-based luxury group Louis Vuitton Moët Hennessy (LVMH), is developing a presence in China. Its Ao Yun wine brand, established in 2008, is described as a Himalayan grand cru (wine of superior quality). It took four years for the company's wine-growing experts to find the ideal terroir for a red wine worthy of comparison with the world's greatest wines. The company purchased vineyards in the Yunnan province of China, close to the edge of the Himalayas, near Tibet, at an altitude of 2200 to 2600 metres (see Figure 4.3.4). Here, the temperatures are like those in Bordeaux, France, enabling the cabernet sauvignon grape to express the full refinement of this unique terroir.

Local farmers have worked the mountainsides for years. The vineyards were planted in the territories of four different villages on either side of the Mekong River. In all, 314 plots cover 27.2 hectares. To respect time-honoured local traditions, the grape harvest and winemaking are done entirely by hand (see Figure 4.3.5).

With the assistance of a Bordeaux winemaker, LVMH created wine under the Ao Yun brand that aims to rival any wine in the world (see Figure 4.3.6). The first vintage was in 2013 and sells for AU$613. Ao Yun means 'flying above the clouds', a reference to the clouds that cap the surrounding mountains.

This high-altitude venture by LVMH may well be a way of hedging against global warming that could lower the quality of French wine in the future.

4.3.4 The Ao Yun vineyards in a remote location in a valley beneath the Meili Snow Mountains in south-western China's Yunnan province.

4.3.5 Local people are involved in tending the vineyards and harvesting is done meticulously by hand.

Concentration of retail ownership

The increasing concentration of retail ownership is an issue in Australia with the dominance of Coles (Liquorland, First Choice Liquor Market and Vintage Cellars) and the Endeavour Group, in which Woolworths has a significant holding (Dan Murphy's, BWS and Cellarmasters). It makes it increasingly difficult for smaller outlets to compete, as these retail giants continue to move in on smaller operators. Depriving smaller brands of prime shelf space in retail outlets makes it more difficult for them to be competitive.

These big players in Australia are also buying into all levels of the supply chain, including their own bottling plants. More shelf space is dedicated to their own brands, and this will make it even harder for smaller vineyards and winemakers to be competitive.

4.3.6 Bottles of Ao Yun wine on display in the Legrand Filles et Fils liquor store in Paris

Activities

Acquiring and processing geographical information

1 Given the current trends in the wine industry, explain why its future directions will be largely influenced by both biophysical and economic factors.

2 Explain why the future of the wine industry will be competitive.

3 Give examples to demonstrate how viticulture may be more sensitive to climate change than other types of agriculture.

4 Describe the motivations behind the establishment of the LVMH vineyards in China.

5 Explain why the increasing concentration of retail ownership in Australia makes it hard for smaller vineyards and winemakers to sell their wine.

Applying and communicating geographical understanding

6 Study Figures 4.3.2 and 4.3.3. Describe and give reasons for the likelihood of a changing map of the world's wine-producing regions.

UNIT 4.4

Sustainability in global winemaking: Challenges and responses

Did you know?

The future of the wine industry is dependent upon an effective course of action. The Romans declared, '*In vino veritas*', or 'In wine there is truth'. The simple, yet tragic, truth is that the Earth's climate is changing. How the wine industry responds will determine if the industry is to survive.

4.4.1 An organic vineyard in Languedoc-Roussillon, France. Their approach follows *Terra Vitis*, or sustainable viticulture, respecting the rhythm of the vines and conserving the ecosystem. At each step, intervention is minimal.

Viticulture and winemaking have long been committed to promoting more sustainable practices, and several sustainability initiatives are underway worldwide. It is widely accepted within the industry that sustainability is required across the entire lifecycle of the product, from the vineyard to the bottle of wine at the point of sale. There are not just ecological concerns in growing the grapes, but considerable waste is generated in the winery, including skins, seeds and stems from the crush and wastewater from hosing down barrels, tanks and floors. The carbon footprint goes beyond the energy used in the winery, as bottling, packaging and transporting wine consume more energy than winemaking. This necessitates the implementation of sustainable practices by producers, both in the vineyard and the winery, and in the transport and distribution of wine (see Figure 4.4.1). Consumer awareness also needs to improve to encourage consumers to choose sustainable wines.

Promoting sustainability

Sustainable viticulture involves identifying the most appropriate varieties and suitable methods of cultivation for different ecological settings. The aim is to achieve optimal land and scientific management outcomes. Plant varieties are selected to ensure the sustainable use of ecological resources. Sustainable viticulture aims to produce high-quality vines and wine, respect people and the environment, and ensure the long-term economic viability of the industry.

Some examples of sustainability strategies in the industry include regenerative agriculture, which helps to improve soil quality while contributing to climate change mitigation, or new water cycles (collecting, using and recycling water). In addition, wine companies can shift their business models towards sustainability by applying three clear principles: avoid using limited resources and creating waste and other forms of pollution; keep products and materials in use for as long as possible and at their maximum value; and regenerate natural systems.

Over a decade ago, many viticulturalists throughout the world noticed that climate change had started to impact their vineyards, since grapevines are very sensitive to temperature changes. As the scope and difficulty of such environmental problems have arisen, so have the opportunities for innovations in the pursuit of sustainability. Various biodynamic, organic and sustainable certification groups have been formed, both at a national and state level, but the requirements of these groups vary from place to place. Furthermore, they are mainly focused on operations within the vineyard and, to a lesser extent, the winery, but have little consideration of the impact of transporting the wine in the distribution process. Hence the labelling of organic and sustainable wines does not include information on the wine's carbon footprint. The global wine industry contributes 0.3 per cent of global greenhouse gas (GHG) emissions and this must be addressed.

Activities

Acquiring and processing geographical information

1 In what ways have viticulturists noticed that climate change is impacting their vineyards?

2 Name some of the certification groups formed to pursue sustainability in the wine industry.

Applying and communicating geographical understanding

3 In terms of addressing the challenges of climate change, what are some of the shortcomings of the certification groups and wine labelling identified in this unit?

Did you know?

Eighty-eight per cent of the carbon emissions from each bottle of wine comes from the operations of its suppliers and distributors.

■ CASE STUDY

Wineries for Climate Action: Responding to climate change

The International Wineries for Climate Action (IWCA) directly targets the challenge of carbon emissions. Founded in 2019 by Familia Torres from Spain and Jackson Family Wines from the USA, the IWCA is a collaborative group committed to finding and accelerating innovative solutions that will mitigate and reverse the impacts of climate change by decarbonising the global wine industry.

At the launch of the IWCA in 2019, its ambitious goals were announced: for all members to have a long-term strategy to reduce their carbon emissions by 80 per cent by 2045, with a shorter-term target of 50 per cent by 2030 (see Figure 4.4.2). Taking collective action to aggressively reduce carbon emissions would decarbonise the global wine industry. The two founding partners have both lowered their greenhouse gas emissions by more than 25 per cent per bottle since they started auditing their own carbon footprints in 2015, well ahead of their own forecasts.

What is significant is that this is an international approach founded by two leading family-owned wine companies (see Figure 4.4.3). The history of both companies extends back over many generations, and their operations have been built on respect for the land and environmentally responsible practices (see Figure 4.4.4). By sourcing the grapes they use to make their wines from their own vineyards, they can be stewards of the land and control the whole supply chain to the point of sale. This gives them the ability to monitor the environmental footprint of each bottle of their wine sold.

4.4.2 Barrels of wine at Voyager Estate, Margaret River, WA. Voyager is a member of the IWCA.

	Familia Torres	Jackson Family Wines
History	The company was founded in 1870 in the Spanish region of Penedès. The family business dates back to the seventeenth century. Familia Torres is Spain's largest wine producer and its winery in Penedès is the biggest in Spain.	The Jackson family were viticulturalists before they were winemakers. They first grew chardonnay grapes in Lake County, California, in 1974 and their first vintage was released in 1982. It is the best-selling producer of chardonnay in the USA.
Location of vineyards and wineries	Familia Torres has vineyards and wineries in many Spanish wine regions, as well as Chile and California.	Jackson Family Wines has a portfolio of over 40 wineries and estate vineyards in California and Oregon, USA, and France, Italy, Australia, Chile and South Africa.

4.4.3 Overview of Familia Torres and Jackson Family Wines

We live from the Earth. Respect for the Earth and achieving a sustainable system are the driving forces.

Miguel Torres, president Familia Torres

As a multigenerational family wine business, environmental stewardship is at the heart of everything we do across all our global operations—from our farming and winemaking practices to our sales and distribution channels, and beyond.

Katie Jackson, senior vice-president of corporate and social responsibility Jackson Family Wines

Early adopters of climate change mitigations

Based on the values held by both families, numerous actions have been undertaken to react to the changing conditions of the global climate and address the threat to the future production of quality wine. They are redefining their businesses with commitments to renewable energy and onsite energy storage, including carbon capture. They are progressive leaders introducing multiple actions to reduce their GHG emissions (see Figure 4.4.5).

Familia Torres	Jackson Family Wines
■ Solar photovoltaic systems produce 29 per cent of the vineyards' energy needs. They have also invested in a wind farm to generate 2.8 megawatts of energy. ■ A biomass boiler turns pruned vines and other organic residue into heat and electricity. This has reduced natural gas consumption by 95 per cent. ■ They have partnered with universities to research ways to use algae to capture the carbon dioxide released during fermentation. The goal is to convert it into a methane biogas which could be used to fuel vehicles. ■ Geothermal installations are used to maintain temperatures in their facilities, including bioclimatic architecture which is energy efficient and warehouses and tank installations placed underground. ■ Reducing the weight of bottles by 22 per cent saves on transport costs and associated carbon emissions. ■ They use electric or hybrid vehicles for the distribution of wine and transport tourists around the vineyards on a solar-powered train. ■ They collaborate with suppliers to lower their emissions and give them awards to recognise their efforts.	■ Low-intensity production methods in the vineyards such as no-till farming and composting organic material keep carbon dioxide in the ground rather it being released into the atmosphere. ■ Fifity per cent of its winemaking operations are powered by onsite renewable energy (see Figure 4.4.5). This includes 8.8 megawatts from onsite solar photovoltaic systems across nine wineries, the wine industry's biggest solar portfolio. ■ They were an early collaborator in the development of technology for Tesla's stationary energy battery storage systems. As one the first winemakers to install it, they currently have one of Tesla's largest installations with 8.4 megawatt hours of Tesla Power packs. ■ Ninety-eight per cent of their waste is diverted from landfill. ■ Over half of the total area of their vineyards are left under natural vegetation to absorb carbon and support biodiversity.

4.4.4 Overview of the steps the IWCA founders have taken to address climate change

Now is the moment to push for even more ambitious environmental actions to mitigate global warming and protect wine growing areas from its effects.

Miguel Torres, president Familia Torres

4.4.5 Jackson Family Wines have installed solar panels across nine of its wineries, including in the Willamette Valley, Oregon.

Decarbonising the wine industry

Familia Torres and Jackson Family Wines have chartered their own courses to decarbonisation, and the plan is for the IWAC to create a road map for other wineries to follow. Such collaboration fosters the sharing of best practices that reduce the impacts of both vineyard and winery practices on climate. The more wineries that commit to decarbonisation, the more awareness there is of climate change and a push for immediate, widespread action. Already within a year, 10 winery members from six different countries had committed to tackling the severity of the climate crisis and are implementing the IWAC's carbon emissions reduction program.

IWAC membership requirements

The IWAC has a strict framework which must be adhered to for a winery to be granted membership.

1. Members must carry out an audit and establish a third-party verified baseline inventory of current GHG emissions, against which future reductions will be measured. This is an independent measurement of a producer's carbon footprint.
2. They must take a science-based approach to reducing emissions. They must prioritise the best practices and mitigation strategies that have been found to effectively work towards decarbonising the wine industry.
3. They must be powered by at least 20 per cent onsite renewable energy.
4. They must demonstrate at least a 25 per cent reduction in carbon dioxide emissions per unit of wine produced from the baseline emissions inventory year.
5. They must commit to reducing their total emissions by 50 per cent by 2030, and 80 per cent by 2045.

Applicant wineries taking immediate action to reduce their carbon emissions include Spottswoode Estate (USA), Symington Family Estates (Portugal), VSPT Wine Group (Chile) and Yealands Wine Group (New Zealand). They have all completed a credible baseline GHG inventory and have committed to fulfilling the remaining requirements to become full-standing IWCA members within five years.

How to draw in the entire global wine industry

Familia Torres and Jackson Family Wines are large wine companies, and they have the funds to research, invest in and trial strategies to reduce carbon emissions. The reality is that achieving the goal of the IWCA requires all wine producers to become part of the movement. So, Familia Torres and Jackson Family Wines are investing heavily in research and development to help smaller wineries in the hope that new technologies will become more affordable.

One innovation of the IWCA is labels that will clearly show the environmental footprint of the wine in that bottle. Once consumers are educated to recognise this, it may well have a powerful influence on their choices as environmental concerns increasingly drive consumer choice as the impact of climate change worsens.

Critical analysis of such a strategy to mitigate climate change

The effectiveness of the IWAC in mitigating climate change will depend on whether it stands up against several variables that are part of the dynamic environment that viticulturists and winemakers must contend with. It has already been noted that all wine producers need to be involved in reducing carbon emissions, and even if they are, there is no guarantee that will be enough to tackle climate change if there is still widespread pollution coming from other sources or if the feared tipping point with regards to global warming is reached regardless.

The potential of producing power from renewable sources may also be affected by shifting climate belts. A more humid climate with increased cloud cover may reduce the amount of solar energy generated and a reduction in the consistency and strength of winds may also lower the energy produced by wind turbines. More severe storms are likely with climate change and large hailstones can damage solar panels and cut into the leading edge of wind turbine blades, lowering their aerodynamic productivity.

Economic limitations also cannot be ignored and with the uncertainty in the global market some producers may find it difficult to afford to implement the strategies they might like to with sustainability in mind. Likewise, if prices continue to rise as they have, will consumers with lower discretionary incomes be willing to pay for higher-priced wine that claims to be sustainably produced?

Activities

Acquiring and processing geographical information

1. What is the focus of the IWCA?
2. Describe how the IWCA was founded and what drew together the two families involved.
3. Using examples, describe how Familia Torres and Jackson Family Wines have modelled actions to reduce GHG emissions.
4. List the goals of the IWCA.
5. Describe the strict requirements to become a member of the IWCA.
6. Explain why Familia Torres and Jackson Family Wines have invested heavily in research and development.

Applying and communicating geographical understanding

7. What is the reason for having an independent authority carry out the audit of GHG emissions?
8. Why is the IWCA introducing a label to show the environmental impact of producing a bottle of wine? Do you believe this will influence consumer purchases?
9. Design an additional logo for the IWCA.
10. Investigate Spottswoode Estate (USA), Symington Family Estates (Portugal), VSPT Wine Group (Chile) or Yealands Wine Group (New Zealand) to determine what progress they have made towards fulfilling the remaining requirements to become full-standing IWCA members. Write a report on your findings.

CHAPTER

5 Global energy production and its sustainability

Energy drives economies, sustains livelihoods and enables individuals to power the technologies to support and enhance their wellbeing. Currently, the world gets 85 per cent of its commercial energy from fossil fuels. These energy resources have underpinned sustained economic growth and improved the quality of life for those benefitting from such development. However, it is evident that this dependence on fossil fuels has adversely affected the environment, as global energy production is the main driver of climate change. What is needed is a transition from fossil-based fuels to a mix of low-carbon renewable technologies. A smooth and secure energy transition will require political will and higher clean energy investment flows from both governments and the private sector. It must be inclusive so that developing countries are supported and are part of the transformation. The challenge ahead this century is to establish universal access to a more sustainable energy system of low-carbon energy sources that are efficient and reliable.

In this chapter, students study the nature and spatial patterns of global energy production, the factors influencing this activity, the current trends and future directions of energy production and its sustainability, as well as challenges and responses.

> **Once you got a solar panel on a roof, energy is free. Once we convert our entire electricity grid to green and renewable energy, the cost of living goes down.**
>
> **Elizabeth May, Canadian politician, environmentalist and author**

5.0.1 A wind farm over the sea, North Holland, Netherlands

Chapter glossary

bioenergy energy produced from organic material, known as biomass, which contains the energy captured by plants; most commonly made from forest waste and crops such as corn and sugar cane

carbon capture the process of removing carbon dioxide from large power and industrial plants and injecting it into deep geological formations

charcoal a lightweight black residue of charred wood

coal a solid carbon-rich material that formed 300 to 360 million years ago in the Carboniferous period when vast swampy forests were buried under sediments

coal seam a layer of combustible sedimentary rock containing coal deposits

conventional oil liquid oil that can flow through a wellbore

crude oil a naturally occurring black, viscous liquid composed mainly of hydrocarbon

firmed renewables energy sources such as wind or solar, where the output is maintained to ensure that enough energy is always available

fossil fuels fuels such as coal, oil and natural gas formed from the fossilised buried remains of plants and animals that lived hundreds of millions of years ago

fracking a method of capturing natural gas by widening cracks in rocks by injecting high-pressure water laced with chemicals and sand; the sand props open the cracks enabling gas to escape

geothermal energy energy generated from reservoirs of hot water below the Earth's surface; its original source is the internal energy of the Earth, as magma heats nearby rock and underground water

green hydrogen a clean energy source as it only emits water vapour and leaves no residue in the air

hydropower any technology that uses the kinetic energy of flowing water to generate electricity; it most commonly involves building a dam to store water, before releasing it down pipes to turn turbines

non-renewable resources resources including coal, oil, gas and nuclear energy; they are in limited supply and once they are used up, they are gone forever in a timescale relevant to humans

nuclear fission the breaking of the nucleus of an atom into two or more parts, releasing energy

nuclear fusion the joining atoms together to form a single nucleus, releasing energy

renewable resources resources including solar, wind and hydropower that can replenish themselves through natural processes; they are sustainable if they are not used faster than they are replaced

shale oil oil that is bound up tightly in impermeable rock and requires mining, crushing and heating the shale to extract the oil

solar photovoltaic where solar cells made of thin, transparent wafers of silicon capture sunlight and turn it into energy

solar thermal usually large-scale solar projects where an array of mirrors tracks the sun and focuses the reflected sunlight on a central tower, which generates electricity using steam and turbines

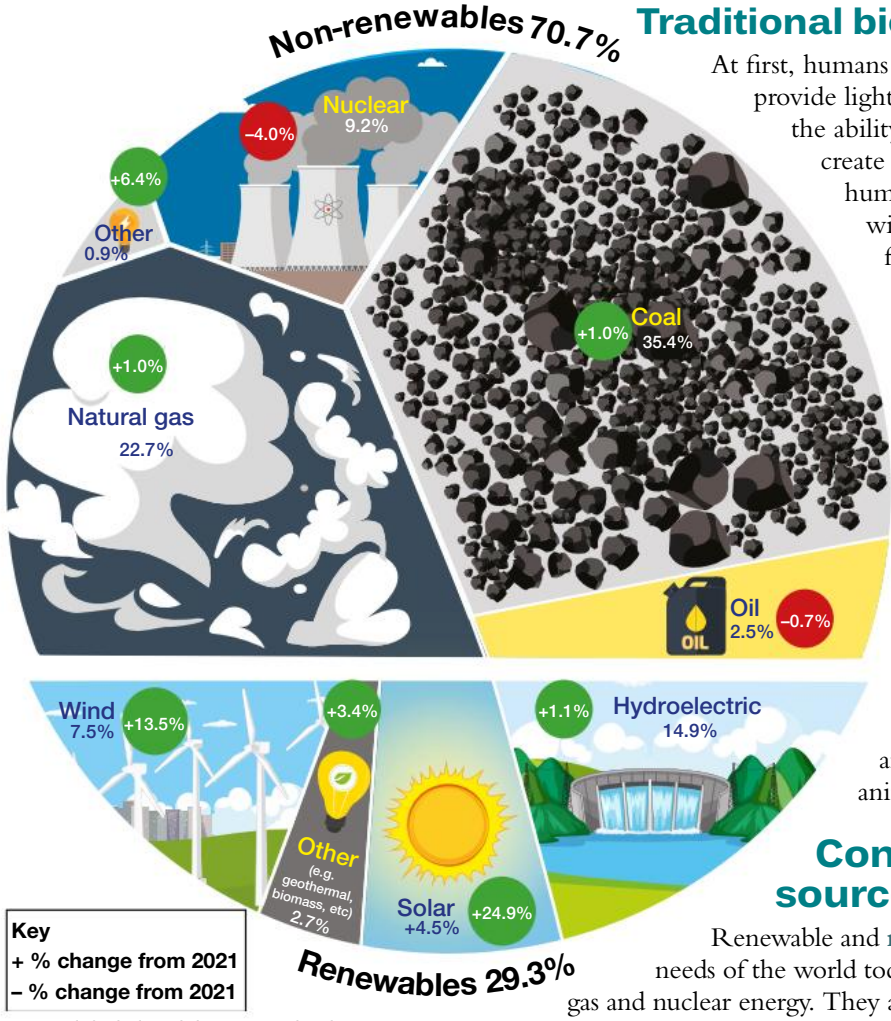
tar sands sticky deposits of bitumen mixed with sand and clay; extracting and converting these deposits into useable crude oil requires excessive amounts of energy and water

unconventional oil thicker oil that cannot be feasibly accessed using conventional vertical drilling techniques because the oil is trapped in rocks or stuck to sand and is hard to access

UNIT 5.1

The nature and spatial patterns of global energy production

The ways in which societies secure the energy they need have changed throughout history. There have been major shifts in the types of fuels used over time and each transition has underpinned major geographical changes in the distribution of production and consumption of resources, and in many cases spurred developments, which have improved standards of living. Figure 5.1.1 shows the sources of the world's electricity by fuel type in 2022.



5.1.1 Global electricity generation by fuels, 2022

Traditional biofuels

At first, humans relied on the Sun as a source of energy to provide light and warmth during the day. Then, with the ability to control fire, humans burned wood to create energy for heating, cooking and lighting. So, humans have used biofuels for a very long time, with evidence suggesting it could have been as far back as 1 million years ago. Wood remained the main source of energy for the world's population until the late nineteenth century.

The first energy source created by humans was **charcoal**, a lightweight black residue of charred wood, probably first discovered in the remains of a wood fire. Charcoal is a better fuel than wood as it produces twice the heat but gives off less smoke and is easily transportable. It has been intentionally produced since prehistoric times.

Until the middle of the nineteenth century, traditional biofuels were the dominant source of energy used throughout the world. These biofuels included the burning of wood and charcoal, as well as crop residue and even animal dung.

Contemporary energy sources

Renewable and **non-renewable resources** meet the energy needs of the world today. Non-renewable resources include **coal**, oil, gas and nuclear energy. They are in limited supply and once they are used, they are gone forever in a timescale relevant to humans. This is of increasing concern as the world relies on these finite resources for most of its energy needs. **Renewable resources**, such as solar, wind and **hydropower** can replenish themselves through natural processes and are sustainable if they are not used faster than they are replaced.

Did you know?

The longest-lasting known fire in the world is Burning Mountain in the Upper Hunter region of NSW. It has been burning for 6000 years, fuelled by a coal seam under the mountain.

Non-renewable energy

Carbon-based **fossil fuels**, such as coal, oil and natural gas, were formed from the fossilised buried remains of plants and animals that lived hundreds of millions of years ago. These fuels are sources of energy because the plants captured energy from the sun before they were buried. This energy drove photosynthesis to convert carbon dioxide and water into the building blocks they needed to grow. By using predominantly carbon and

hydrogen atoms, these ancient organisms stored the energy in hydrocarbon compounds. Over geological time this organic material remained buried and was thereby protected from oxidation and subjected to immense heat and pressure. The organic remains were slowly converted into fossil fuels with their hydrocarbon compounds serving as fuel when burned.

Fossil fuels are sought after for this trapped energy. Along with the Industrial Revolution came the need for energy and the rise of coal, followed by oil and natural gas. Industrial economies built their wealth using fossil fuels, as they provided electricity and powered both machinery and transportation.

Coal

Coal is an abundant but dirty fuel. It is a solid, carbon-rich material that formed 300 to 360 million years ago when vast swampy forests were buried under sediments. As a combustible sedimentary rock, it is found underground in **coal seams**. These are found on every continent. Coal is mined both above the ground in open-cut mines and underground (see Figure 5.1.2). The three largest coal producers are China, India and Indonesia, with each of these countries producing record amounts of coal in 2022 (see Figure 5.2.5, page 108). In contrast, the United States, once the largest global producer of coal, has more than halved its production since 2008.

Coal has been a critical energy source and the mainstay of global energy production for centuries. It's the world's most affordable fuel and is used in thermal power plants to generate electricity. Coal is also used in industrial plants and is crucial to raising the temperature of blast furnaces to smelt metal and make steel. Global coal consumption has been increasing and hit a fresh record high of 8.3 billion metric tons in 2022, largely in response to continued strong growth in Asian economies. China and India lead the world in coal consumption, together accounting for two-thirds of the market.

However, coal is the most polluting energy source in terms of the amount of carbon dioxide it produces per unit of energy, so moving away from coal energy is vital to tackling climate change.

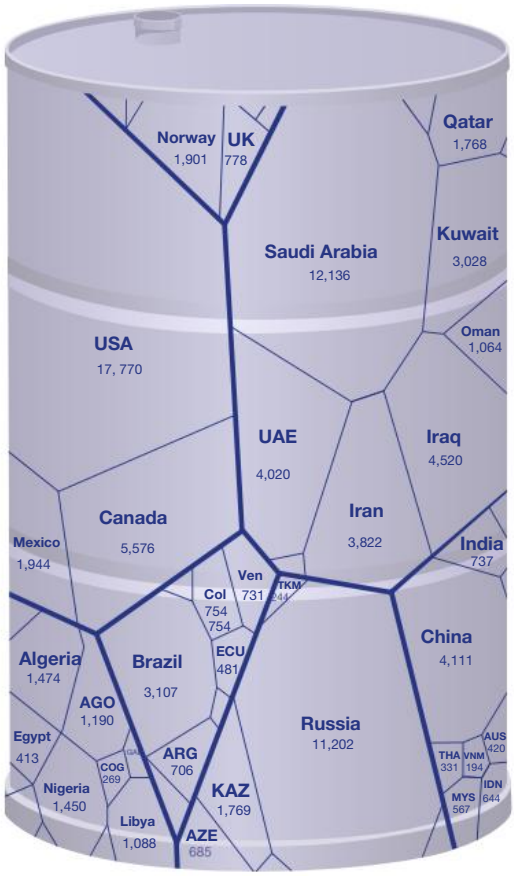
5.1.2 Underground coalmining at Longyearbyen in Norway's Svalbard archipelago

5.1.3 A pumpjack on an oilfield that mechanically lifts the oil out of the well if there is not enough pressure for it to flow up to the surface from the reservoir below.

Oil

Crude oil is a naturally occurring black, viscous liquid composed mainly of hydrocarbons. Crude oil was formed over millions of years from the decayed remains of ancient organisms sinking to the bed of shallow seas. Oil is usually trapped in reservoirs between layers of impervious rock. Crude oil is known as **conventional oil**, if, as a liquid, it can flow through a wellbore. It is extracted by drilling down vertically into the reservoir and pumping the oil out (see Figure 5.1.3).

Earth's reserves of conventional oil are in decline. As a result, unconventional sources are being exploited. **Unconventional oil** is thicker oil that cannot be feasibly accessed using conventional vertical drilling techniques. This is because the oil is trapped in rocks or stuck to sand and is hard to access. Technological advances have made them economically viable to recover, where they were once too costly to tap. **Shale oil** is bound up tightly in impermeable rock and requires mining, crushing and heating the shale to extract oil. **Tar sands** are sticky deposits of bitumen mixed with sand and clay. Extracting and then converting these deposits into useable crude oil requires enormous amounts of energy and water.



5.1.4 Oil production in barrels per day by country, 2022

Saudi Arabia, Iran, Iraq and Russia have the largest reserves of conventional oil. As illustrated in Figure 5.1.4, the United States and Saudi Arabia dominate production. Russia also has the largest recoverable reserves of shale oil, followed by the United States and China. The main producers of shale oil are China and Estonia. The largest tar sands deposits are in Canada (mostly in Alberta) and Venezuela. Canada dominates global production and it provides more oil to the United States than any other country. Exports to Asia of oil from tar sands reached record levels in 2022, with India the leading destination, followed by China and South Korea.

Oil is the world's largest energy source today. It is the dominant source of energy for the transport sector and powers global industry. The value of the oil market is evident in Figure 5.1.6, as it clearly dwarfs all other commodity markets by value. The United States is the largest consumer of oil, followed by China and India.

Natural gas

Natural gas is a fossil fuel energy source. It is a naturally occurring mixture of gaseous hydrocarbons, consisting mainly of methane. Natural gas is often found lying above reservoirs of conventional oil and in permeable material between layers of impermeable rock. Stores of natural gas can be accessed by standard drilling. If the gas is tightly trapped in hard rock formations such as shale, it is not easy to extract and **fracking** is performed. This process involves widening cracks in the rock by injecting high-pressure water laced with chemicals and sand. The sand props open the cracks enabling the gas to escape. Fracking requires large quantities of water and can radically lower the hydrology of an area. It also releases highly toxic wastewater that may leak into and contaminate groundwater.

● **SPOTLIGHT**

The dirtiest project on Earth

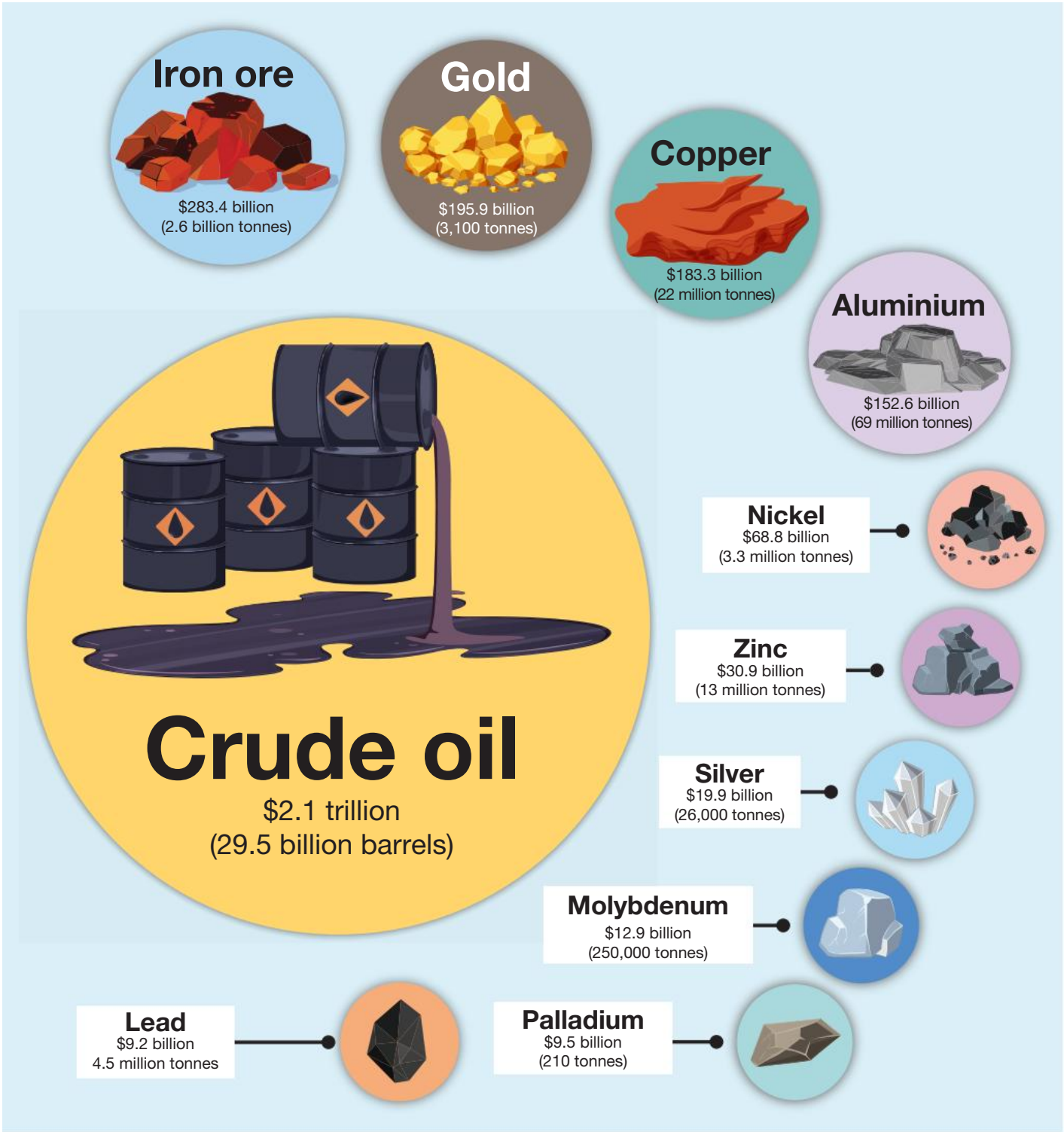
Extracting the tar sands in Alberta, Canada, is one of the world's largest industrial projects. It has been judged by many as the most destructive in human history. Canada has the world's third-largest proven oil reserves with the capability of producing 1.8 trillion barrels of crude bitumen. The tar sands are found under 140 000 square kilometres of ancient boreal forest. Vast swathes of the forest have been removed and replaced by a treeless toxic swamp with open pit mines, toxic waste ponds, pipelines and roads (see Figure 5.1.5). The landscape is punctuated by over 300 000 oil and gas wells.

The two extraction methods used are both environmentally disastrous. Strip mining involves removing the overlying mineral deposit, then digging down 75 metres and shovelling up the deposits. The entire ecosystem is lost. Removing four tonnes of soil only yields one barrel of oil. As half of the deposits are too deep for strip mining, steam is pumped down to melt the bitumen embedded in the sand so it can be brought to the surface.

The mines use huge amounts of energy and water in the extraction process and the water must be retained in open, unlined tailings ponds. These now cover 260 square kilometres and they swell each day with millions of litres of new waste. The ponds are highly toxic as they are heavily contaminated with mercury, lead and other carcinogenic heavy metals. They are so poisonous that in 2008, 1600 ducks died after landing on a Syncrude tailings pond north of Fort McMurray, Alberta.

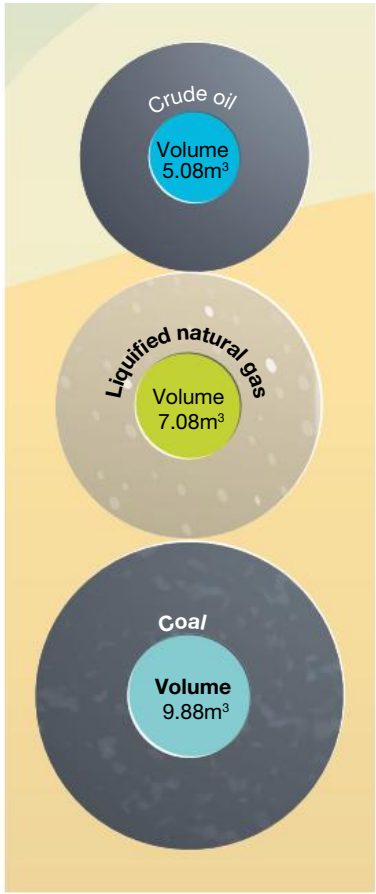
The sands pump out more than three million barrels of oil a day, making Canada the world's fourth-largest oil producer. Despite the growing need for countries to shift away from fossil fuels, both the Canadian government and the oil companies expect the output will continue to rise into the 2030s. Canada's tar sands are among the world's most climate-polluting sources of energy.

5.1.5 The Athabasca oil sands near Fort McMurray, Alberta, Canada



5.1.6 By value, crude oil dominates the commodities markets. The crude oil itself is simply the raw product. Before it can be used, it is processed into different components, ranging from plastics to gasoline, from diesel to jet fuel, and from lubricant oils to asphalt.

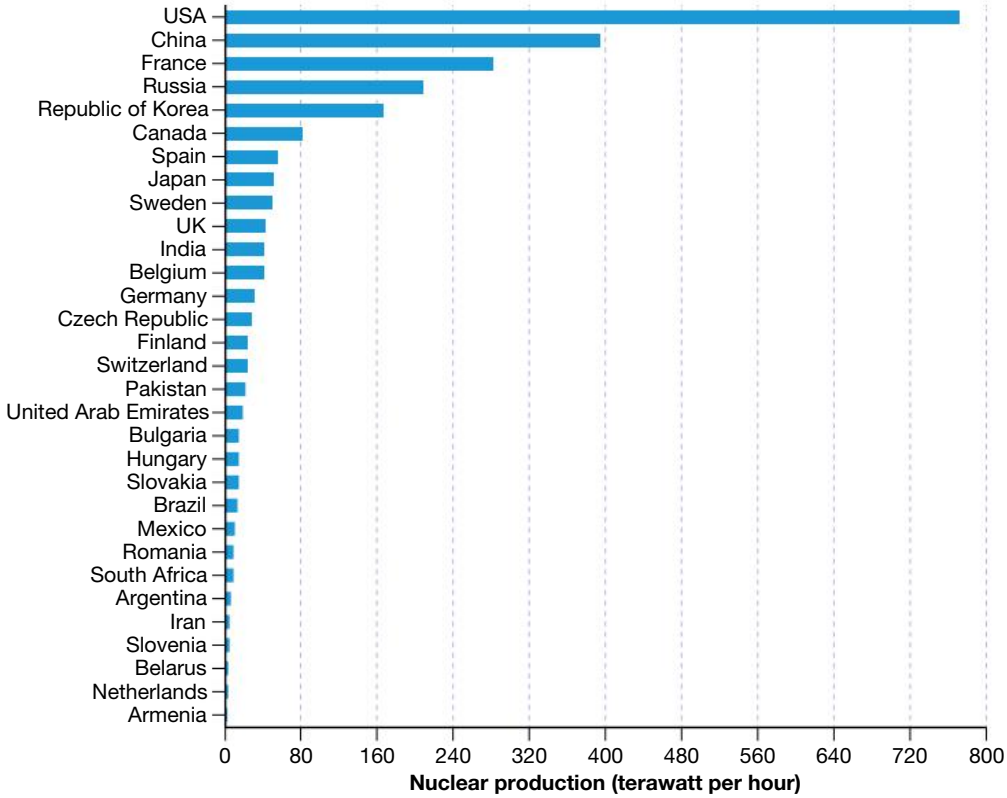
Natural gas has, for decades, lagged behind coal and oil as an energy source. However, today its consumption is increasing rapidly as it is seen as a replacement for coal in the energy mix (see Figure 5.1.7). Gas is the cleanest burning fossil fuel, as it releases few by-products. Gas is a major provider of electricity production and is an alternative fuel in vehicles. It is a key source of heat and power in homes and in industrial settings. Natural gas is also used in a variety of processes such as waste treatment, food processing and refining metals. The United States and Russia dominate the global production of natural gas.



5.1.7 Coal, liquefied natural gas and crude oil account for most fossil fuel usage.

Nuclear power

Nuclear power uses nuclear reactions to produce electricity. The energy is in the nucleus of an atom and through **nuclear fission** the nucleus is split into several parts, releasing the energy. The nuclear fission of uranium and plutonium in nuclear power plants produces the world's nuclear energy. Initially, the technology was developed during World War II for making bombs, but in the 1950s attention turned to using it to generate power. Nuclear power plants are now operational in 32 countries worldwide and approximately 440 nuclear reactors provide about 10 per cent of the world's electricity (see Figure 5.1.8).



5.1.8 Nuclear power generation by country 2022. Thirteen countries produced at least one-quarter of their electricity from nuclear. France gets up to 70% of its electricity from nuclear energy, while Slovakia, Belgium and Hungary get about half their electricity from nuclear.

Did you know?

Nuclear energy can also be produced through **nuclear fusion** or joining atoms together. The Sun is constantly undergoing nuclear fusion as hydrogen atoms fuse to form helium. Nuclear power plants currently cannot safely produce energy from nuclear fusion, but research into this continues.

Nuclear power is a low-carbon source of energy. However, the initial capital required, and the ongoing maintenance costs are much higher than for other energy projects.

There is also the issue of safely managing the waste generated by nuclear reactors as it remains radioactive for hundreds of thousands of years. Although uncommon, accidents in nuclear reactors can have devastating and long-lasting consequences for both humans and the environment. The Chernobyl (Ukraine) and Fukushima (Japan) nuclear disasters are often cited in arguments against nuclear power.

Renewable energy

As the global population increases and existing fossil fuel supplies diminish, countries will need to move to other sources of energy. More importantly, the world needs to steer away from fossil fuels to tackle climate change and move towards low-carbon renewable resources.

Solar power

Solar power is generated when energy from the sun is converted directly into electricity or used to heat air, water or other fluids. There are two main types of solar energy technologies.

- **Solar photovoltaic**: where solar cells, made of thin transparent wafers of silicon, capture sunlight, and turn it into energy. They are wired together in a panel, and many panels can be connected to produce energy for a household or, on a much larger scale, a solar power plant. These systems can store the energy in batteries until needed or send it to the electrical grid. The largest solar power plants operate in Spain, Portugal, Germany, China and the United States.
- **Solar thermal**: usually large-scale solar projects where an array of mirrors tracks the sun and focuses the reflected sunlight on a central tower which generates electricity using steam and turbines (see Figure 5.1.9).

5.1.9 This solar thermal power station is in north-west China. The total reflection area of the power station's mirror field is 1.4 million km². When the sun shines down, the heliostat will reflect and concentrate the light on the top of the heat absorption tower.

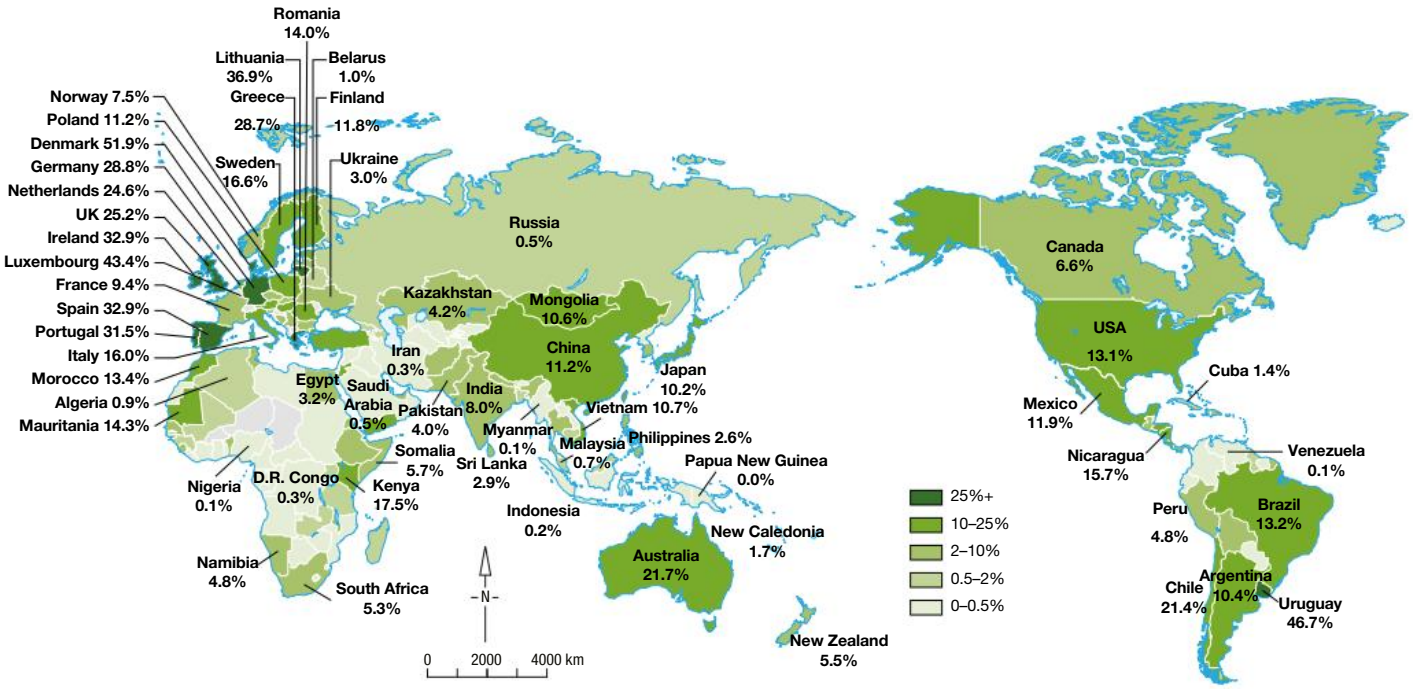
Wind energy

Wind energy is an indirect form of solar power as differential heating across the Earth's surface is what causes winds to blow. The kinetic energy of the wind can be converted into electricity by wind turbines. As the turbines' three blades spin in the wind, they drive a generator that produces the electricity. Wind turbines as tall as an 80-storey building are able to access winds that are stronger and steadier than winds at lower altitudes. The blades themselves are over 100 metres long. Groups of wind turbines in wind farms transmit their electric energy to the grid.

Most of the world's wind farms have been built on land in the United States, Europe and China, but increasingly, offshore locations are favoured where the winds are stronger and more consistent. Figure 5.1.10 illustrates the global wind and solar share.

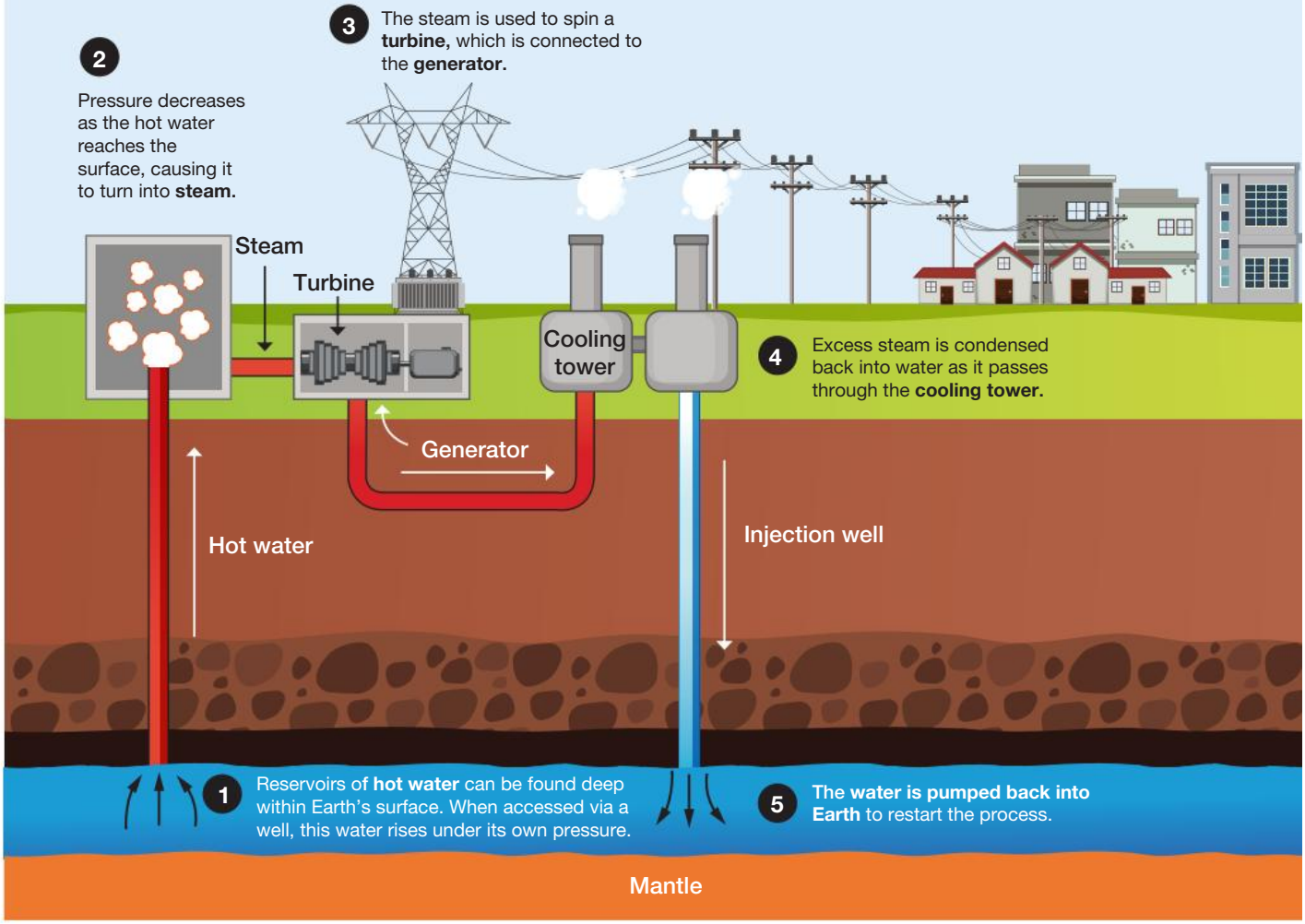
Hydropower

Just like wind power, hydropower is another indirect form of solar energy as the Sun powers the water cycle. Hydropower is any technology that uses the kinetic energy of flowing water to generate electricity. This most commonly involves building a dam to store water and then releasing it down pipes where turbines at the bottom of a gradient are turned to produce electricity.



5.1.10 Solar and wind power generation by country

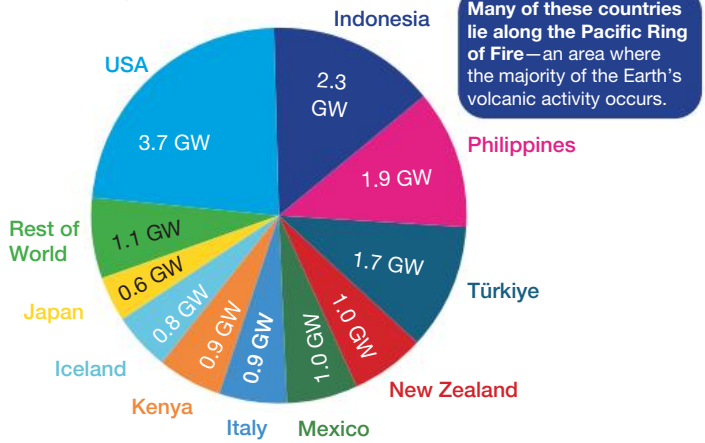
Geothermal energy: How it works



Global consumption of geothermal energy, 2021

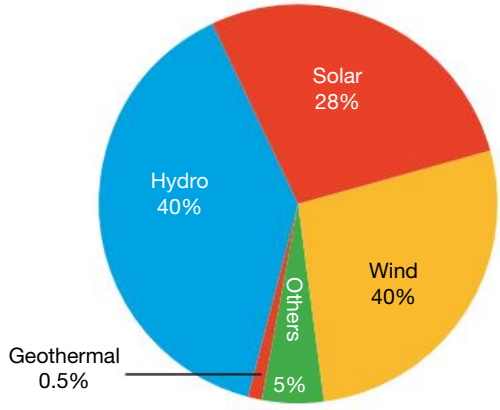
At the end of 2021, global geothermal power generation amounted to 16 gigawatts (GW). Only a handful of countries have surpassed the 1 GW milestone.

Many of these countries lie along the Pacific Ring of Fire—an area where the majority of the Earth's volcanic activity occurs.



Global renewable energy capacity, 2021

Geothermal energy accounts for just 0.5% of the world's total renewable energy capacity (3,064 GW).



5.1.11 Geothermal energy

Hydropower is the most widely used renewable resource, providing 6.4 per cent of the world's energy. China, Canada, Brazil and the United States are the leading producers and consumers. It also has the greatest potential for further development as, according to the UN, only 13 per cent of the world's hydropower has been utilised. India and several countries in Central Africa and South America are suitable for such developments.

Geothermal energy

Geothermal energy is renewable energy generated from reservoirs of hot water below Earth's surface. Its source is Earth's internal energy, as magma heats nearby rock and underground water. Geothermal power plants harness the steam that forms when this water comes to the surface, which rotates turbines to generate electricity. While this energy source is reliable and takes up less space than other types of renewable energy sources, it is expensive to build these plants and geothermal energy plants can only be built on reservoirs with temperatures above 100°C. Figure 5.1.11 shows how this works, as well as where geothermal energy is being used and how it compares it to other types of clean energy.

Bioenergy

Bioenergy is produced from organic material, known as biomass, which contains the energy captured by plants. This is converted into heat, electricity, biogas and liquid fuels. Liquid biofuels have been used since the beginning of civilisation. One of the first biofuels was simple vegetable oil used to light pottery lamps. Modern biofuels help underpin efforts to move away from fossil fuels and cut carbon emissions. At the end of the twentieth century, the value of bioenergy was linked to the recognition of pollution from fossil fuels. Countries such as the United States responded and now generate 26 per cent of ethanol in the world used for fuel.

There is a real push to bring together the energy, forestry and agricultural sectors to create technologies to advance the use of biofuels. Bioenergy most commonly consists of forest waste and crops such as corn and sugar cane. It has the potential to supply significant amounts of energy, but it comes at a cost as it takes land away from food production.

Activities

Acquiring and processing geographical information

1 Name the first two sources of energy used by humans.
2 Explain why charcoal is a superior fuel to wood.
3 Distinguish between renewable and non-renewable resources.
4 Explain why coal, oil and natural gas are referred to as fossil fuels and why they contain energy.
5 Explain why coal has been such a critical source of energy for the world.
6 Justify why coal is considered a dirty fuel.
7 Distinguish between conventional and unconventional oil.
8 Describe shale oil and tar sands.
9 Describe the problems caused by the process of fracking to extract natural gas.
10 Describe how power is produced from nuclear fission and the extent of global use of this energy source.
11 Distinguish between solar photovoltaic and solar thermal generation of electricity.
12 Explain how wind turbines work.
13 Describe the global use of hydropower.
14 Describe how the use of biofuels has evolved.

Applying and communicating geographical understanding

15 Study Figure 5.1.1. Write a report summarising the sources of electricity by fuel type.
16 Study the text in this unit and write a paragraph on the importance of incoming solar radiation for the variety of energy sources used by humans.
17 Using the internet, investigate the occurrence of coal in Antarctica and what this reveals about the continent's former climate.
18 Study Figure 5.1.4. Determine which country is the biggest oil producer in Asia, North America, Africa and South America.
19 Study Figure 5.1.10. Compare the generation of wind and solar energy in North America to South America. Use the internet to investigate the difference. Write a paragraph summarising your findings.
20 Study Figure 5.1.11. Write a paragraph on the advantages and disadvantages of geothermal energy.

UNIT 5.2

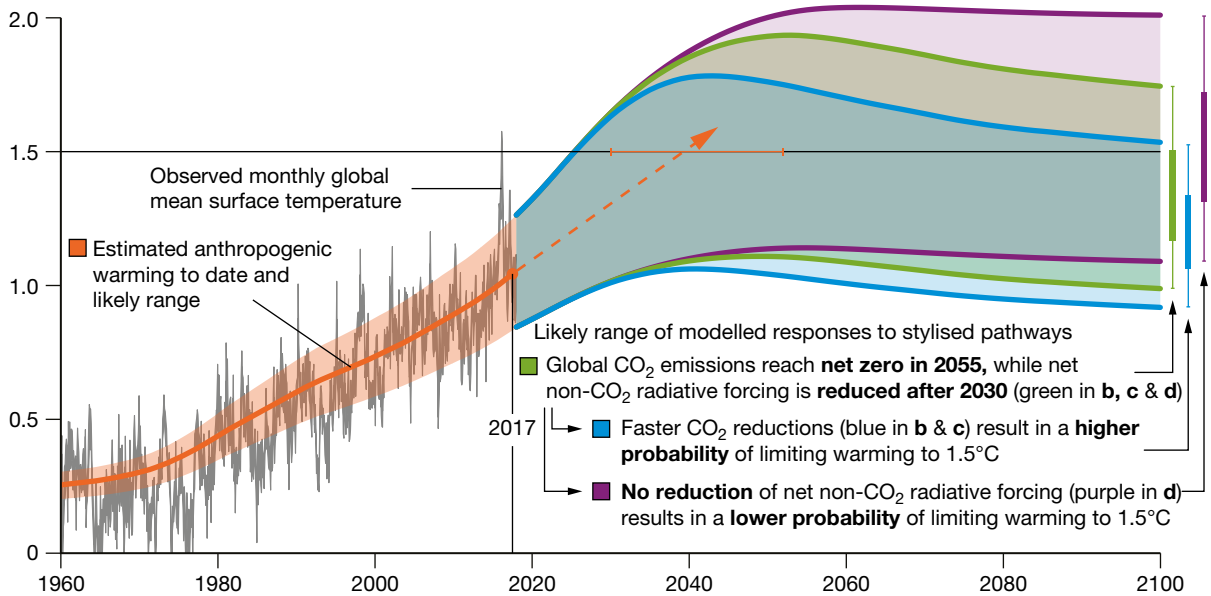
Factors influencing global energy production

There is an urgency to move away from fossil fuels as the effects of climate change continue to appear, with record-high temperatures and more extreme weather events occurring. Despite best intentions, many nations have faltered in their energy transition as several factors have influenced the decisions of their policymakers. Over the last decade there has certainly been progress, with the production of renewable energy more than doubling. However, the use of fossil fuels has similarly expanded to meet the growing demand for energy. Global coal demand rose to an all-time high of over 8.3 billion tonnes in 2022. The share of energy generated from fossil fuels has remained unchanged and global carbon emissions have increased by 5 per cent.

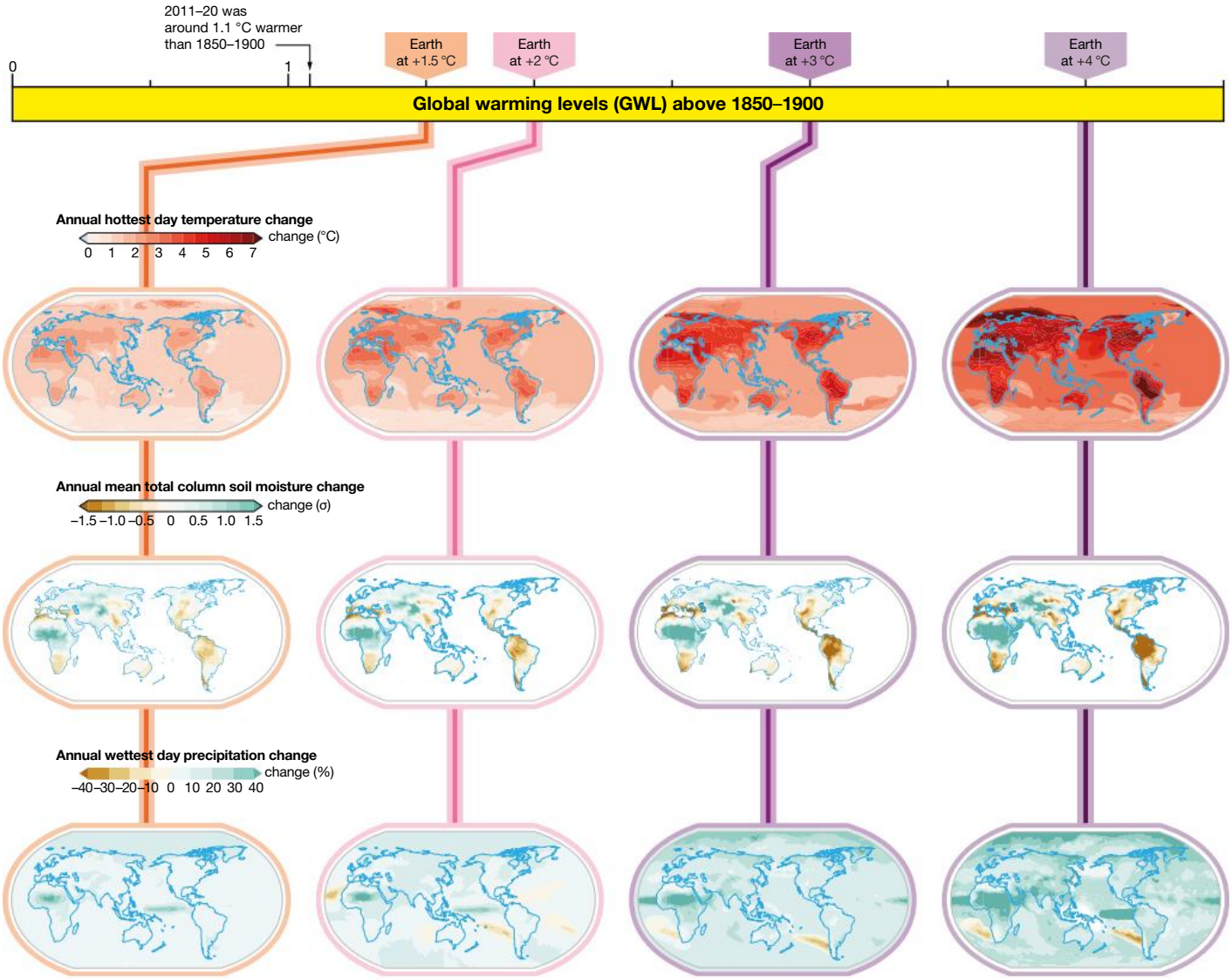
The call to action by the IPCC

An international treaty, the 2015 Paris Agreement, was signed by 193 nations and the EU in response to the urgent and potentially irreversible threat of climate change to Earth. The signatories agreed to cut greenhouse gas emissions to keep the global rises in temperature this century below 2°C above pre-industrial levels and pursue the goal of limiting the total rise to 1.5°C. This will require reaching net zero emissions by 2050.

The IPCC was assembled by the UN to conduct regular scientific assessments on climate change and inform policymakers of current trends and associated potential risks, as well as give them technical guidance. The IPCC has concluded that human activities are estimated to have been responsible for approximately 1°C of global warming above pre-industrial levels. If it continues to increase at the current rate, global warming is predicted to reach 1.5°C in the 2030s, perhaps even as early as 2027. The IPCC has indicated that by 2030, global carbon dioxide emissions need to be 45 per cent lower than 2010 levels to reach net zero around 2050. The importance of reducing carbon dioxide emissions can be clearly seen in Figures 5.2.1 and 5.2.2.



5.2.1 This graph shows observed temperature changes from 1960 to 2017, and the predicted continued changes in temperature based on whether carbon dioxide emissions are reduced quickly, slowly or not at all.

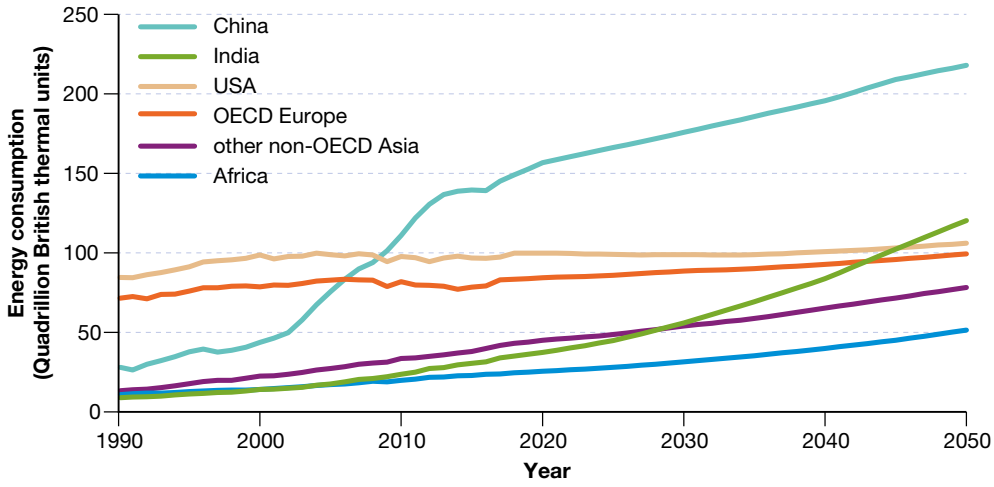


5.2.2 Projected changes of annual maximum daily maximum temperature, annual mean total column soil moisture and annual maximum 1-day precipitation at global warming levels of 1.5°C, 2°C, 3°C and 4°C, relative to 1850–1900

India and China: The big energy users

The two most populous nations in the world, India and China, are both competitively pursuing economic growth. As they do, their use of fossil fuels increases to meet their increased need for energy (see Figure 5.2.3). The middle-class expansion that is happening in these countries will be the largest in history. As people enjoy a better standard of living, there is a higher demand for energy. Electricity consumption per capita in China increased to 5.728 kilowatt hours in 2022, doubling in the last decade. India's per capita consumption is one-quarter of China's. As more people are lifted out of poverty in India, consumption will rise, leading to the greatest potential for increased demand for energy in the future.

Domestic consumption of energy in both countries is driven by the pursuit of economic growth by their policymakers, which has dramatically expanded their energy needs. China has maintained decades of rapid economic growth, reaching 10 per cent in the 2000s and 7 per cent in the 2010s. China's industrial sector still accounts for two-thirds of its total energy consumption. Similarly, India's growing demand for energy is tied to the twin processes of urbanisation and industrialisation. Over the next two decades, its import bill for fossil fuels is expected to double, with oil being the biggest component.



5.2.3 Total energy consumption in selected countries and regions 1990–2050

Source: U.S. Energy Information Administration, *International Energy Outlook 2019*

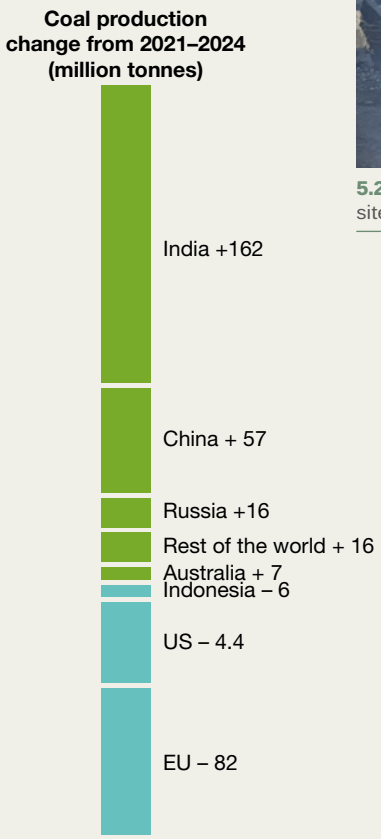
SPOTLIGHT

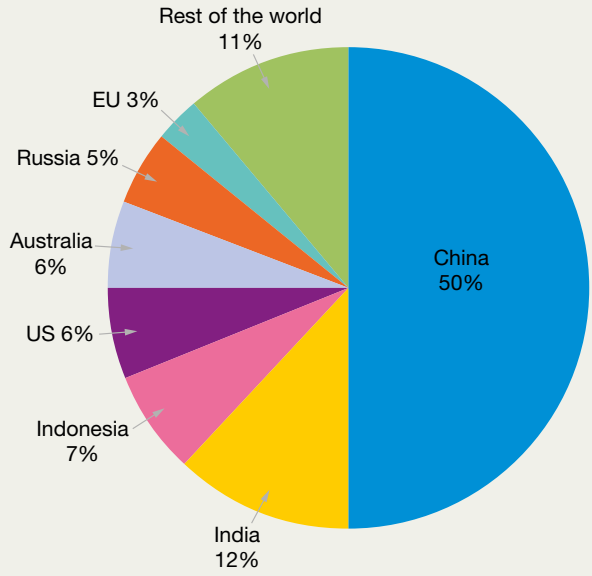
Coal fuels China and India

China and India produce almost 60 per cent of the world's coal (see Figures 5.2.4 and 5.2.5). They are expected to raise their combined production by more than 200 million tonnes each year. The demand for coal in both nations is driven by their need to produce electricity for industry and their large populations. China has pledged to start reducing coal consumption in 2026. In the meantime, they intend to build 43 coal-fired power stations to satisfy demand. Some of this extra production is to cover a lower reliance on imports, which are forecast to drop by 16 per cent or 51 million tonnes by 2024.

By 2024, China's coal consumption is expected to increase by 3.3 per cent and India's by 12.2 per cent, to support economic growth. This would mean that their combined consumption would use two-thirds of the world's coal.

5.2.4 A coal picker rests between shifts near an open cast mining site on the outskirts of Dhanbad, India, 2023





5.2.5 Global coal production 2021–24

Geopolitical factors

Given that energy underpins the operation of national economies, geopolitics can put acute strains on the energy market. One of the most severe disruptions in modern energy history was the OPEC crisis (Organization of the Petroleum Exporting Countries) in the 1970s. Overnight, the price of oil quadrupled, and the United Arab States prohibited oil exports to the United States and Western Europe in retaliation for their support of Israel in the Arab–Israeli conflict of the time.

The global energy crisis of 2022 was of unprecedented depth and complexity. It had multiple dimensions across all energy markets and occurred at a crucial time in history when the focus needed to be on tackling climate change by transitioning to clean energy. While there were shortages and increased prices after the COVID-19 pandemic, the situation escalated following the 2022 Russian invasion of Ukraine. Europe has been the main stage in which this crisis has played out as Russia has sought to gain political leverage over nations opposing its actions by withholding gas supplies. The price of gas soared, reaching record highs. The immediate response to the crisis was more reliance on fossil fuels, which increased their prices. Oil hit its highest price level in four years. The rise in prices for energy and food resulted in hardship for families, and caused businesses to suffer as economic growth slowed.

The global energy market shifted dramatically, as in many parts of the world energy has become more expensive. It has brought into sharp focus the global dependence on fossil fuels, where production is dominated by a few producers, where supplies may be insecure and prices volatile. This has galvanised action in developing renewable resources.

Activities

Acquiring and processing geographical information

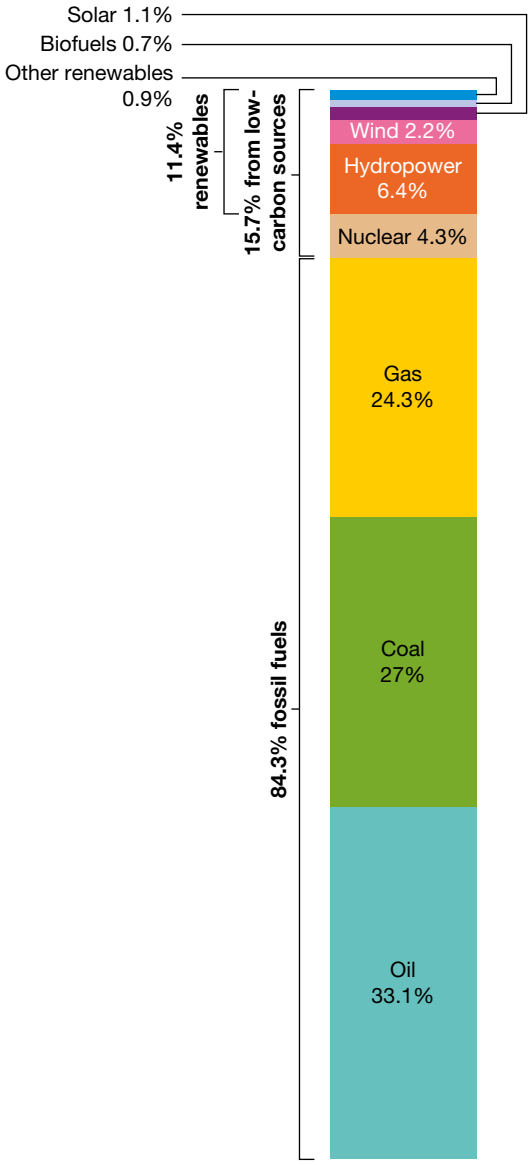
1. Explain why there is an urgency to move away from fossil fuels.
2. Describe the Paris Agreement and explain why it was put into place.
3. Explain why China and India are the biggest consumers of fossil fuels in the world.
4. Describe how China and India dominate the production of coal.
5. Describe the 2022 global energy crisis. Why it was more complex than the OPEC crisis of the 1970s?

Applying and communicating geographical understanding

6. Study Figure 5.2.1. Determine what the rate of anthropogenic warming was between 1960 and 2017.
7. Study Figure 5.2.2. Compare the impact of a 4°C warming on Africa to the rest of the world.
8. Study 5.2.3. Calculate the projected percentage increase in carbon dioxide emissions in China between 1990 and 2050.

UNIT 5.3

Current trends and future directions in global energy production



5.3.1 Global primary energy consumption by source, 2020

Fossil fuels have been the main source of global energy for over a century, and vast amounts of coal, oil and natural gas are still extracted and consumed every year (see Figure 5.3.1). Their dominance in the energy market is evident, despite the adoption of the Paris Agreement in 2015, in which many countries committed to reducing their energy emissions. While there has been growth in renewable energy sources in recent years, there has been little change in the consumption of fossil fuels for power generation in the last two decades (see Figure 5.3.2).

An energy transition

An energy transition involves a change in an energy system, usually from one fuel source to another. Historically, major global energy systems that moved the world from wood to coal and then to oil slowly, each taking 50 to 60 years.

The current energy transition is driven by the realisation that if Earth is to avoid the catastrophic effects of climate change, there must be a radical reduction in greenhouse gas emissions. Given the alarm of what is unfolding today, a rapid shift from fossil fuel energy production to renewable resources is crucial. Decarbonisation of the energy sector requires urgent action, and a renewable energy transition is important now, not sometime in the future. This is what is needed in the twenty-first century: to transition to a more sustainable energy system that provides universal access to a reliable supply of efficient low-carbon energy. The speed and scale of the energy transition needed today is a new challenge, one that is very different from the past and certainly much more important.

Transitioning to a renewable energy-based economy will provide resilient, low-cost, sustainable energy for all. However, if the world is to avert a climate catastrophe, and meet the pledges of the Paris Agreement, investment in renewable energy will need to triple by 2030. Fulfilling the commitment to reduce carbon emissions and shifting to renewable technologies has been uneven across the world.

In Europe, Iceland generates 79 per cent of its energy from hydropower (55%) and geothermal power (24%). Other countries also sourced most of their energy from low-cost carbon sources, such as renewables or nuclear. These have included Sweden (69%), France (49%) and Switzerland (49%).

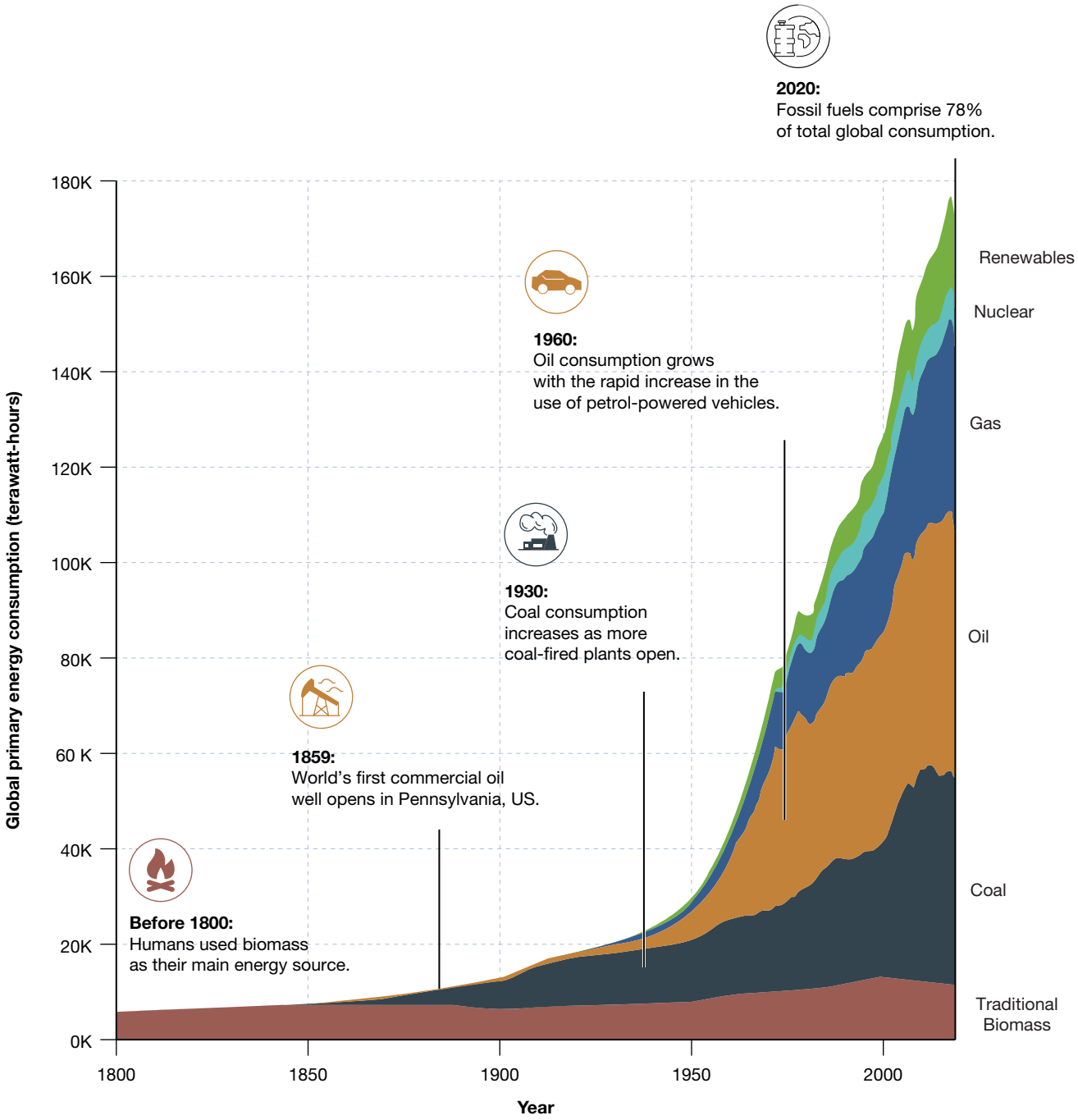
● **SPOTLIGHT**

Highway to climate hell

The UN Secretary-General, Antonio Guterres, issued a stark warning at a climate change summit in 2021, that the world was losing its fight against climate change while repeating his call to phase out coal by the year 2040.

We are in the fight of our lives, and we are losing. Greenhouse gas emissions keep growing, global temperatures keep rising, and our planet is fast approaching tipping points that will make climate chaos irreversible. We are on a highway to climate hell with our foot still on the accelerator.

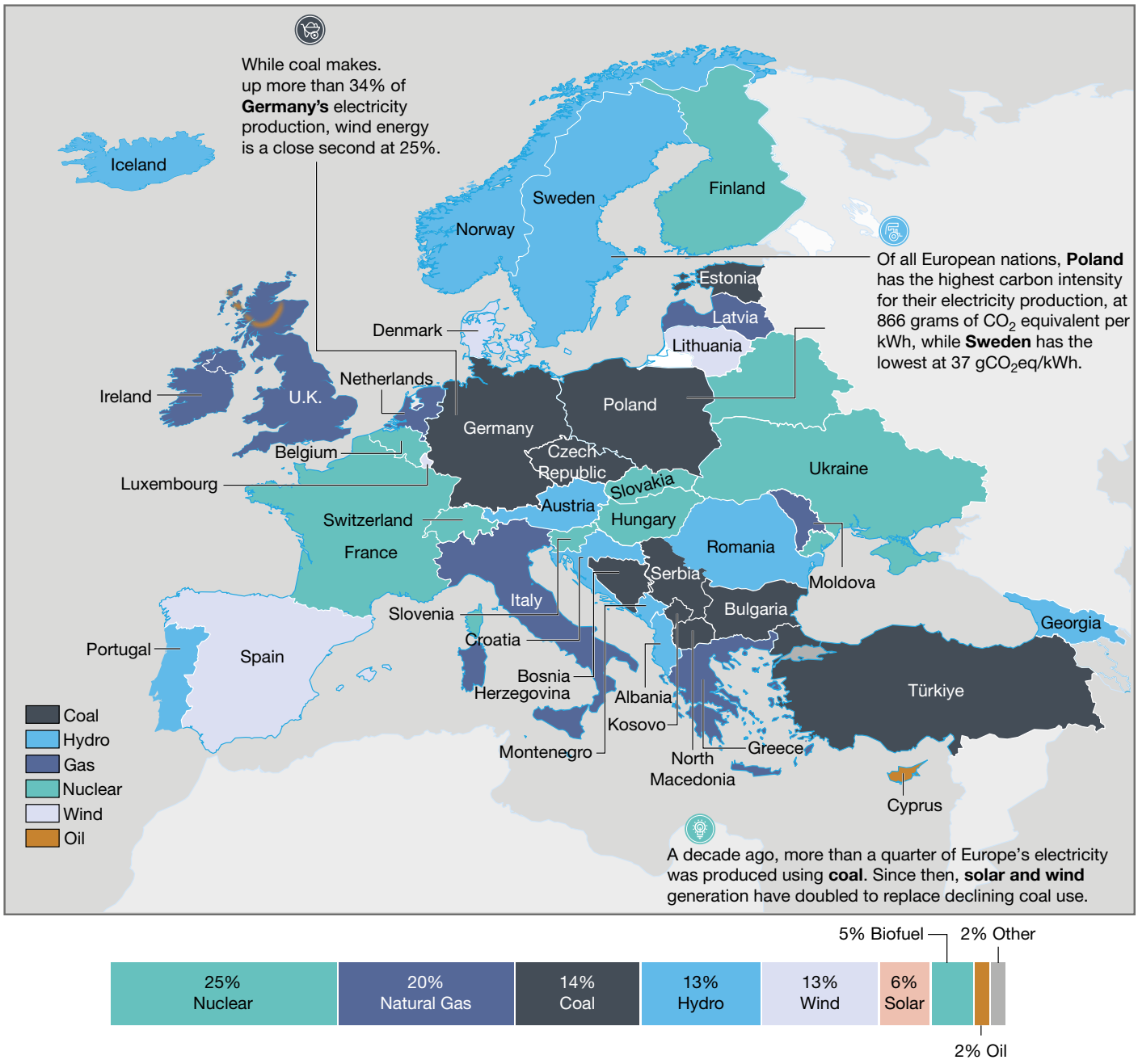
António Guterres, UN Secretary-General



5.3.2 The history of energy transitions, 1800–2020

Many of these countries have the advantage of a suitable physical environment allowing them to generate hydroelectricity or geothermal power. They are also wealthy developed countries with the capital to invest in new renewable technologies and infrastructure (see Figures 3.3.3 and 3.3.4).

Although clean energy has gained momentum in Asia, coal still made up over half of the continent's electricity generation in 2023. Asia is also the region that relies most heavily on coal for energy, so decarbonisation will be a challenge with continued rises in population and economic growth. No country in Asia uses solar, wind or nuclear energy as their primary source of energy, even though their combined share of these renewables has doubled in the last 10 years. Asia is expected to increase the share of renewables in power generation in the future. Initially, solar energy installations will be more heavily funded, but after 2031 wind power capacity will also accelerate. Nuclear power is also being considered by several countries in Asia to reduce their reliance on imported energy.

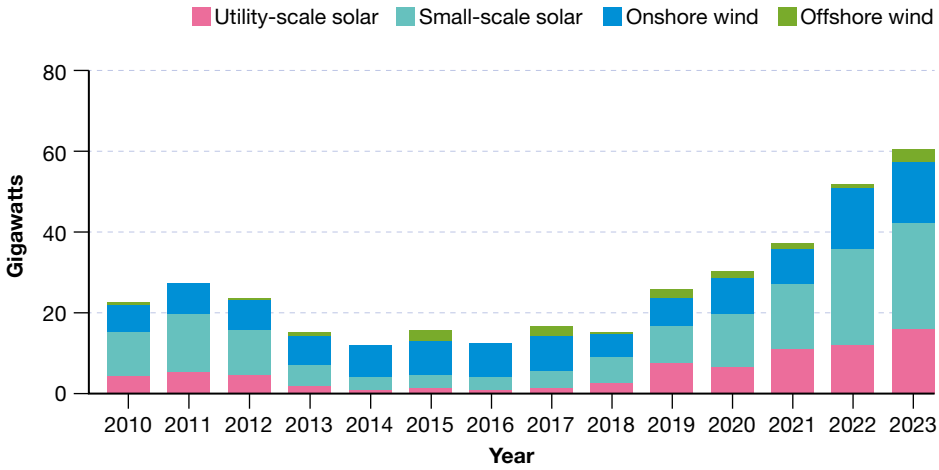


5.3.3 Europe's biggest sources of energy 2022

Trends in renewable energy investment

The 2022 global energy crisis laid bare the vulnerability of energy systems that were heavily dependent on fossil fuels. The crisis made clear that there had not been enough investment in renewables. Global investment into such technologies reached a record high of US$1.3 trillion in 2022, but this will need to triple to limit global warming to 1.5°C. The only way to tackle climate change effectively is to invest in clean power and infrastructure.

Solar photovoltaic systems and onshore wind farms are the cheapest options for clean energy generation in most countries. Solar investment has been increasing by 38 per cent each year. China led the world in renewable energy investment in 2022, spending $164 billion on new solar farms and $109 billion on new wind farms. The United States also invested $50 billion in solar and wind technologies and the EU $39 billion. The EU's mix of investments in renewable energies is illustrated in Figure 5.3.4.



5.3.4 Annual increase in renewable energy production, showing another record year for renewable additions in Europe, 2023

The world energy outlook

The International Energy Agency (IEA) is a Paris-based intergovernmental organisation that provides policy recommendations, analysis and data on the entire global energy sector. It works with governments around the world to shape their energy policies for a secure and sustainable future. The IEA plays a crucial role as it realistically assesses the current situation to alert policymakers to what needs to be done to limit global warming to 1.5°C. Each year it publishes the World Energy Outlook (WEO).

In the 2022 WEO, the IEA released its Stated Policies Scenario (STEP) to provide a more conservative benchmark for the future of the global energy industry. This is because it does not take for granted that governments will reach all the goals that they have announced. Instead, it looks at what has been put in place to reach these energy objectives, considering not just existing policies and measures, but those under development. What is most important is that a realistic assessment of the energy system is made, predicting where it might end up without interference from policymakers to ensure that 1.5°C is not exceeded. The WEO does not assume that aspirational targets are met, unless they are backed up with the details of exactly how they are going to be achieved.

Figure 5.3.5 provides an insight into the energy transition underway:

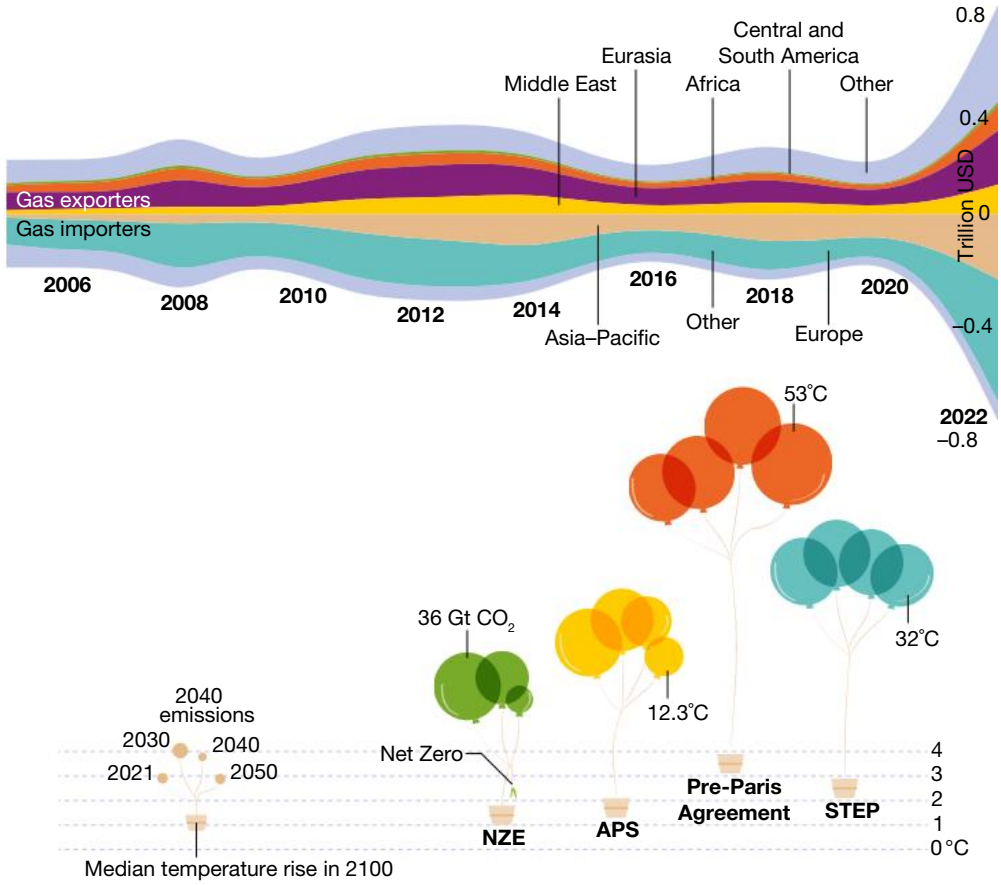
- **Pre-Paris Agreement:** the scenario if there had been no reduction in greenhouse gas emissions
- **STEP:** how the energy system will evolve if current policy settings are retained, but this must be substantiated with detail on how it will be done
- **Announced Pledges Scenario (APS):** where governments are given the benefit of the doubt that they are going to achieve their targets in full and on time. This scenario represents the extent of the world's collective ambition when it comes to tackling climate change
- **Net zero emissions (NZE):** the main goal of capping global warming at 1.5°C.

What is evident from Figure 5.3.5 (overleaf) is that even if the world's collective ambition to limit global warming falls short of the targets, it is even more worrying that many nations are already not meeting their targets.

It was the IEA that warned in 2022, that the world's energy system was vulnerable and there needed to be a major increase in clean energy investment flows to secure a smooth energy transition. It also advised that this needs to happen alongside a shift towards support for and much higher investments in developing countries and emerging markets.

Did you know?

Asia is and will continue to be the world's largest market for renewable energy investment, with the most significant investment in developing new installations in China, India, Japan and South Korea.



5.3.5 The cost of global gas imports from 2006 to 2022, when the energy crisis occurred. The graph shows various scenarios of the impact of policies tackling climate change from 2021 to 2050. Red balloons represent the pre-Paris Agreement, indicating the highest carbon emissions and temperature rise. The blue balloons, denoting STEP, show a modest drop in carbon emissions and reduced global temperatures. The yellow balloons for APS show a greater drop in carbon emissions, limiting the temperature increase further, but still above 1.5°C. The NZE scenario's green balloons show what is needed to keep the increase in temperature below 1.5°C.

Activities

Acquiring and processing geographical information

1 Describe the changes in the generation of power from fossil fuel sources and renewable sources over the last two decades.

2 Define an energy transition.

3 Name the main energy transitions that have already happened in the world.

4 Describe the current energy transition and justify the urgent need to accelerate it.

5 Explain what is needed to avert a climate disaster.

6 Describe the trends in renewable energy investments and assess whether they are adequate.

7 Explain the significance of the Stated Policies Scenario (STEP).

Applying and communicating geographical understanding

8 Study Figure 5.3.2. Estimate how many terawatt hours were consumed from each of the following sources in 2000:

- traditional biomass
- coal
- oil
- gas
- nuclear
- renewables

9 Study Figures 5.3.3 and 5.3.4 and the text under the headings, An energy transition and trends in renewable energy investment. Write a paragraph comparing Europe and Asia's biggest sources of energy. Account for your findings.

10 Study Figure 5.3.5. Complete the following table.

Scenario	Emissions	Median temperature rise
Pre-Paris Agreement		
APS		
STEP		
Net zero emissions		

UNIT 5.4

Sustainability in global energy production: Challenges and responses

The energy sector holds the key to averting the worst effects of climate change. The transition to a net zero world by 2050 is one of the greatest challenges humankind has ever faced, and it must meet it to ensure that the planet remains liveable. It requires a complete transformation of how we produce and consume what we need, and how we move around. Across the world, there is a growing coalition of countries, businesses and institutions pledging to get to net zero emissions. However, the commitments made by governments to be acheived by 2023 fell far short of what is necessary to avert a climate disaster. The energy transition must be accelerated, and quickly. Policymakers must shoulder the challenging task of tackling the seemingly opposing agendas of energy security needed for economic growth against the need to transition to low-carbon energy resources. In the face of conflict and uncertainty, the overarching goals must be halting climate change and achieving sustainable development.

Almost 200 countries committed to reducing carbon emissions, but their commitment levels have varied. Some have reduced their emissions, while others have continued to grow their emissions, despite promises of further decarbonisation. Global regulatory bodies responsible for energy transition have been uneven in their policy positions across the world, with some more interested in change, particularly the speed of change, than others.

Costa Rica leads the charge

Costa Rica, a small nation in Central America, is well known for its commitment to environmental sustainability with a strong record in tackling deforestation. It has set ambitious goals to become carbon neutral, with 100 per cent of its energy generated from renewable sources, such as hydroelectricity, wind, solar and geothermal power. Since 2014 it has successfully produced 98 per cent of its power from these renewable sources.

In the 1970s the government started investing in hydroelectric power, recognising the suitability of the country's physical environment with its high rainfall and many rivers. Hydroelectric power now provides 70 per cent of the country's electricity. Concerned that climate change might disrupt rainfall patterns, Costa Rica added other renewable sources to its energy mix, such as wind, geothermal and solar. The mountainous terrain and consistent trade winds suit wind farms, and, as the country sits on a tectonic plate boundary, geothermal power can be tapped. One obstacle Costa Rica faces is transport and reliance on oil, so it has promoted public transport and electric vehicles.

Costa Rica provides an excellent model to other countries on how to transition to sustainable renewable resources. It also collaborates with neighbouring countries and exports energy to them, assisting these countries to lower their fossil fuel dependence.

The European Union's Green Deal

In 2023 the EU launched the Green Deal, a package of policies designed to assist countries on the path to a sustainable green energy transition. The EU set itself a legally binding target of achieving net zero carbon emissions by 2050, with an immediate target of reaching a 55 per cent reduction of 1990 levels, by 2030. As only 22 per cent of the EU's total energy consumption came from renewables in 2021, this was an ambitious project. Under the new laws, countries that fail to add enough renewable resources in the form of solar or wind installations will be fined by the EU. To reach the target by 2030, the share of renewables in each country must rise 0.8 per cent annually by 2025 and after that by 1.1 per cent each year. This should generate more than 100 gigawatts of new clean energy each year across the bloc. More specifically, the transport, industrial and housing sectors will have their own targets to meet.

Did you know?

Carbon capture is the process of removing carbon dioxide from large power and industrial plants and injecting it into deep geological formations.

The US *Inflation Reduction Act*

In a sign that the climate crisis has galvanised policy support, the landmark *Inflation Reduction Act 2022* (IRA), commits more than US$370 billion to accelerate the transition to net zero emissions in the United States. It provides new support and long-term visibility of decarbonisation to address climate change and provide energy security. This will bolster efforts to lower greenhouse gas emissions in the United States to less than 40 per cent of 2005 levels. This comes on top of the US$190 billion *Infrastructure Investment and Jobs Act 2021* for cleaner energy and mass transit. Along with the IRA, the United States is the first country to approach the challenge with incentives, rewriting the rules of industrial policy and changing the politics of climate change. It will continue to have a significant impact on incentivising investment in the transition to net zero emissions (see Figure 5.4.1).

The IRA will:

- supercharge renewable energy and transform energy demand in the United States, thereby achieving industrial decarbonisation
- provide incentives to reduce the cost of clean manufacturing from solar and wind to batteries and hydrogen
- invest in technologies that will dramatically lower the costs of clean energy and green finance.

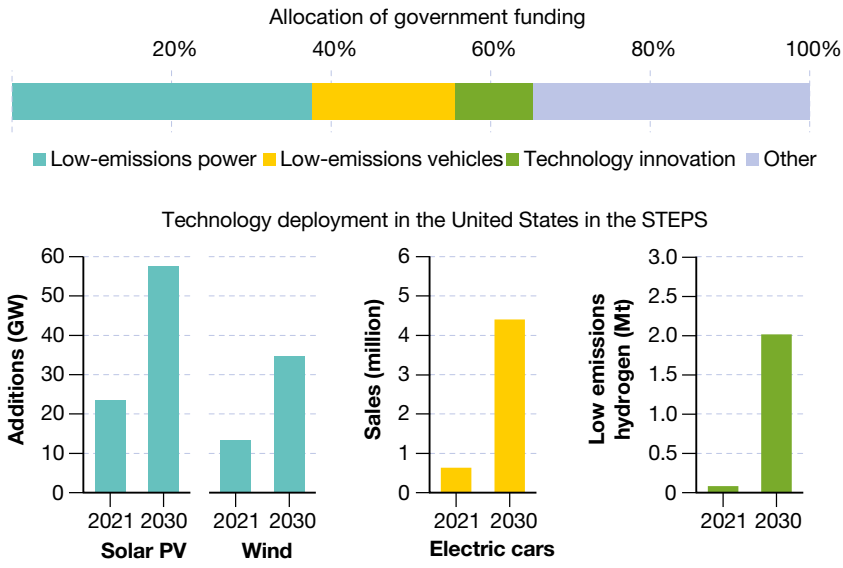
With the IRA committing to years of support for green technologies, including solar, hydrogen, wind, **carbon capture** and storage, efficient heating and appliances, and electric vehicles, there are many challenges and opportunities. The big winners are likely to be new and developing technologies of carbon capture and **green hydrogen**. These technologies are being provided with bigger subsidies, so are more likely to attract investors.

The IRA has had a significant global impact, increasing the production of renewable energy sources. As it is heavily subsidised by the US government, other countries are putting pressure on their own governments to do the same, to kickstart the production of new renewables. Of course, this is fraught with political problems and conflict, as governments grapple with many issues, national and global.

Did you know?

Green hydrogen is a clean energy source as it only emits water vapour and leaves no residue in the air. This gas has long been used as a transport fuel.

The IRA has also impacted global supply chains as the United States moved quickly to secure necessary supplies. This may cause problems for other nations seeking the same supplies and will increase geopolitical complexities globally. The IRA is an ambitious approach to clean energy and manufacturing in the United States, but there are concerns about the availability of crucial inputs, such as graphite and lithium, holding back progress. Gaining permits and approvals could also slow the speed of rolling out crucial infrastructure. While there is plenty of funding to upgrade industrial facilities, there is little available to improve the US electricity transmission network and this presents a key risk to the transition to net zero emissions.



5.4.1 Government funding in the IRA, the *Infrastructure Investment and Jobs Act* and technology deployment in the United States, 2021–30

China's 2025 renewable energy targets

China is leading emerging economies in its efforts to improve energy access and sustain economic development while transitioning to cleaner resources with a renewable-dominated power system in the country's future. China's renewable energy targets are listed in Figure 5.4.2.

Indicators	Unit	2020 level	2025 target
1 Renewable electricity utilisation			
■ Renewable energy consumption share	%	28.8	33
■ Non-hydro renewable energy consumption share	%	11.4	18
■ Renewable electricity generation	trillion kWh	2.21	3.3
2 Renewable non-electric utilisation (geothermal heating, biomass heating and fuel, and solar heating)	million tonnes of standard coal	–	>60
3 Total renewable consumption	billion tonnes of standard coal	0.68	1
4 Non-fossil fuel power generation share	%	33.9	39
5 Electrification rate	%	27	30
From 2021 to 2025, more than 50% of the country's incremental electricity and energy consumption shall come from renewables.			

5.4.2 China's 2025 renewable energy targets

Did you know?

South Korea and Japan have announced an intention to move to a partial 'hydrogen economy' to decarbonise.

Australia's 2022 Integrated Systems Plan

The future of Australia's energy is a matter of great national urgency. The Integrated Systems Plan (ISP) supports Australia's net zero emissions ambitions to address climate change. In 2022, the Australian Government formalised its 2030 emissions reduction target at 43 per cent of 2005 levels by 2030, to align with the Paris Agreement. Both the federal and all state governments have confirmed their objectives of a net zero emission economy by 2050 or sooner.

The ISP is intended to transform the National Energy Market (NEM) from fossil fuel energy to a greater mix of **firmed renewables** and provide a reliable, secure and affordable energy supply to the eastern and southern states of Australia. As part of the transition to renewables, people will be able to draw on low-emission electricity for their transport and to run their homes and businesses. This will require levels of investment in the generation, storage and transmission of energy exceeding the combined total of all previous investments in Australia. The IPS provides a clear roadmap for each decade through to 2050.

5.4.3 The Tesla 100MW 'big battery' at Hornsdale Wind Farm, South Australia

Did you know?

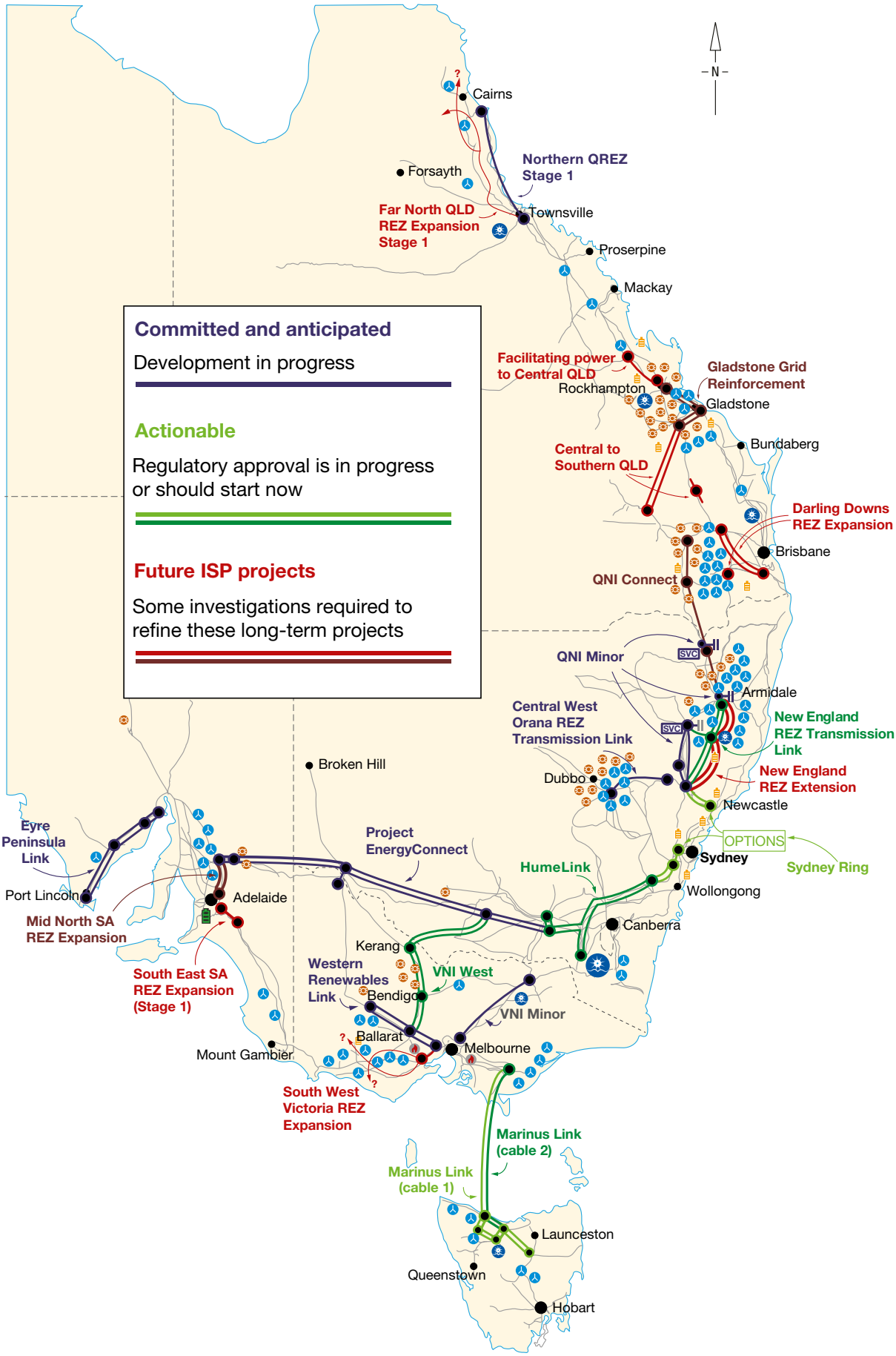
Firmed renewables are energy sources such as wind or solar, where the output is maintained to ensure that enough energy is always available. Technological developments in large battery storage to support this also need to be increased (see Figure 5.4.3).

Energy transition in Australia is accelerating in line with what is happening globally, strengthening the shift to renewable energy sources. Investment in these resources and the infrastructure that transmits the power is the key strategy. Australia has some of the best renewable resources in the world, especially solar and wind power. To take advantage of these opportunities there needs to be substantial investment in modernising the electricity system, including building transmission lines and providing long-duration storage. The new transmission towers that will connect the geographically spread renewable sources to consumers need to start working on the earliest planned schedule. A firm commitment from all stakeholders is crucial if Australia is to secure a sustainable energy future and reach net zero emissions by 2050.

The energy transition in Australia requires a double transformation—electrification of the economy while switching to firmed renewables. This will require:

- doubling the amount of energy delivered from 180 terawatt hours in 2023 to 360 terawatt hours in 2050, to power the electrification of transport, industry, offices and homes, thereby replacing petrol, gas and other fuels
- lowering coal-fired thermal generation capacity by 60 per cent by 2030
- tripling the amount of wind and solar energy generated by 2030, doubling it again by 2040, and then doubling it again by 2050. Much of this will be built in renewable energy zones, including offshore wind farms
- harnessing the generation and feed-in capability of millions of individual consumer-owned solar photovoltaic systems exporting power back into the grid
- as weather-dependent wind and solar sources start to dominate, the NEM must effectively match when and where the power is generated, with when and where it is needed. There is an urgent need to develop effective storage such as grid-scale batteries over the next decade to manage daily and seasonal variations in output from solar and wind generation and ensure their reliable availability.

The successful transformation of the NEM involves many projects linked by 10 000 kilometres of new transmission lines to connect these developments and efficiently deliver firmed renewable energy to consumers. The extent of such developments in Eastern Australia is evident in Figure 5.4.4.



5.4.4 Energy generation and transmission projects planned for Eastern Australia

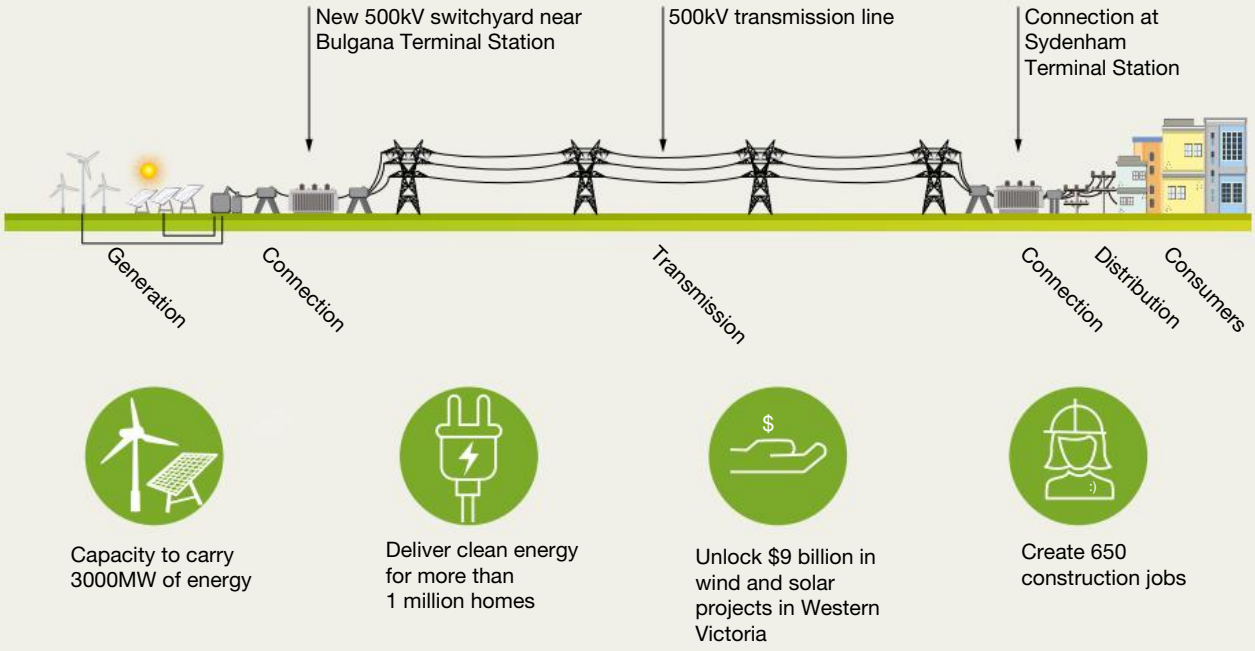
● SPOTLIGHT

The Western Renewables Link

The Western Renewables Link is a crucial infrastructure project designed to provide Victoria with cleaner, more sustainable energy. The state's richest wind and solar resources are in its west and north, and given their potential, the region has been declared a key Renewable Energy Zone (REZ). The Western Renewables Link is the key to enabling Victoria to meet its renewable energy targets. Having achieved 20 per cent by 2020, it aims for 40 per cent by 2025 and 50 per cent by 2030. However, the existing transmission network in Western Victoria is already at capacity, meaning only limited power can be transported out of the region into the wider grid network. This will undoubtedly impact energy security and electricity prices for consumers over the long term. The Western Renewables Link is a proposed new 190-kilometre overhead high-voltage electricity transmission line that will provide the crucial connection to carry renewable energy from Bulgana in Western Victoria to the Sydenham Terminal Station in Melbourne's north-west (see Figure 5.4.5). This will reduce the extreme congestion of the existing transmission network and unlock up to 900 megawatt hours of renewable energy capacity.

There have been objections from landholders and communities along the route of the Western Renewables Link, wanting it to be buried underground, but the costs of doing so are high. Farmers rallied outside Victoria's Parliament House in 2023, bringing their tractors and horses in protest of restrictions on machinery and irrigation near easements and under transmission lines. For these projects to be successfully delivered, a social licence needs to be created and maintained in the interest of all stakeholders.

Accessing the vast reserves of renewable energy in Victoria and making them available to the national electricity market will play a key role in energy security and place downward pressure on energy prices. The Western Renewables Link is a vital project to help Australia transition to a low-carbon future in line with the Paris Agreement.



5.4.5 The Western Renewables Link is a project where a proposed 500kV double circuit transmission line will run from Bulgana to Sydenham in Western Victoria.

An inclusive global energy transition

While wealthy countries grapple with the energy transition, poorer developing countries face a far bigger challenge. They are trying to grow their economies, alleviate poverty, give their populations access to the basics and provide energy—all while needing to avoid the carbon-intensive pathways that the rich countries previously took to achieve these outcomes. This challenge is made more difficult by the cost of capital for renewable resources in developing countries where solar photovoltaics are two to three times more expensive than in advanced economies. Developing countries need cheap, clean energy which is more cost-effective for them than fossil fuel alternatives.

Many countries are sliding into energy poverty because of COVID-19 and the global energy crisis. Seventy-five million people were unable to pay for electricity in 2022. Poor households consume one-tenth of the energy that wealthy households do, yet it takes a much larger proportion of their income. Developed countries need to collaborate to bring down the cost of capital and give poor communities a lift up into the new energy economy. Worsening energy poverty trends need to be turned around for a successful global energy transition that is inclusive. A global threat demands a global response.

Activities

Acquiring and processing geographical information

1 Describe the energy mix of Costa Rica. Assess its sustainability.

2 Describe the EU's Green Deal as a path to achieving net zero emissions by 2050.

3 Describe what the United States has put in place to accelerate its transformation to net zero emissions.

4 Explain what could hinder the progress of the United States in achieving this goal.

5 Outline the plan put in place by Australia to address climate change.

6 Define a firmed renewable.

7 Explain what needs to be done to assist developing countries in the energy transition process. Why this is important?

Applying and communicating geographical understanding

8 Hold a class discussion on the punitive approach of the EU and the incentives approach of the United States. Decide which is more likely to be successful. Write a paragraph justifying your answer.

9 Using the internet, investigate carbon capture and green hydrogen technological advancements. Prepare a report on the role that they may play in the global energy transition.

10 Study Figure 5.4.4. Select two planned energy projects and undertake internet research on them. Present your findings as a slideshow presentation.

SECTION

2 Rural and urban places

Humans are, by their nature, social beings. They have an innate, biologically driven tendency to develop and form interpersonal connections. These social bonds, formed early in life, establish the foundation for humans to coexist in and across groups. It is an essential part of the human experience. It is not surprising then that they should group together in the form of settlements.

In Geography, a settlement is a community of people living in a particular place. The complexity of settlements ranges from a single rural dwelling to several dwellings grouped together to form a hamlet or village, to the largest cities and their surrounding metropolitan areas. All such places are dynamic—they change over time. Understanding the processes driving these changes is of particular interest to geographers. With this knowledge and understanding, we are well placed to propose and implement strategies that enhance the sustainability of such places and address the challenges resulting from their rapid growth.

Content focus

In this section, students investigate the size, pattern and spatial distribution of settlements, urban hierarchies of settlements, and the nature of urbanisation and urban growth at a global scale. They examine settlements with a small ecological footprint and high level of wellbeing and explore strategies for the sustainable management of rural and urban places. Students contextualise this knowledge through a study of a rural place, an urban settlement and a large city outside Australia. Case studies are provided for Tamworth—a place in rural setting, Darling Harbour Precinct—a place in an urban setting, and New York City and Mumbai— two case studies for large cities outside Australia.

In this section

Chapter 6	Rural and urban settlements
Chapter 7	A rural place: Tamworth
Chapter 8	An urban place: Darling Harbour Precinct
Chapter 9	A city outside Australia: New York City
Chapter 10	A city outside Australia: Mumbai

CHAPTER

6 Rural and urban settlements

Few people choose to live in isolation. Instead, they tend to live in clusters, ranging from small hamlets and villages with small populations, to megacities with tens of millions of people. These places are an important focus for most aspects of human existence: economic activities, transportation systems, communications, the media, political and administrative systems, education, culture and entertainment. The geographically informed person understands the varying forms of human settlements in terms of their size, location, morphology and history. They also have an appreciation of the relationships among settlements—their functional connections and economic specialties. Relationships between settlements are shaped by trade and the movement of raw materials, finished products, people, capital and ideas. Patterns of settlement across Earth's surface differ markedly from region to region and place to place. The numbers, types and range of the functions of settlements change over space and time.

In this chapter, students investigate different types and hierarchies of human settlements, the factors that influence settlements, urbanisation and urban growth, the challenges of rural and urban settlements and strategies for sustainable settlements.

> **Human settlements are like living organisms. They must grow, and they will change. But we can decide on the nature of that growth—on the quality and the character of it—and where it ought to go. We don't have to scatter the building blocks of our civic life all over the countryside, destroying our towns and ruining farmland.**
>
> **James Howard Kunstler, US author and social critic**

6.0.1 The remote village of Banaue in the Batad region of the Philippines

Chapter glossary

affordable housing housing that is appropriate for the needs of a range of very low- to moderate-income households and priced so that these households can still meet other basic living costs, such as food, clothing, transport, medical care and education

cultural geography the study of the relationship between culture and place

brownfield sites that have previously been developed

conurbation a large urban agglomeration formed by the gradual growth and merging of formerly separate towns

greenfield areas available for development on the edges of urban areas or in suburban locations

hamlet a small settlement, smaller than a village; typically home to people focused on a single economic activity, such as farming

hinterland a settlement's sphere of economic influence

informal housing housing that does not comply with local authority requirements for conventional (formal) townships; typically unauthorised and invariably located upon land not zoned or designated for residential use; also called slums or shanty towns

megacity a city with more than 10 million inhabitants

metropolitan area a city and its commuting zone, consisting of suburban, peri-urban and rural areas economically and socially linked to the city

peri-urban the area just beyond the metropolitan fringe, the interface between city and country, but within the economic and social catchment of a large urban centre; the area on the urban periphery into which cities expand or which cities influence

pour-flush toilet a toilet similar to a regular flush toilet, except that instead of the water coming from the cistern above, it is poured in by the user

range the maximum distance people are willing to travel to access a particular good or service

settlement pattern the distribution of buildings in a settlement

site the characteristics of the place in which a settlement is located

situation where a place is in relation to other places or a prominent physical feature, such as a river or mountain range

social housing housing provided by government agencies or non-profit organisations for people on low incomes or with particular needs

threshold the minimum number of people required to support a particular service

urban agglomeration cities whose contiguous territory has surpassed the 'city proper' or local administrative boundaries and includes the adjacent suburban and peri-urban areas

urban consolidation policies directed at increasing the density of housing in established residential areas

urban decay the physical deterioration of the urban environment

urban renewal the redevelopment of blighted urban areas, so that they better meet the needs of people

urban sprawl the spread of urban land uses into undeveloped land on the outskirts of a city

world city a centre of global economic and cultural authority

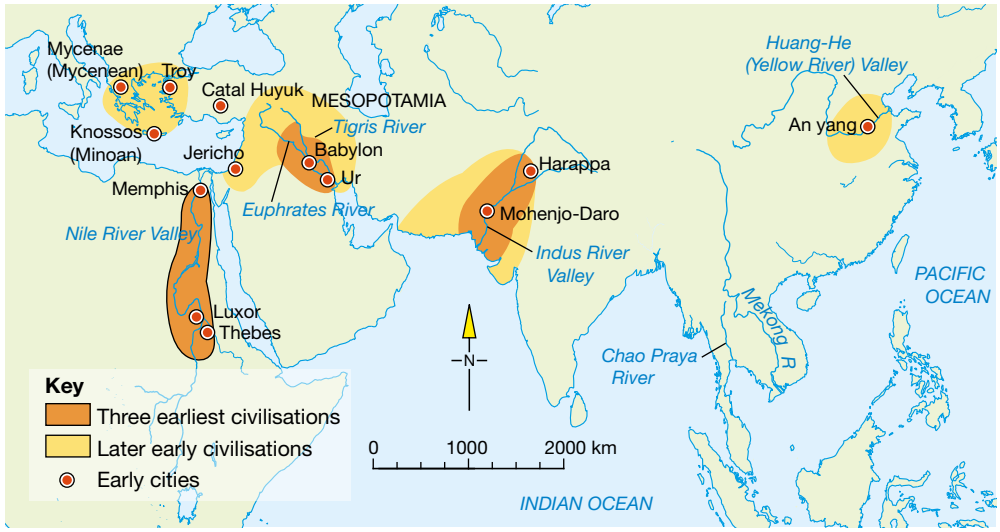
UNIT 6.1

The size, pattern and spatial distribution of settlements

6.1.1 The ruins of the Ancient Greek city of Ephesus, İzmir Province, Türkiye. Ephesus was built in the tenth century BCE on the site of Apasa, the former Arzawan capital. Humans began inhabiting the area surrounding Ephesus by the Neolithic Age (about 6000 BCE).

At the end of the last ice age, about 10 000–11 000 years ago, the world's population largely comprised small bands of people living at a subsistence level on subtropical lands. These groups moved from place to place in their search for food. Two technological advances—the domestication of animals (sheep and cattle) and the cultivation of grains such as wheat, rice and maize—transformed these migratory hunters and gatherers into sedentary farmers. These agricultural advances enabled people to produce a surplus of food. This surplus resulted in the emergence of a division of labour and trade. Farmers could trade their extra food for specialist goods like metal tools, ceramics and clothes. Markets—the spaces in which this trade took place—became a central land-use feature of the earliest settlements.

By the fourth and third millennium BCE, civilisations had developed independently in the river valleys of Mesopotamia (which includes parts of modern-day Iraq, Syria, Iran and Türkiye) (see Figure 6.1.1), India, China and Egypt (see Figure 6.1.2). Each of these civilisations, and the urban places they would spawn, have features in common. They were developed on large, fertile alluvial flood plains adjacent to a major river, which provided a permanent water supply. They were in places with relatively dry, warm, subtropical climates. These conditions helped to maintain soil fertility by minimising the leaching of nutrients from the soil profile.



6.1.2 Civilisations and cities before 1500 BCE

Did you know?

The ancient city of Uruk, located on the banks of the Euphrates River in Mesopotamia, is generally considered to be the world's oldest city. It was first settled c. 4500 BCE. At its height (c. 2000 BCE), Uruk had 50 000–80 000 residents living in a walled area that was 6 square kilometres in size, making it the largest city in the world at the time.

Around 3000 BCE, larger urban centres emerged with an increasingly wide range of functions, including trade, commerce and administrative functions, made necessary by increasingly sophisticated societies. These settlements were typically controlled by religious leaders or powerful secular rulers. As settlements continued to grow, it became necessary to develop and enforce a legal code and raise an army to defend them.

Site and situation

Site describes the characteristics of the place where a settlement is located. Site was a major determinant in the development of early settlements. **Situation** refers to a place's location in relation to other places or prominent physical features, such as rivers or mountain ranges. Situation, along with a range of human and political factors, determined whether early settlements remained small or grew into larger towns or cities.

The most important factors in determining the site of settlements included the following.

Access to water: An accessible source of water. In places with low and/or unreliable rainfall, settlements developed where the watertable was close enough to the surface to allow wells to be constructed. Over time, as technologies improved, humans found ways of moving water over long distances. For example, the Romans built aqueducts to transport fresh water to developing cities throughout the Roman Empire (see Figure 6.1.3). Today, large-scale water storage, transport and treatment infrastructure supply the water essential for settlements.

Too much water was, however, an inhibiting factor. In some notable instances, coastal wetlands have been drained to create land suitable for settlement. For example, the Acadians, an ethnic group of French origin who settled in the New France colony of Acadia in the Canadian Maritime provinces during the seventeenth and eighteenth centuries, are noted for their draining of coastal wetlands. The Acadians lived mainly in the coastal regions of the Bay of Fundy where they reclaimed farming land from the sea by building dikes to control water and drain wetlands. Another example is the polder lands of the Netherlands (see Figure 6.1.4). The polders are tracts of lowland reclaimed from the sea and wetlands by the construction of dikes roughly parallel to the shoreline, followed by drainage of the area between the dikes and the natural coastline. A final example is the Pontine Marshes of Central Italy. The marshes were drained and infilled in the 1930s to create 80 000 hectares of agricultural land and are now home to some 520 000 people.

Defence: Protection from potential enemies was an important site-based consideration for early settlements. Easily defended hilltop locations (see Figure 6.1.5) were favoured, as were sites on meander bends where the settlement would be surrounded on three sides by water. An alternative was to retreat behind fortified walls. Jericho, founded in 9600 BCE, was the first walled city. The remnants of city walls are a common cultural artefact in many European towns and cities. These include Segovia and Toledo, Spain; Dubrovnik, Croatia; Rhodes, Greece; Siena, Italy; and York, England. Given the nature of modern weaponry, the consideration of defence is not as important as it was in the past.

Fertile soils and food supply: The fertility of soil determines the quantity and quality of farm produce needed to sustain non-rural settlements. Deep alluvial soils were favoured, as were places suitable for both the growing of crops and the grazing of animals. Given the sophisticated nature of today's transport systems, this locational consideration is not as influential as it once was.

6.1.3 Ancient Roman aqueduct, Plaza del Azoguejo, Segovia, Spain

6.1.4 Dyke protected, reclaimed polder in the Netherlands

6.1.5 Carcassonne, a hilltop town in southern France, is famous for its medieval citadel, La Cité, with numerous watchtowers and double-walled fortifications. The first walls were built in Gallo-Roman times, with major additions made in the thirteenth and fourteenth centuries.

6.1.6 The Hong Kong–Zhuhai–Macau Bridge in China is a 55-kilometre bridge–tunnel system consisting of a series of three cable-stayed bridges, an undersea tunnel and four artificial islands. It is the longest such crossing in the world.

6.1.7 The Swiss mountain village of Lauterbrunnen. A range of site-related factors have contributed to the development of this settlement—topography, nodal point, aspect, bridging point and water supply.

Bridging points: Settlements often developed at points at which rivers could readily be crossed, initially at shallow fords and later at points that could be readily spanned by a bridge. Of special significance, especially in terms of trade, was the lowest bridging point before a river reached the sea. Increasingly sophisticated bridge and tunnel engineering is transforming this locational factor (see Figure 6.1.6).

Nodal points: These are found at junctions where several valleys or mountain passes meet settlements developed to facilitate trade. Because many of the world's mountain ranges presented formidable barriers to travel, passes have, throughout history, played a key role in trade, war, and both human and animal migrations. Settlements were often established to oversee the movement of goods and people through such passes, especially when they formed part of an international border (see Figure 6.1.7).

Topography: Flat land, rather than hilly terrain, has long been preferred for building. The costs of construction are lower and movement is easier.

Aspect: Aspect is perhaps an even more important determinant than topography, especially in mountainous areas (see Figure 6.1.8). This is because the sun's rays are in the west at the hottest time of day in the afternoon, so in most cases a west-facing slope will be warmer than a sheltered east-facing slope. In the Northern Hemisphere, the north side of slopes is often shaded, while the southern side receives more solar radiation because the slope is tilted toward the sun. In the Southern Hemisphere, north-facing slopes receive more solar radiation.

Building materials: Historically, access to a supply of building materials, such as timber and stone, were important considerations, primarily due to their weight and the limits of transport technologies.

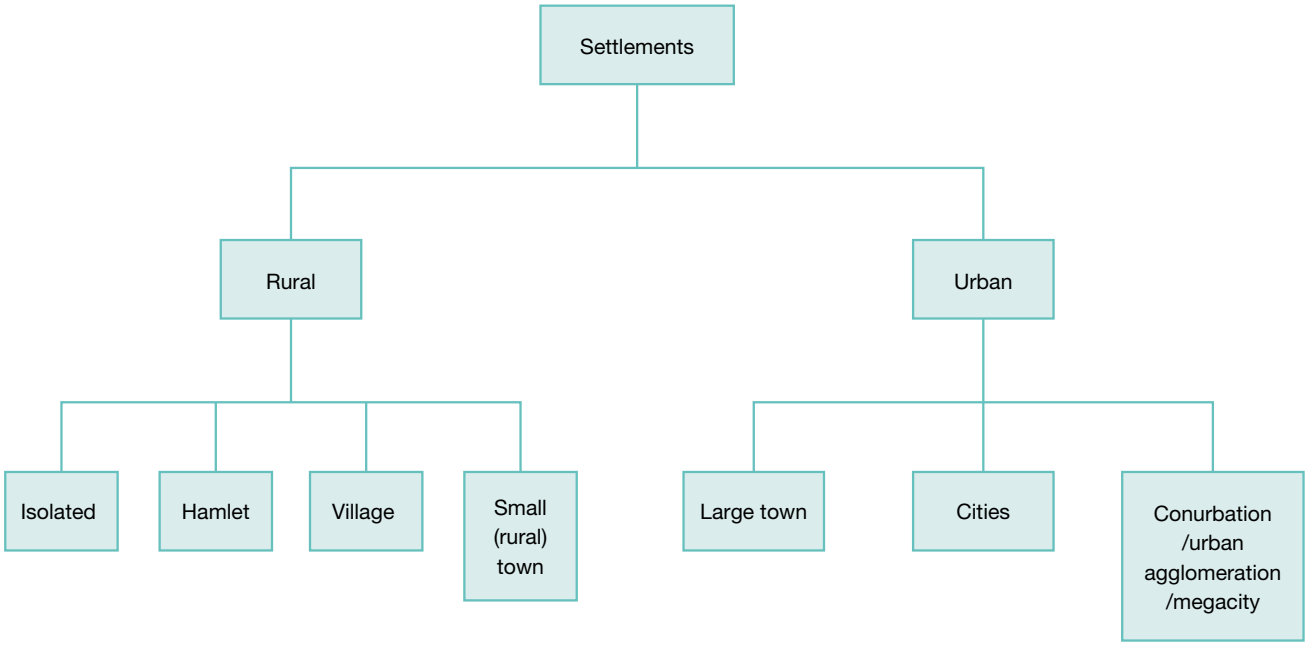
6.1.8 Livigno village, Lombardia, Italy. The pattern of settlement reflects the fact that in the Northern Hemisphere west- and south-facing valley sides receive more direct sunshine than those facing east and north.

Types of settlements

Settlements can be defined either by their principal function (rural or urban) or their size.

Settlements by function

As settlements grew, they developed a specific function or functions. A function refers to a place's main activity. All settlements, regardless of size, have more than one function. There is, however, often one function that stands out. For example, Canberra is widely associated with its role as a centre of Australia's federal government and administration; Port Kembla, Wollongong is an industrial centre; Sydney is known as a financial services centre; the Gold Coast as a tourism destination; and Dubbo as a rural service centre. Figure 6.1.9 distinguishes between rural and urban settlements.



6.1.9 Settlement types by principal function and size

DIFFERENCES BETWEEN RURAL AND URBAN CENTRES

Apart from size, there is a range of factors that distinguish rural from urban settlements. In rural settlements, most of the work available is farming-related. In some instances, it might also include mining-related activities, especially where these occur in isolated or remote places. In urban areas, most of the workforce is engaged in secondary (manufacturing) or service sector employment. Access to services such as shops, schools, hospitals, public transport and banks is often absent or limited in rural settlements. Urban areas, on the other hand, offer a diverse range of goods and services and far greater consumer choice.

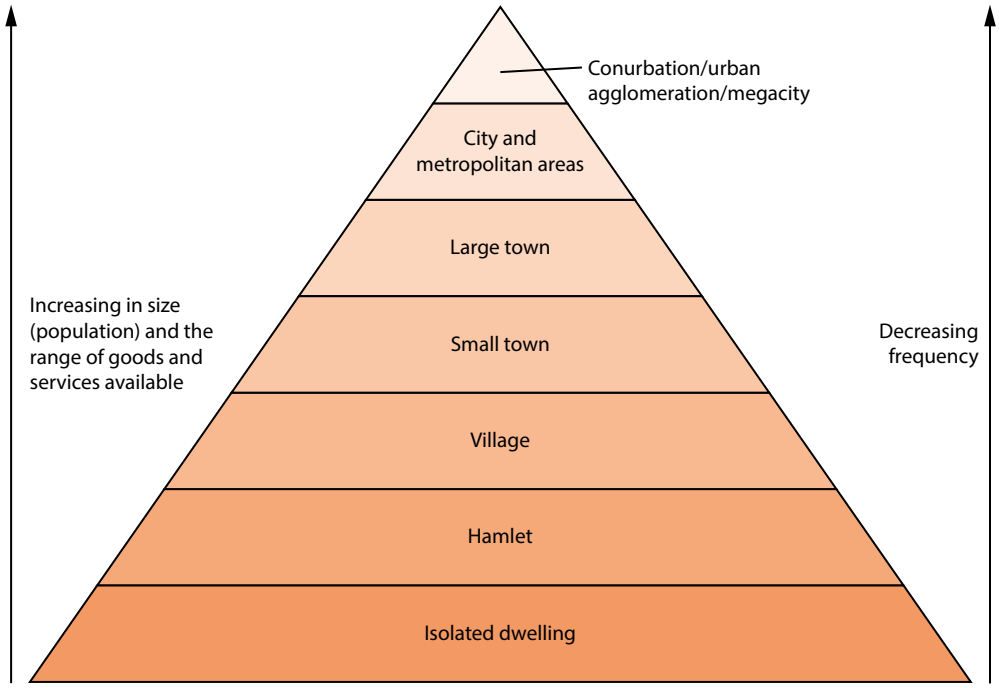
Land uses differ markedly; rural settlements tend to have buildings that are well spaced, with detached housing dominating and some light industry (often rural-related) evident. Commercial activities often line one main street. In urban areas, buildings are often more tightly packed. There may be specific areas devoted to industrial activity, and commercial activities are likely to extend over several blocks or, in the case of cities, form a core known as a Central Business District (CBD). There are also demographic differences. Rural settlements, especially those in remote places, often have an ageing population as young people move to urban areas for further education and work. Urban areas have a significant proportion of their population in the economically active age groups.

Did you know?

Hamlets are settlements that are too small to be considered a village or town. As a rule, hamlets are rural, and many of them develop around a specific site, such as a mill or a large farm. In some countries, hamlets are legally defined, while in others, it is simply a term to describe a small settlement, with no firm definition attached.

Settlements by size

Settlements vary in size, from a single isolated rural dwelling to the world's largest cities and **urban agglomerations**. The hierarchy of settlements is shown in Figure 6.1.10. The further up through the hierarchy a settlement is, the greater the range of goods and services or functions it provides.



6.1.10 Settlements by size

Did you know?

Formal administrative boundaries rarely delineate the spatial extent of an urban area. Greater Sydney, for example, is made up of 33 local government areas. Brisbane, on the other hand, is a single local government entity.

SPOTLIGHT

Names applied to large urban areas

In the past, definitions of cities, urban agglomerations and **metropolitan areas** varied depending on legal, administrative, political, economic or cultural criteria in the respective countries and regions. In other words, there was no agreed way of distinguishing between these places.

In March 2020, the UN Statistical Commission endorsed a global definition of cities to facilitate international comparison. This definition captures the full extent of a city, including the dense areas beyond the municipal boundaries. It defines a metropolitan area as a city and its commuting zone, which consists of suburban, **peri-urban** and rural areas, economically and socially linked to the city. This approach is supported by metropolitan authorities and experts and the World Urbanization Prospects (WUP).

WUP now uses the term urban agglomeration for cities with contiguous territory that has surpassed the 'city proper', or local administrative boundaries, and includes the adjacent suburban and peri-urban areas. WUP also uses the term metropolitan area to include rural areas that are socially and economically linked.

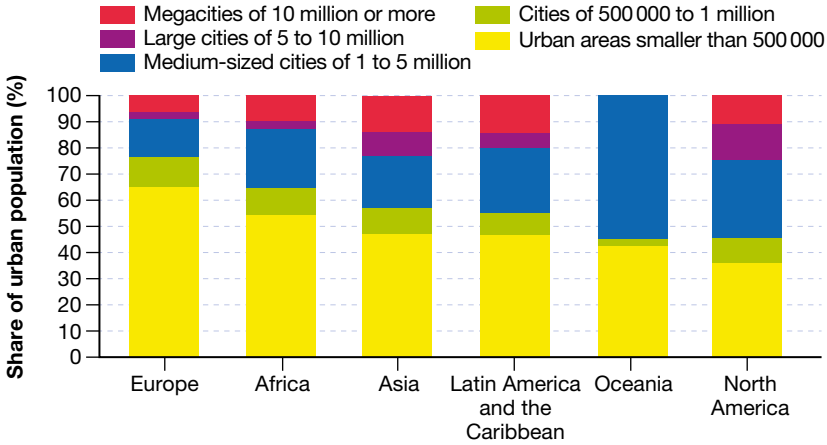
The spatial distribution of large cities

The big city is a relatively recent development. In 1900, there were only 13 cities with a population of more than 1 million people. These were London, New York, Paris, Berlin, Chicago, Vienna, Tokyo, St. Petersburg, Manchester, Philadelphia, Birmingham, Beijing and Moscow. By 1950, this number had risen to 83, and in 2023, it was 512. By 2030, it is projected that 662 cities will have at least 1 million residents.

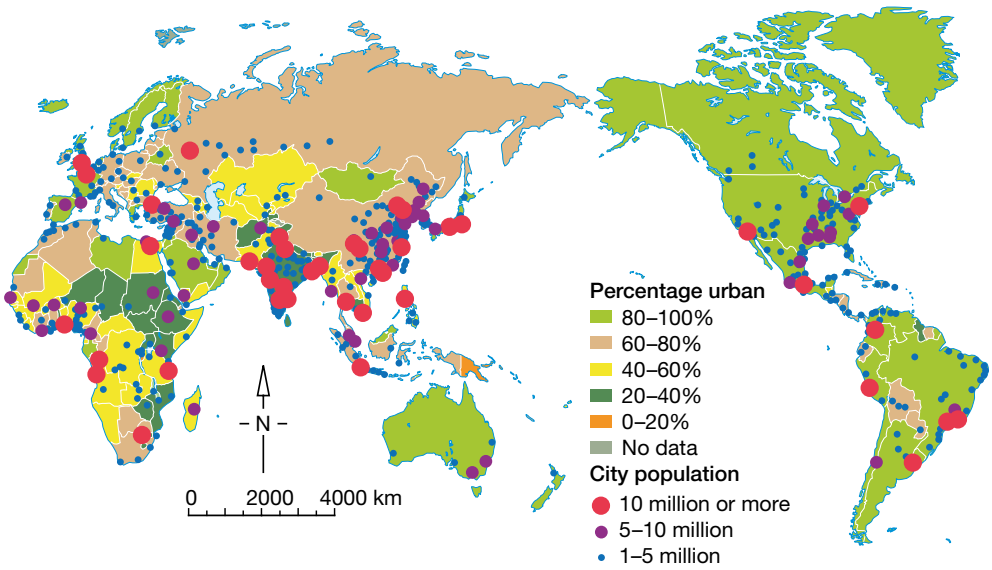
The UN defines cities with more than 10 million inhabitants as **megacities**. In 2023, the UN identified 33 megacities.

In 2023, 48 cities had populations between 5 and 10 million inhabitants. By 2030, at least eight of these are projected to exceed 10 million inhabitants to become megacities. Projections indicate that an additional 29 cities will exceed 5 million inhabitants by 2030. Of these, 15 are in Asia and 10 in Africa. By 2050, it is projected that 73 cities will have between 5 and 10 million inhabitants.

Most of the world's cities have fewer than 5 million inhabitants (see Figures 6.1.11 and 6.1.12). In 2020, there were 494 cities with between 1 and 5 million inhabitants and 1355 cities with between 300 000 and 1 million inhabitants. By 2035, the number of cities with 1 to 5 million inhabitants is projected to grow to 559, and 731 cities will have between 500 000 and 1 million inhabitants. Cities with less than 1 million inhabitants are projected to be the fastest growing.



6.1.11 Regional share of urban population by size of settlement



6.1.12 Global urbanisation rates and distribution of large cities, 2030 (projected)

As noted above, there are 40 cities with populations of at least 10 million inhabitants or more, 33 are in the developing countries. China has seven megacities, while India has six (see Figure 6.1.14). The world's 10 largest cities are shown in Figure 6.1.13.

Rank	City	Country	Population, 2023
1	Tokyo	Japan	37 194 104
2	Delhi	India	32 941 308
3	Shanghai	China	29 210 808
4	Dhaka	Bangladesh	23 209 616
5	Sao Paulo	Brazil	22 619 736
6	Mexico City	Mexico	22 281 442
7	Cairo	Egypt	22 183 200
8	Beijing	China	21 766 214
9	Mumbai	India	21 296 516
10	Osaka	Japan	19 013 434

6.1.13 The world's most populous cities, 2023

6.1.14 This striking satellite image of India at night shows the spatial distribution of settlements on the Indian subcontinent. The more intense the light, the larger the settlement.

● **SPOTLIGHT**

Determining the size of cities

Determining the size of a city can be a complicated process. It all depends on how you define the city's boundaries. Toronto, Canada, for example, has approximately 3 million people living within the 'city proper', but the population of the surrounding 'urban agglomeration' is more than twice as large, at 6.2 million, and the population of the metropolitan area is larger still, at 6.7 million (see Figures 6.1.15 and 6.1.16).

6.1.15 Toronto's population ranges from 3 million to 6.7 million, depending on how the city's boundaries are defined.

6.1.16 Toronto, Canada

Hierarchy of settlements based on function and spheres of influence

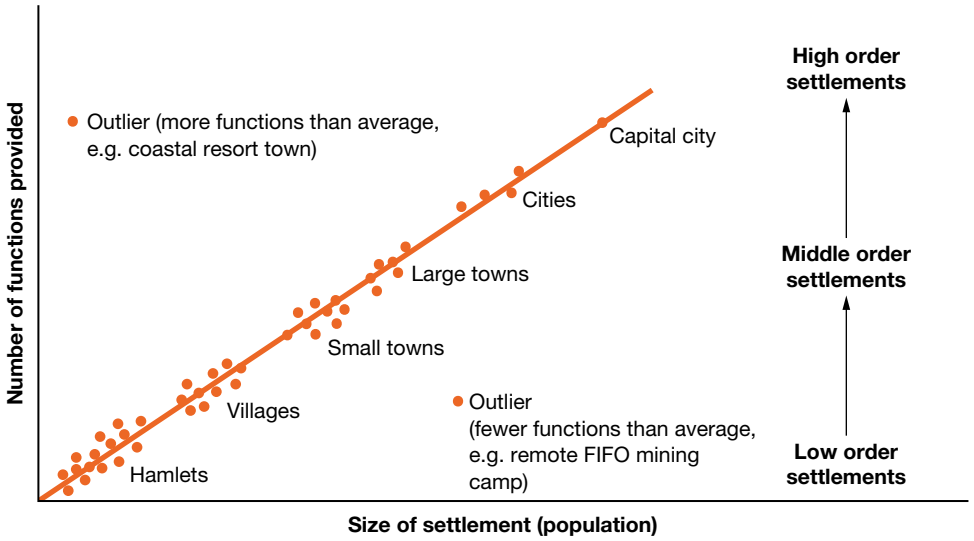
Hierarchies of settlements can be defined by population, function or spheres of influence. We have already considered the role of population. Size is important but does not determine a place's global influence. Many places are large, but their influence is limited to the country or region in which they are located.

Function

The larger the settlement, the greater the range of goods and services they can provide people. This is because a certain population **threshold** is needed to support their provision. For example, it is suggested that a population of at least 10 000 is needed to sustain a McDonald's restaurant and 15 000–20 000 people are needed to support a full-service supermarket. In summary, as settlements grow, the range of higher-order services increases. For example, specialist medical providers are only found in larger towns and cities.

Range and hinterland

Range is also an important determinant of the nature of a place's functions. That is, what is the distance that people are willing to travel to access a particular good or service? Another relevant and related geographic concept is that of **hinterland**. The hinterland of a settlement is its sphere of economic influence—the area from which it imports the things needed to sustain its population and across which it distributes the goods and services it provides (see Figure 6.1.17).

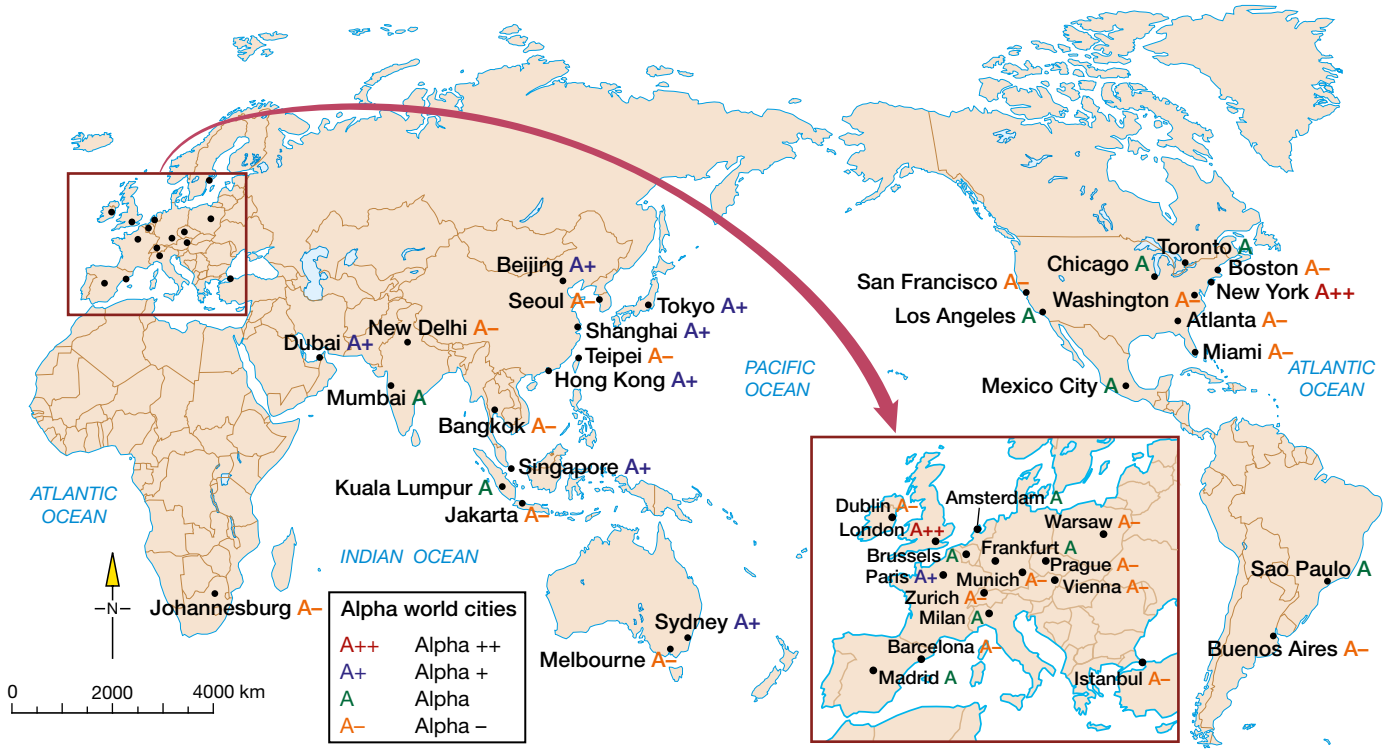


6.1.17 The relationship between settlement size and functions

Spheres of influence

The **world cities** concept is useful when considering spheres of influence. As explored in Unit 8.5 of Global Interactions 11, world cities are the command-and-control centres of an increasingly integrated global economy. They are not necessarily the world's largest cities, but they are its most important, especially in terms of their economic and cultural authority. These cities control the flow of information, cultural products and finance that sustain the world's economic activity and culture. They are also innovation hubs and rich in human capital (the skills, knowledge and experience held by an individual or population). These cities dominate popular culture through their powerful media outlets and creative industries. Their high art, fine restaurants and vibrant nightlife help to attract and retain talented workers. They are magnets for migrants and visitors, who add to their diversity, another key strength. New York, London, Paris and Tokyo are at the top of the hierarchy of world cities.

The Globalisation and World Cities Research Network (GaWC) has developed a classification system that measures the influence or interconnectedness of cities. They use the terms Alpha, Beta and Gamma to classify the extent to which cities exercise this influence. Within each category, there are two, three or four subcategories. The outcome of this analysis is a detailed hierarchy of such places (see Figure 6.1.18).



6.1.18 The spatial distribution of Alpha-ranked world cities

Settlement patterns

While no two settlements are exactly alike, many have features in common. One of these is layout, which is the spatial arrangement of buildings within a settlement. **Settlement pattern** is the term used to describe the distribution of these buildings. Site can also play an important role in the development of a settlement pattern. For example, hill- or ridge-top settlements may have quite different settlement patterns than those that develop on flat land.

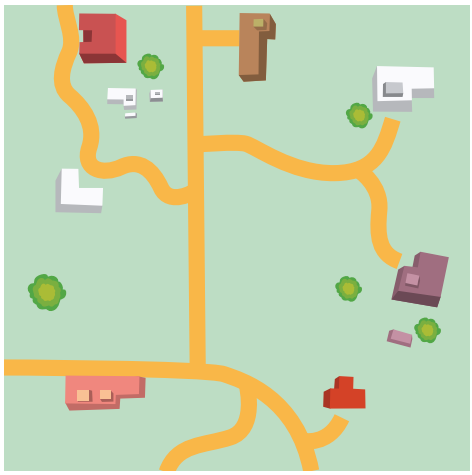
Five types of settlement can be identified by their pattern. These are isolated/remote, dispersed, nucleated, linear, and those that combine elements of both integrated and linear settlements.

Isolated/remote settlements: Isolated or remote settlements consist of small clusters of houses and some commercial activities. They can include remote indigenous settlements and mining communities. The latter may be permanent settlements or temporary camps catering for fly-in-fly-out (FIFO) workers (see Figures 6.1.19 and 6.1.20).

6.1.19 Remote Indigenous settlement of Ulukhaktok, Northwest Territories, Canada

6.1.20 Remote mining camp, Central Queensland

Dispersed settlements: Dispersed (rural) settlements typically consist of scattered houses or homesteads, which may be one or more kilometres apart. This pattern is common throughout Australia's cropping and grazing areas (see Figures 6.1.21 and 6.1.22).



6.1.21 Dispersed (rural) settlement

6.1.22 Dispersed rural settlement, Lake Sempach, Central Switzerland

Nucleated settlement: In nucleated settlements, buildings are clustered, linked by roads, laneways or paths, and the settlement itself may be either circular or irregular in shape. Some planned nucleated settlements have a skeleton grid (see Figures 6.1.23 to 6.1.25).

6.1.23 Examples of cluster and grid nucleated settlements

6.1.24 Italian hilltop town of Rotondella. An example of a nucleated or clustered settlement, with the nature of the site playing an important role in shaping its morphology—its functional form and character.

6.1.25 A village in East Anglia, UK. Elements of a skeleton grid are evident in this nucleated settlement.

Linear settlements: Linear settlements consist of buildings aligned along a road, river or ridge. They are common in rural areas and on the outskirts of larger rural settlements (see Figure 6.1.26 and 6.1.27).

Integrated nucleated and linear settlements: These combine elements of both nucleated and linear settlements. They are often star-shaped (see Figure 6.1.28).

6.1.26 Linear settlement pattern

6.1.27 The village of Saint Louis, France is an example of a linear village.

6.1.28 Palmanova, Italy, combines elements of both nucleated and linear settlements.

Activities

Acquiring and processing geographical information

1 Identify the technological advances that enabled people to become sedentary farmers. How did this lead to the development of settlements? Over what timeframe did this occur?

2 List where the first civilisations, and the urban places they spawned, developed. Why did this occur in the places it did?

3 Distinguish between site and situation.

4 Summarise the factors that were important in determining the site of settlements.

5 Name the factors that can be used to determine the type of a settlement.

6 Summarise the differences between rural and urban settlements.

7 Access the Geoscience Australia website. List their criteria for a populated place. What other names are applied to settlements and by which authority?

8 Summarise the spatial distribution of large cities.

9 Define the terms threshold, range and hinterland as they apply to the functions provided by settlements.

10 Explain the concepts of world city and spheres of influence.

11 Explain what is meant by settlement pattern. List and describe the principal settlement pattern types.

Applying and communicating geographical understanding

12 Study Figure 6.1.10. Summarise the hierarchy of settlements by size, the frequency at which they occur, and the range of goods and services available as you move up through the hierarchy.

13 Study the box, Spotlight: Names applied to large urban areas. Define the following: metropolitan area, peri-urban and urban agglomeration.

14 Study Figure 6.1.12 and complete the following tasks.

- a Identify the parts of the world with the highest and lowest percentage of the population living in urban areas.
- b Identify the principal clusters of cities with a population of more than one million people.

15 Study Figure 6.1.14. With the aid of an atlas of India, list the larger urban places visible on the night-time satellite image of the subcontinent.

16 Study Figure 6.1.17. Describe the relationship between the size of settlements and the number of functions provided.

17 Study Figure 6.1.18. Describe the global distribution of Alpha-ranked world cities.

18 Study the box, Spotlight: Determining the size of cities. Explain why is often difficult to determine the actual size of cities.

UNIT 6.2

Factors influencing the size and spatial distribution of settlements

There is a range of factors influencing the size and distribution of settlements. These include location, climate, topography, natural resources, population and economic development.

Location

As noted in Unit 6.1, early human settlements were historically located in places with fertile soils and a reliable source of fresh water, to support agricultural production. They were typically located at natural crossing points on rivers or with access to mountain passes, which were important trade routes in mountainous regions. Defensively, hilltop positions were ideal settlement locations. As trade developed, so did the world's great port cities.

Today, most settlements are located on coastlines, or on the banks of rivers with access to the sea, because there is a range of transport, food and ecological benefits in such locations (see Figure 6.2.1). Products—and therefore money—traditionally flowed into countries through their ports. Over time, people have moved closer to coastlines. Today, nearly 2.4 billion people—40 per cent of the world's population—live within 100 kilometres of a coastline, and around 50 per cent within 200 kilometres of a coastline. Today, eight of the top ten most populated cities in the world are located by a coast.

6.2.1 Positano, Italy. The attractions of coastal locations often outweigh other factors, including topography.

SPOTLIGHT

Imperilled coastal cities

More than 600 million people (around 10% of the world's population) live in coastal settlements less than 10 metres above sea level. Rising seas threaten to displace 150 million people by 2050 and inundate some of the world's great coastal cities. Sea levels are projected to rise more than 30 centimetres by the middle of this century, possibly more.

In Shanghai, one of Asia's most important economic centres, water threatens to flood the heart of the city, and many areas surrounding it.

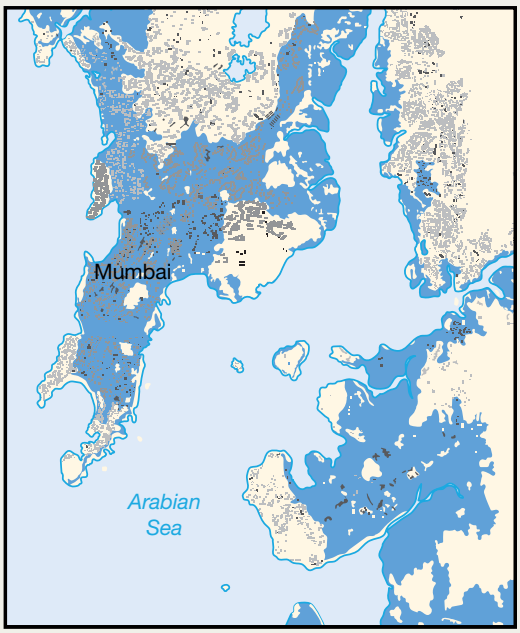
More than 20 million people in Vietnam, almost one-quarter of the country's population, live on land that could be inundated. Much of Ho Chi Minh City, the nation's major economic centre, would disappear with it.

In Thailand, more than 10 per cent of the population lives on land that is likely to be inundated by 2050, The political and commercial capital, Bangkok, is imperilled.

Much of Mumbai, India's financial capital and one of the largest cities in the world, is at risk of being inundated (see Figures 6.2.2 and 6.2.3). Built on what was once a series of islands, the city's historic downtown core is especially vulnerable. Many parts of the city lie just above sea level. Mumbai is explored in detail in Chapter 10.

The port city of Alexandria, Egypt, founded by Alexander the Great around 330 BCE, could be lost to rising waters together with its rich cultural heritage.

To survive, coastal cities will need to invest vast sums of money in defences against the rising waters. However, defensive measures can only do so much. New Orleans, in the United States, for example, a city that sits below sea level, was devastated in 2005 when its extensive levees and other protections failed during Hurricane Katrina.

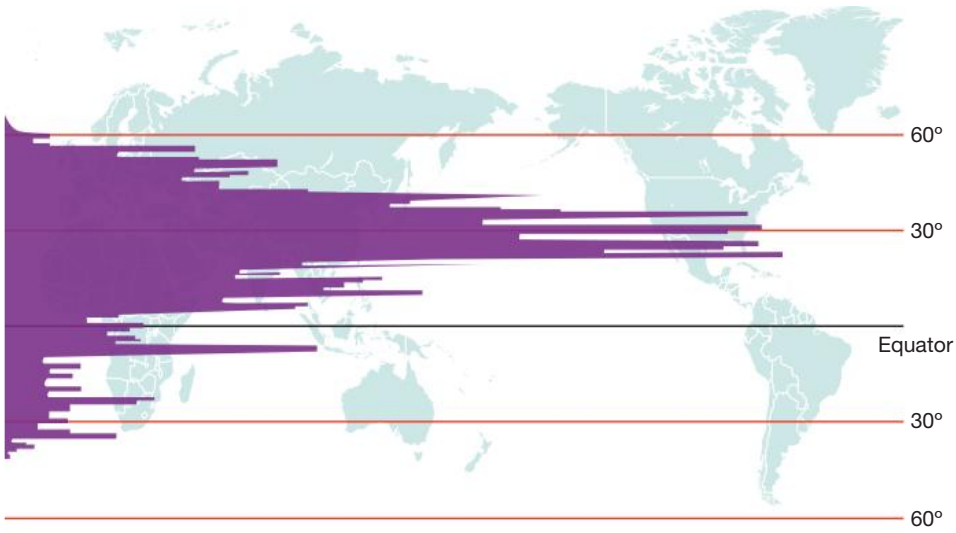


6.2.2 Projections suggest that much of Mumbai, India, is at risk of being wiped out. The map shows projected sea level rise by 2050.

6.2.3 Many of Mumbai's informal settlements are found on land subject to inundation by rising sea levels.

Climate

While most of the world's population and settlements are found in the temperate mid-latitudes of the Northern Hemisphere (see Figure 6.2.4 overleaf), settlements are found in all but the most extreme climates—the arid lands, the parts of the world that experience extreme cold, and places at high altitudes. However, even in places where humans would have once found it difficult to live, technology has made life possible. The rapid growth of Dubai (population 3.3. million) into a place of global importance, has been made possible by the process of desalination—the process of extracting potable water from seawater.



6.2.4 Distribution of the human population by latitude

Topography

While there are many notable exceptions (see Figure 6.2.1, for example), settlements are typically built on relatively flat or gently sloping land in valleys. Landform features, such as mountains, often form a barrier to the expansion of settlements. On a relatively small scale, Figure 6.2.6 shows how topography has influenced the expansion of Las Vegas. On a larger scale, the landforms of the United States and the impacts these have on rainfall have influenced the distribution of settlements (see Figures 6.2.7 to 6.2.9). In the case of Figure 6.2.1, the attractions of the Italian coast have displaced topography as a principal locational factor.

● **SPOTLIGHT**

Las Vegas: Defying the restraints of climate

Las Vegas (see Figure 6.2.5) is a city that has grown rapidly, despite its location in one of the driest parts of the United States. The city's population has increased from 530 000 in 1984 to 2 899 000 in 2023, making it one of the fastest growing cities in the country. The growth has been driven by the city's large gambling, convention and entertainment industries. Together, these attracted 38.8 million visitors in 2022. This influx creates jobs for skilled and unskilled workers, who flood into the city.

The city's rapidly expanding urban area (see Figure 6.2.6) is located within a basin on the floor of the Mojave Desert and is surrounded by mountain ranges. The landscape is rocky and arid, with drought-resistant vegetation. The peaks surrounding Las Vegas reach elevations of over 3000 metres and act as barriers to the flow of moisture.

Amid a prolonged megadrought that has depleted water resources across the South-West United States, the need to save every drop of water has intensified. Water conservation is now a way of life in Las Vegas. Lake Mead, the city's principal source of water, was at 45 per cent capacity in mid-2023. Strategies to reduce water consumption include the banning of mega-pools, water recycling, replacing 'non-functional' lawns with artificial turf or gravel, and restrictions on garden watering.

6.2.5 Las Vegas attracted 38.8 million visitors in 2022.

6.2.6 The Las Vegas urban area in 1984 and 2024

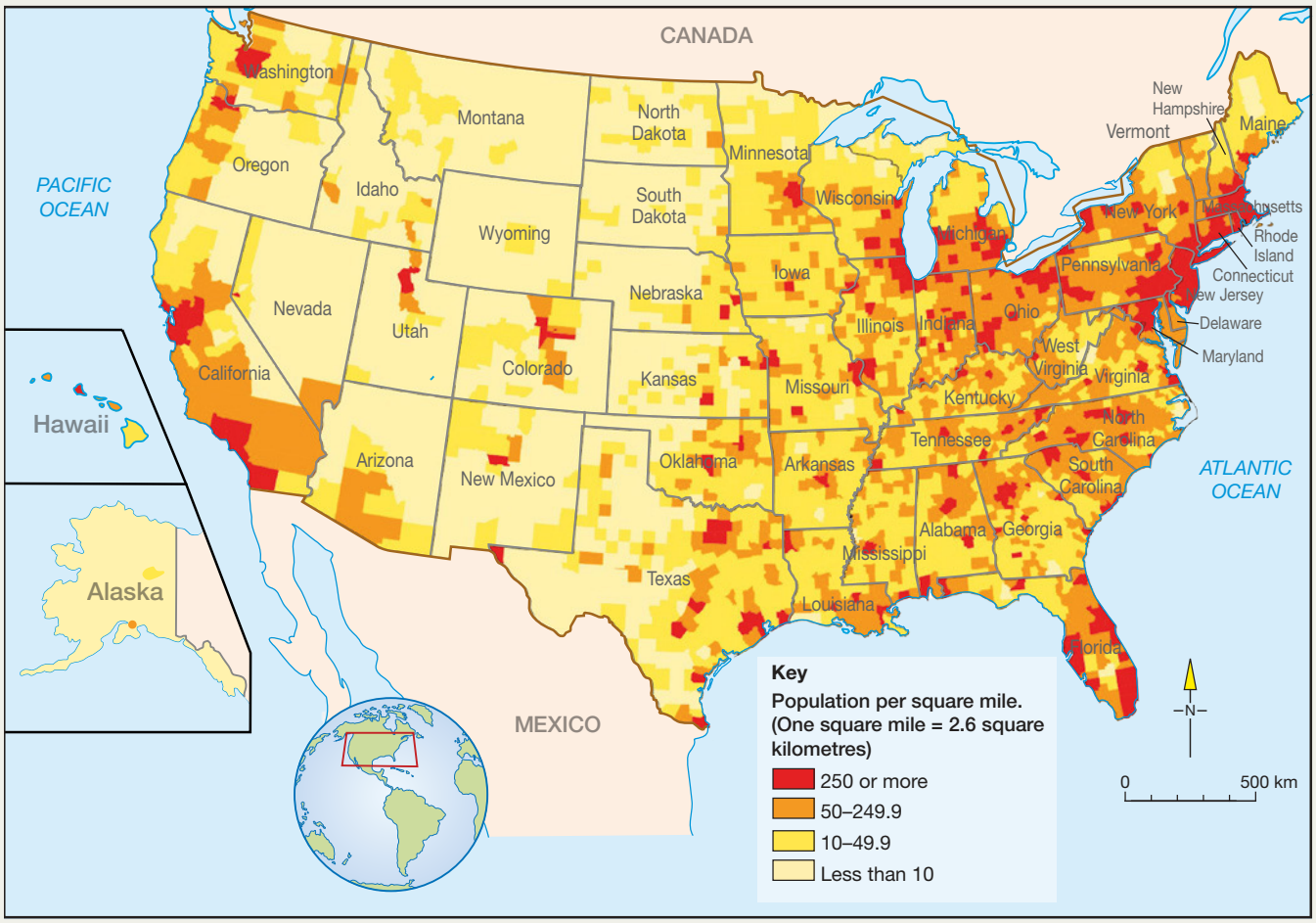
● SPOTLIGHT

Relationship between climate, topography and settlement in the USA

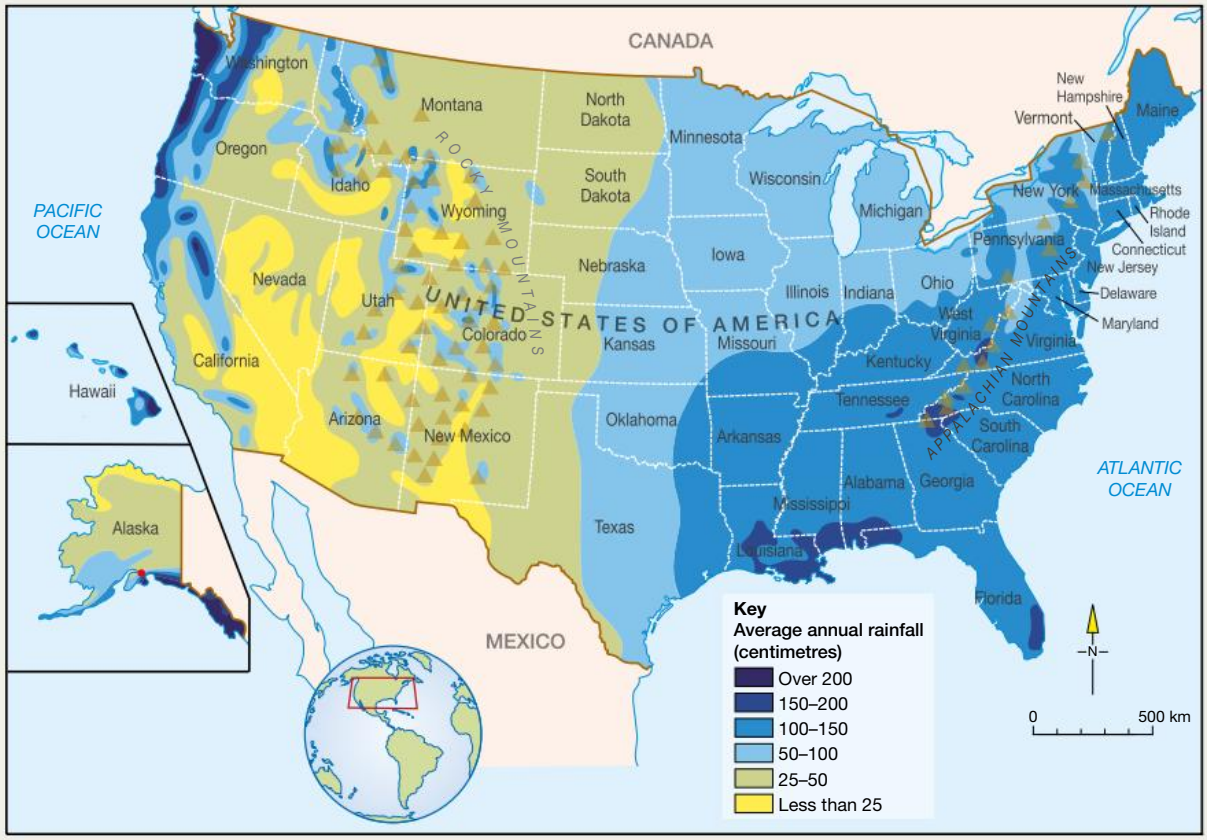
The settlements in which 332 million people live in the United States are not evenly distributed across the vast country (see Figure 6.2.7). Some parts are home to large cities and towns housing millions of people, while other parts are sparsely settled. This is because people tend to live in those places where they are able to meet their basic needs for food and water (see Figure 6.2.8). In the United States, like Australia, the most densely settled places tend to share the following features:

- a temperate climate (one that is not too hot or too cold)
- access to a reliable water supply
- fertile soils
- relatively flat land (see Figure 6.2.9)
- access to the coast or major inland waterways.

Despite these similarities, Australia's settlement pattern is quite different to that of the United States. Australia's arid interior has discouraged the establishment and growth of settlements. The country's population is largely coastal with 85 per cent of the population living in settlements within 50 kilometres of the sea, and 67 per cent living in the state and territory capitals, all of which—except for Canberra—are coastal and have their origins in the colonial era.



6.2.7 Map of US population density



6.2.8 Pattern of rainfall, USA. The amount of rain varies from east to the west. Mountains, such as the Rocky Mountains in the west and the Appalachian Mountains in the east, have an impact on rainfall across the country. For example, they create rain shadows (dry areas) on their leeward side.

The narrow strip of land between the Pacific Ocean and the Sierra Nevada Mountain Range is home to several large urban areas, including those of Seattle, Portland, San Francisco, Los Angeles and San Diego.

Much of the western half of the USA is dominated by mountain ranges and plateaus that block the inland movement of rain-bearing winds, the outcome of which is a sparsely settled arid region. The notable exceptions to this are Las Vegas and the resort city of Palm Springs.

Stretching from the Rocky Mountains range eastwards is a vast plain—the Prairies. The region features two vast river systems, the Mississippi and the Missouri. The region is home to the country's grain and grazing industries. The climate of the region is subject to extremes of temperatures, with cold snowy winters and hot summers. The number of rural settlements and cities increases as you move to the east.

The northeast is the most densely settled part of the country. The region has fewer extremes in temperature and more rainfall than the central plains. It was also the first part of the country settled by Europeans and today is home to the country's largest urban conglomerations.

The south of the USA can be extremely hot and humid. Here are found the large and rapidly growing urban centres of Texas, such as Austin and Huston, and Atlanta in Georgia. Much of Florida is densely settled.

6.2.9 Satellite image showing major US landform features

Natural resources

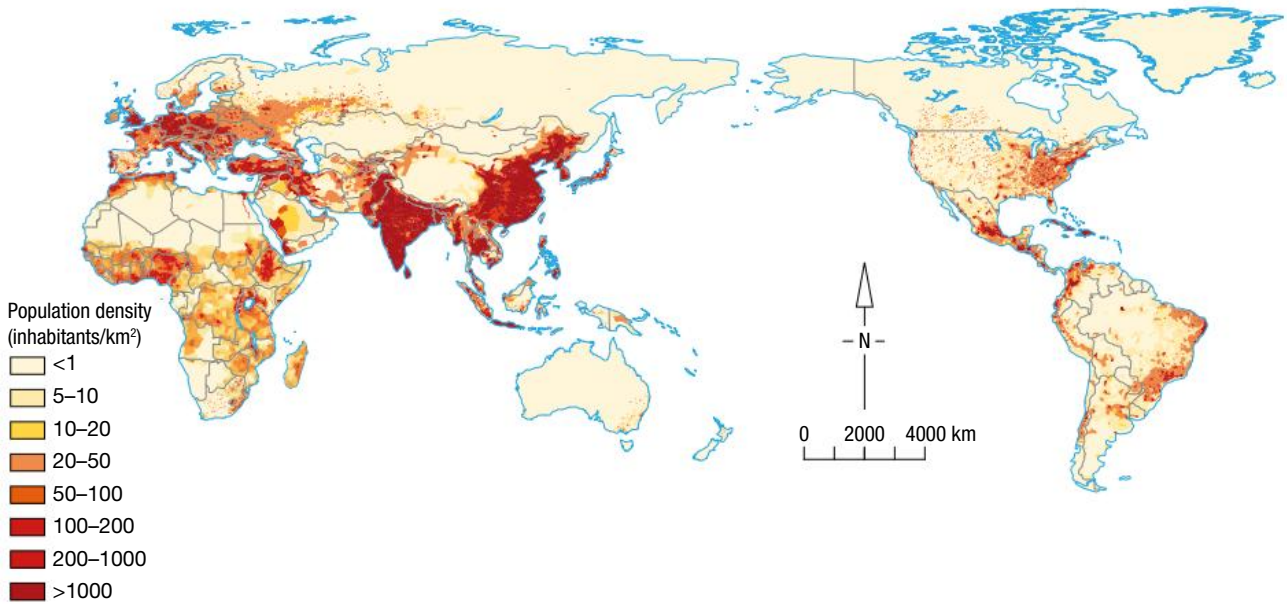
For thousands of years, settlements have been established in places where the resources necessary to sustain an increasingly sophisticated way of life are readily available. The founding and growth of Australia's mining towns illustrates this point. Places such as Kalgoorlie, Ballarat and Bendigo prospered because of the gold rushes of the nineteenth century. As a result, they would play an important role in Australia's transition from convict settlement to rich, developed country. Broken Hill, another example, was founded to exploit some of the world's largest silver, lead and zinc deposits. The coalmining towns of the Hunter Valley grew in response to the exploitation of the region's rich coal deposits. Today, however, mining-related settlements tend to be more transitory in nature. FIFO miners often live in temporary, company-supplied accommodation that is abandoned or relocated once the resource is depleted.

6.2.10 Aquaculture supplements the fish resources harvested from the sea in many parts of the world. It is also an important economic activity in coastal settlements, especially in the developing countries of Asia.

The resources extracted from the sea are also another important locational factor. They are especially important for the 37 per cent of the world's population living in coastal settlements, large and small. Fish is one of the most important sources of animal protein. It accounts for about 17 per cent of protein consumed by humans globally and exceeds 50 per cent in many of the least-developed countries (see Figure 6.2.10).

Population

Population distribution—the pattern of where people live—is an important indicator of settlement patterns because all people live in settlements, whether it is a single isolated homestead or a vast **conurbation**. Places that are sparsely populated contain few people and few settlements. Places that are densely populated contain many people and have many, often closely spaced settlements. Figure 6.2.11 shows the global distribution of the world's population and, consequently, the distribution of settlements.



6.2.11 Global population density

Economic development

Settlement patterns have changed as economic activity has evolved. In pre-industrial societies, rural settlements dominated. With the onset of the Industrial Revolution, from about 1760, sources of energy became a critical locational factor. Steam-power, generated by the burning of coal, meant that proximity to the source of coal became the principal locational force in the development of industrial cities, including those of the English Midlands, the Ruhr Valley of Germany and the north-east manufacturing belt of the United States. Development of alternative sources of energy, the construction of electricity transmission grids and the transition to service and information-based economic activity has greatly reduced the importance of energy sources as a locational factor.

Today, access to high-quality communications networks is an important locational consideration, especially for places with a functional focus on financial services, the media and entertainment.

Coastal or river-based port locations, however, remain important as the increasingly integrated global economy has greatly boosted the world trade of goods. See the box, Spotlight: Port of Rotterdam.

Finally, the nature of settlements themselves changes according to the level of economic development achieved by a country or regions. This will be examined in more detail in Unit 6.3.

SPOTLIGHT

Port of Rotterdam

The Port of Rotterdam (see Figure 6.2.12), in the Netherlands, is the largest seaport in Europe, and the world's largest seaport outside of East Asia. The port is located at the mouth of the Nieuwe Maas River, a northern branch of the Rhine River. One of the principal navigable rivers of Europe, the Rhine flows through six countries (Switzerland, Liechtenstein, Austria, Germany, France and the Netherlands), before flowing into the North Sea at Rotterdam.

Covering 105 square kilometres, the port handled 468.7 million tonnes of cargo in 2021. This involved 28 876 ships and 16.3 million containers.

6.2.12 The port of Rotterdam, in the Netherlands

Activities

Acquiring and processing geographical information

1 Describe the importance of coasts in terms of settlement location.

2 Summarise the relationship between climate and location of settlements. How has technology led to a relaxation of this relationship?

3 Describe the relationship between landforms and settlement. How does Figure 6.2.6 illustrate this relationship?

4 Summarise the locational relationship between natural resources and settlements.

5 Explain why population distribution/density is an important indicator of settlement patterns.

6 Summarise how the nature of economic development and the size and spatial distribution of settlements have changed over time.

Applying and communicating geographical understanding

7 Study the box, Spotlight: Imperilled coastal cities. Summarise the threat posed to coastal settlements by rising sea levels.

8 Study Figure 6.2.4. What does the graph reveal about the distribution of the world's population?

9 Study the box, Spotlight: Las Vegas: Defying the restraints of climate. Summarise how the experience of Las Vegas stands out as an exception in terms of locational factors and illustrates the importance of water as a factor. How is the city responding to the region's megadrought?

10 Study the box, Spotlight: Relationship between climate, topography and settlement in the USA. Write a report summarising the nature of the relationship between the three locational factors.

11 Study Figure 6.2.11. Identify the most densely settled parts of the world.

12 Study the box, Spotlight: Port of Rotterdam. What does this example reveal about the continuing importance of coastal and riverine locations?

UNIT 6.3

Urbanisation and urban growth

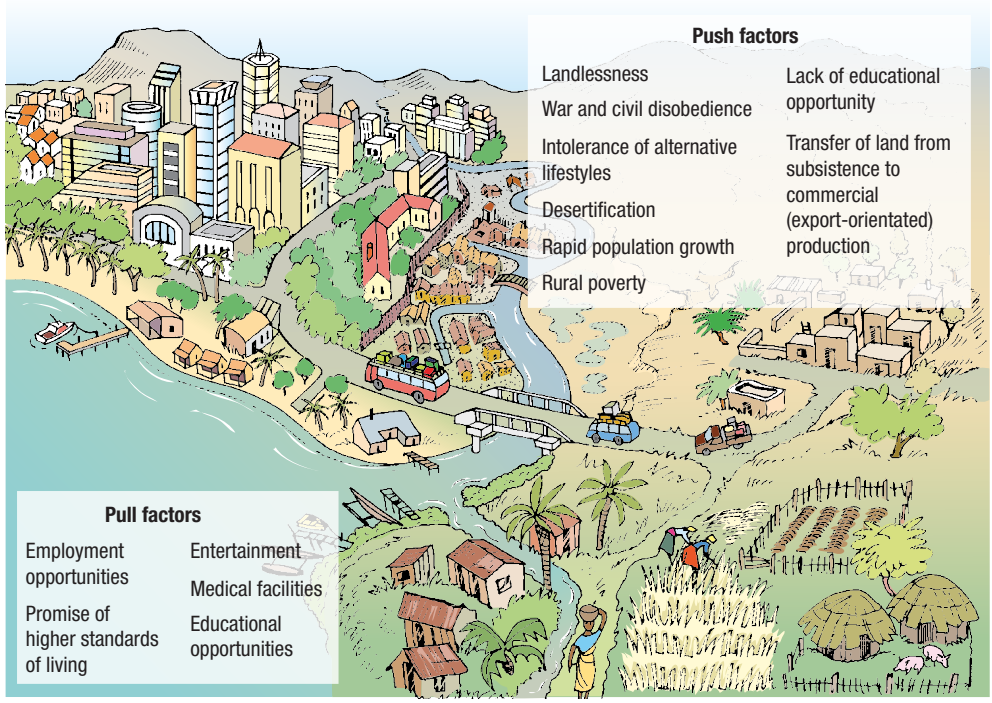
6.3.1 Hong Kong has grown from a small colonial outpost of the British Empire into one of the world's most spectacular urban landscapes.

Urbanisation is arguably the most important geographical process shaping Earth's **cultural geography**. The shift from a rural-based lifestyle to one centred on life in towns and cities is the most significant terrestrial event in human history (see Figure 6.3.1). More than half the world's population now lives in urban places. This trend will continue for the foreseeable future. As a result, the world's economic, social, cultural and political processes are increasingly played out within and between the world's system of towns and cities. This trend now appears irreversible, due to the global shift to technological, industrial- and service-based economies.

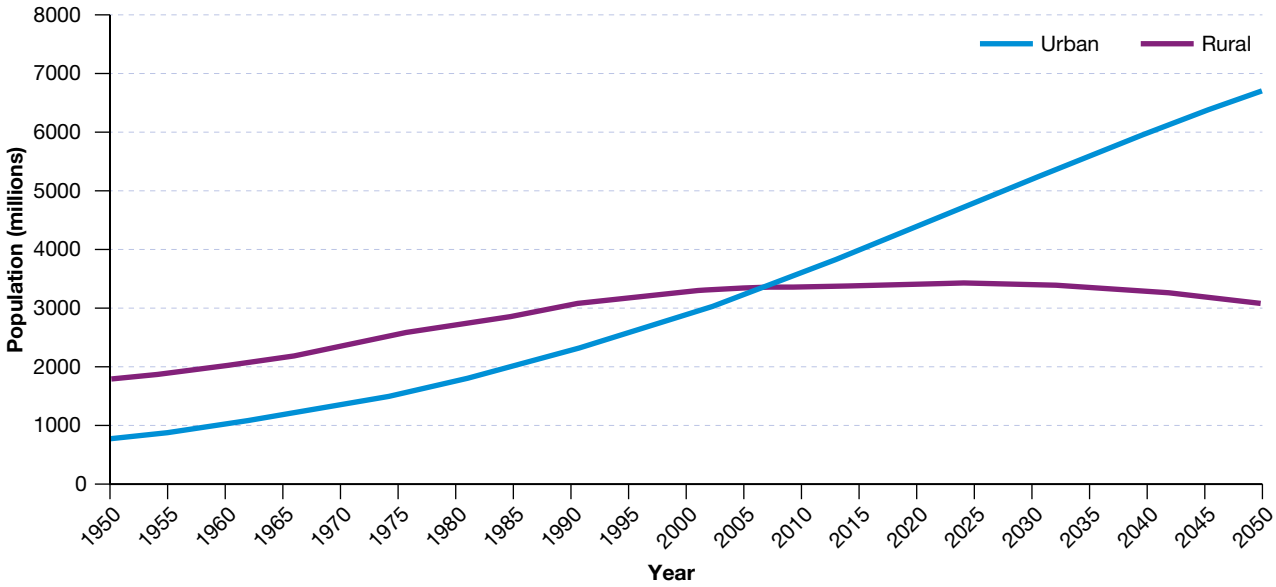
Urbanisation versus urban growth

The emergence of large cities is largely the result of the process of urbanisation. Urbanisation refers to the increasing proportion of a country's population living in towns and cities. It is important to note that the process of urbanisation is distinct from the process of urban growth. Urban growth is defined as the rate at which an urban population increases in a given period, relative to its size at the start of that period. In theory, it is possible to have urban growth while having a negative rate of urbanisation. This would occur if the growth rate of the rural population was greater than the growth rate of the urban-based population. Rates of urbanisation are highest in the world's developing countries. In developed countries, the level of urbanisation is already high.

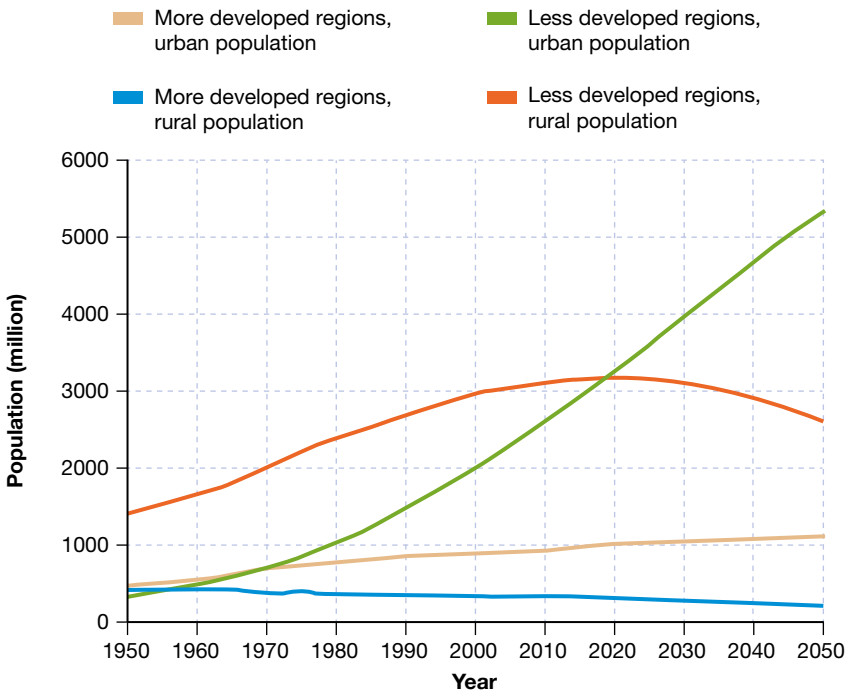
Urbanisation involves a shift of population from rural to urban areas. The 'push' and 'pull' factors responsible for this movement are shown in Figure 6.3.2. The impact of these factors is shown in Figures 6.3.3 and 6.3.4.



6.3.2 The 'push' and 'pull' factors responsible for urbanisation



6.3.3 The number of people living in urban places exceeded that of rural areas in 2008.



6.3.4 Urban populations in developing countries are growing rapidly, while rural populations are projected to decline steadily from 2020.

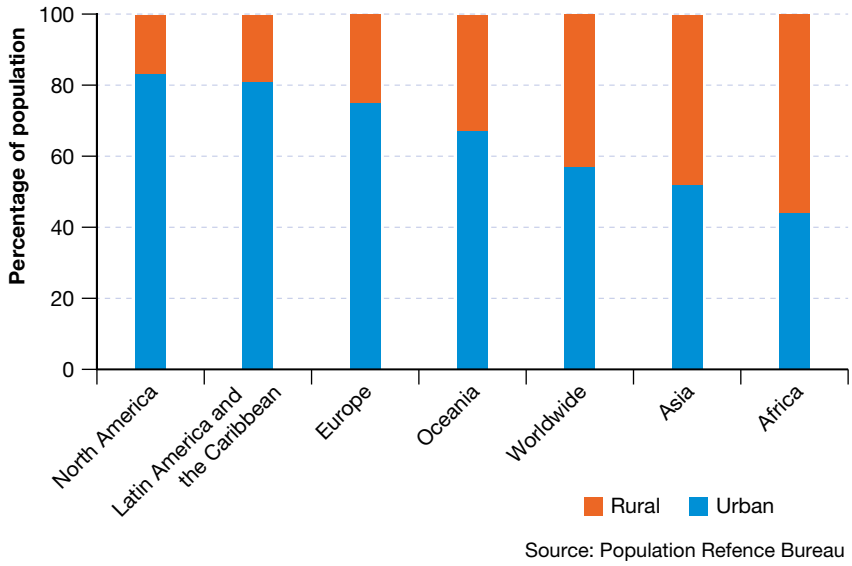
Spatial pattern of urbanisation

In 2023, 57 per cent of the world's population lived in urban places. The most urbanised regions of the world include North America (83%), Latin America and the Caribbean (81%), Europe (75%) and Asia (52%). Only Africa remains mostly rural, with only 44 per of its population living in urban areas (see Figure 6.3.5).

All regions are expected to urbanise further over the coming decades. Africa and Asia are urbanising faster than other regions and are projected to become 56 per cent and 68 per cent urban, respectively, by 2050 (see Figure 6.3.6). By 2100, the world's top 20 cities by population are expected to be in Africa and Asia. Urban areas will absorb almost all the future growth of the world's population.

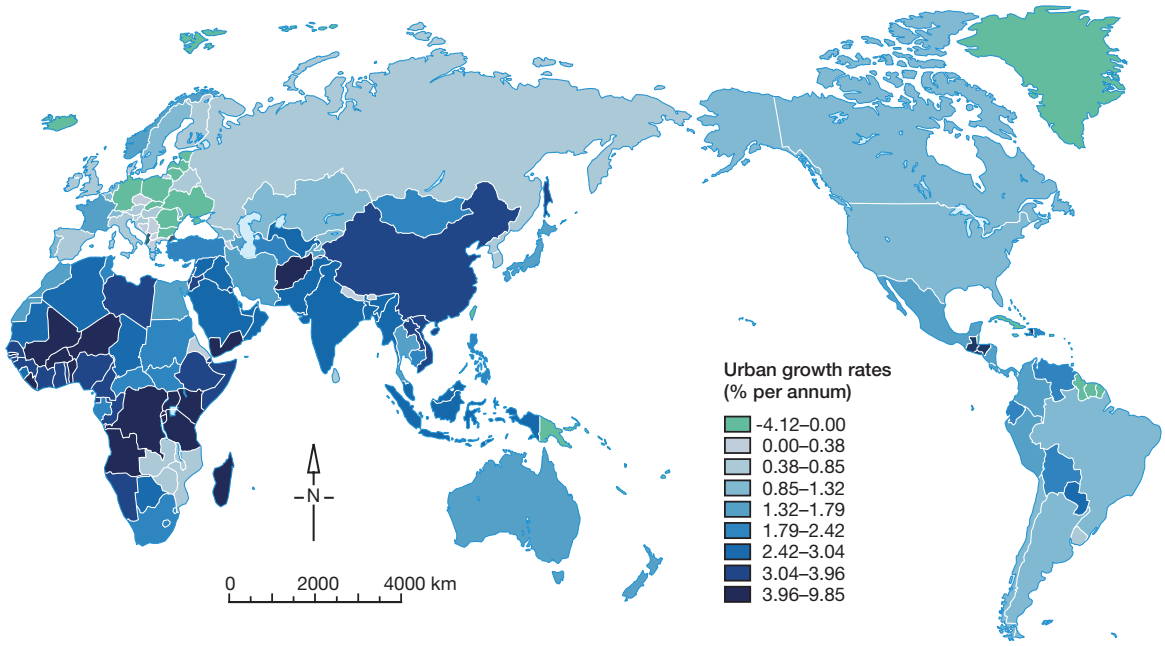
Did you know?

The global level of urbanisation will increase by 12 per cent over the next three decades. This translates to an increase of 2.2 billion urban residents, with most of these living in Africa and Asia.



Source: Population Refence Bureau

6.3.5 Level of urbanisation by region, 2022



6.3.6 Urban growth rates are highest in Africa and South and East Asia, 2020

Activities

Acquiring and processing geographical information

1 Summarise the extent to which the cultural geography of the world has been transformed by the process of urbanisation.

2 Distinguish between urbanisation and urban growth.

3 Outline the spatial pattern of urbanisation.

Applying and communicating geographical understanding

4 Study Figure 6.3.2. Write a report outlining the 'push' and 'pull' factors driving the process of urbanisation.

5 Study Figures 6.3.3 and 6.3.4. Using data from the graphs, write two paragraphs describing the trends evident in each graph.

6 Study Figure 6.3.5. Describe the regional variations in levels of urbanisation.

7 Study Figure 6.3.6. Rates of urbanisation vary considerably across the world. Identify the regions with the fastest rates and those with the lowest rates.

UNIT 6.4

Challenges facing rural and urban places

Both rural and urban places face a range of environmental and social challenges. In the case of large urban places, there are some challenges that are unique to cities in the developing world, and some that are especially relevant to developed world cities. Some, of course, impact on all places.

Challenges facing rural places

There are many positives about living in rural places compared to urban places There is more open space and less crowding, and the air is clean because there is less traffic, fewer factories and other pollution-emitting sources. The pace of life is slower, resulting in lower levels of anxiety and stress. Less time is spent commuting to work and housing is generally much cheaper. There is often a greater sense of community as people need to collaborate to facilitate sporting and other cultural activities.

The challenges of living in Australia's rural places include a lack of services, employment opportunities and a limited range of leisure activities. Access to medical services is one key challenge (see the box, Spotlight: Rural NSW's GP crisis). Those living in rural places often need to travel long distances to access all but the most basic medical services. This is because rural places often lack healthcare professionals, and their hospitals and clinics offer only basic medical care. A related issue is the long distances that ambulances and patients must travel. As a result, emergency care can be delayed, increasing the chance of adverse health outcomes. Smaller rural places often lack mental healthcare, drug abuse counselling and other services related to physical and mental health.

Educational opportunities rarely extend beyond the secondary years. As a result, school leavers from rural places must leave home to access the further education offered in larger urban places. A challenge for those who remain is to find a job where the range of employment opportunities is often limited. Promoting employment-generating economic activity is a challenge faced by many local authorities.

Poverty rates tend to be higher in rural places than in urban places. Contributing factors include the out-migration of young, skilled workers, often a consequence of the lack of high-paying jobs, increasingly a feature of the information age. Compounding the general problem of poverty, rural places are also more likely to lack human services programs to help the poor, disabled, elderly and other people in need of assistance.

Poverty rates are generally higher for First Nations peoples living on their Country in remote places, especially those areas classified as very remote. Most indicators of poverty and related disadvantage show that First Nations people are two to three times worse off than non-indigenous people in Australia. In remote and very remote locations there is a lack of employment opportunities, and rates of overcrowded and inadequate housing are much higher for First Nations peoples. They often must travel long distances to access health, education and other services.

Young people living in rural places often complain of boredom, and drug and alcohol use can be common. In some instances, the level of youth crime is higher than in urban places.

Did you know?

In Sydney, life expectancy is now 84.5 years, and in Far West NSW, it's 79.2, even though residents of both places die of similar diseases. Availability of doctors, health screening and treatment are key factors contributing to this difference.

Did you know?

Suicide rates are generally higher in rural places than in urban areas. In 2022, the suicide rate outside Australia's capital cities was over 60 per cent higher than in the capital cities, with NSW and the Northern Territory having over twice the suicide rate outside their capitals. The age groups with the highest suicide rates are 35–44 years (18.9 deaths per 100 000 persons), 45–54 years (18.8), and those 85 years and over (17.8).

● SPOTLIGHT

Rural NSW's GP crisis

While Australia has one of the world's highest ratios of doctors per head of population, this workforce is not evenly distributed. In late 2022, towns across NSW were facing critical doctor shortages.

Authorities reported that there were fewer than 200 general practice (GP) proceduralists (those who also work as doctors at local hospitals) working in rural NSW. It is feared that this number could dwindle to fewer than 100 by 2030.

The lack of GPs has been blamed on financial pressures that threaten the sustainability of rural practices, the increasing specialisation of the medical workforce and generational change as the decreasing number of rural GPs struggle with increasing workload pressure, and discourage young doctors who may be seeking a better work–life balance.

Clearly, there is a need to develop strategies that will attract GPs working in urban places to move to rural places, as well as providing additional support to those already based regionally. If nothing is done, at least 45 towns across regional NSW are at risk of being without a GP within the next 10 years.

In developing countries, the challenges of living in rural places are often even more apparent. Accessing medical services is difficult; often they don't exist and, if they do, they are very basic. Utilities such as electricity, treated water, sewage infrastructure and waste collection services are often very basic, if they exist. Employment is often limited to those opportunities associated with the agricultural sector. This is especially the case in areas dominated by subsistence agriculture.

Challenges facing urban places

There are many challenges facing urban places. Among the most significant of these are:

- urban heat islands and air quality
- overcrowding and urban poverty
- housing affordability
- traffic congestion
- **urban sprawl** and its responses
- the provision of infrastructure, including water supply and quality and waste disposal
- the availability of education
- the availability of healthcare services.

6.4.1 Delhi's air was found to be the foulest and most toxin-laced of any national capital for the fourth year running, in 2022.

Urban heat islands and air quality

Urban heat islands develop when large urban areas absorb and retain heat. Most of the sun's energy is absorbed by buildings and hard surfaces like concrete and asphalt, because there is less vegetation and exposed soil. This results in higher surface temperatures. Pollution from vehicles, factories, and heating and cooling units in homes and commercial buildings releases even more heat. As a result, cities are often 1–3°C warmer than surrounding non-urban areas. Parts of metropolitan Sydney have recorded temperatures of up to 6°C above those experienced in surrounding rural areas.

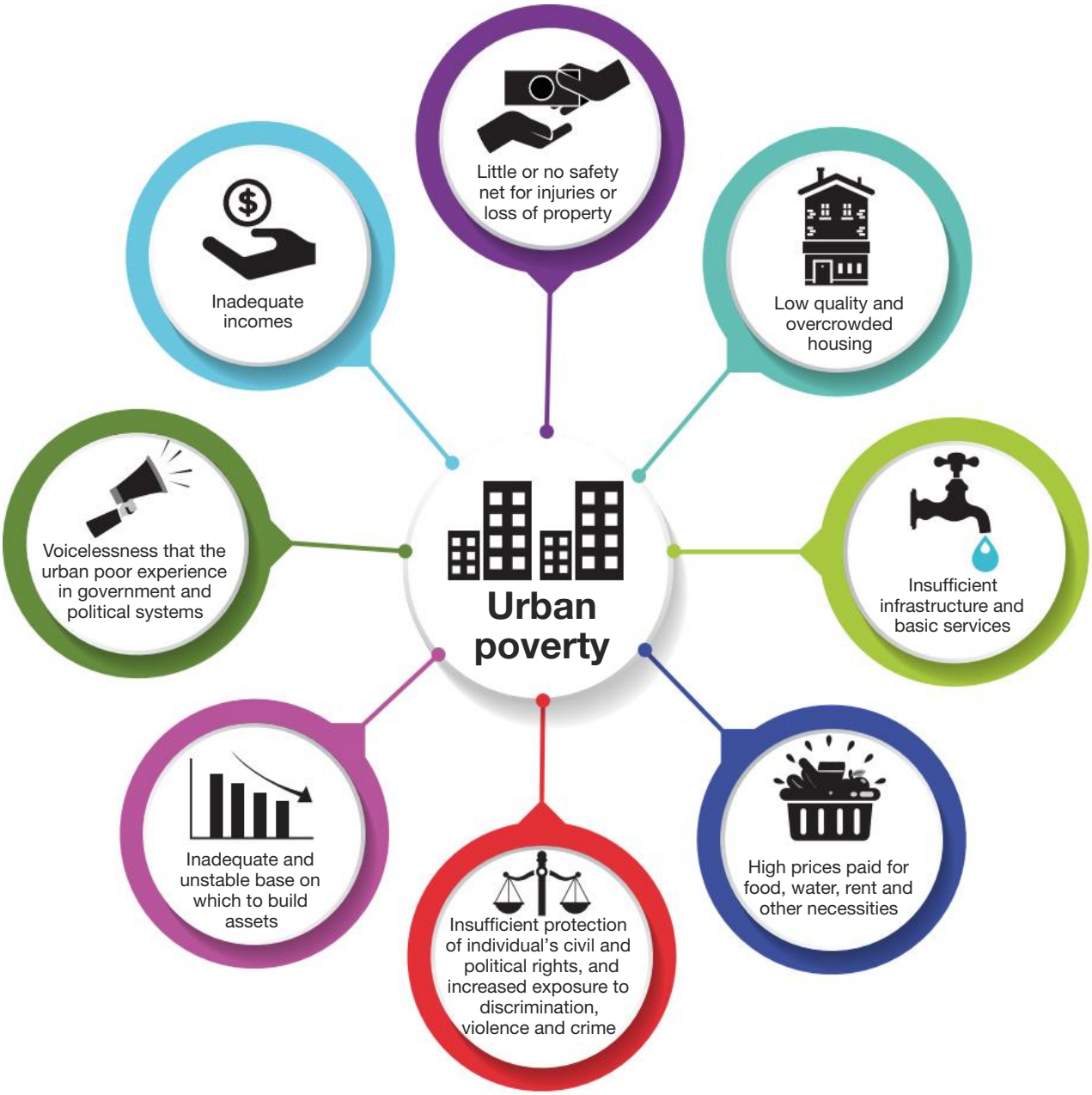
While progress has been made to reduce urban atmospheric pollution throughout the developed world, it remains a major concern in many developing countries. The air quality in India's capital, Delhi (population 30 million), has, for example, been identified by the World Health Organization (WHO) as the worst in the world. Each year it causes and aggravates debilitating, often fatal, conditions and illnesses among tens of thousands of people (see Figure 6.4.1).

Indian authorities blame the pollution largely on the burning of crop stubble by poor farmers. This misrepresents the situation. The total biomass combustion, including stubble burning, accounts for 20–35 per cent of the pollution, while vehicular exhaust fumes, industrial emissions and those from construction and thermal power stations account for 65 per cent.

Poor air quality kills an estimated 6.67 million people around the world each year. In 2020, 1.67 million people were killed in India alone, a figure only surpassed by China, where 1.85 million people died due to air pollution. Nearly all the deaths occurred in urban places.

Overcrowding and urban poverty

Many cities are neither prepared nor equipped to deal with the overcrowding that results from rapid urbanisation and urban growth. The problem is most acute in developing countries, where overcrowding is often associated with poverty. Figure 6.4.2 illustrates the multidimensional nature of urban poverty.



6.4.2 Multidimensional nature of urban poverty

6.4.3 Dharavi, east Mumbai. In cities of developing regions, informal settlements are the most enduring faces of poverty.

Did you know?

UN-Habitat, the UN Human Settlements Programme, defines informal housing (squatter settlements and slums) as having at least some of the following five characteristics:

- inadequate access to safe water
- inadequate access to sanitation and infrastructure
- poor structural quality of housing
- overcrowding
- insecure residential status.

In informal settlements, residents mostly live in temporary dwellings made from tarpaulin, bamboo, cardboard, corrugated iron and other materials that are set up on vacant plots of land. These are often located near construction sites, along railway tracks, behind large buildings and around the city's fringe.

Overcrowding in Mumbai, India, and Lagos, Nigeria, illustrate that the poverty observed in cities is quite different from that experienced in rural areas and, for the most part, in developed world cities. Mumbai, with a population density of 25 357 per square kilometre, is notorious for its overcrowding. The city serves as India's commercial capital and is home to the Bollywood movie industry, making it a magnet for immigrants. The population of the city has doubled in 25 years, leading to the development of vast neighbourhoods of **informal housing**, such as Dharavi (see Figure 6.4.3). Half of the city's population now lives in overcrowded, unsanitary, informal and squatter settlements—also known as slums—that cover just 8 per cent of the city's geographic area. See Chapter 10 for a detailed study of Mumbai.

Lagos is Africa's fastest growing city. In 2023, the population was 15.9 million and is projected to exceed 24 million by 2030. Situated between the Atlantic Ocean and a lagoon, Lagos is Nigeria's commercial capital. One-fifth of the city's residents live in poverty. Informal settlements, fashioned from scrap metal are elevated on stilts to protect residents from flooding. There is little, if any access, to clean water, basic sanitation, electricity or quality education.

In developed countries, population densities within urban centres are a result of the interaction of economic and social factors, including land values and a lifestyle preference for apartment living and/or being close to the employment and social opportunities offered in the city centre. New York City's Manhattan borough has a population density of 10 194 per square kilometre. Here, it is the high cost of land and a preference for living in the centre of one of the most vibrant cities on Earth that results in its density. (See Chapter 9 for a detailed study of New York City.) The City of Sydney, by way of comparison, has a population density of 8800 people per square kilometre in the city's east, while its suburban population density is just 380 per square kilometre.

Overcrowding puts pressure on existing urban infrastructure, including water, sanitation and electricity utilities, air quality and public transport. Traffic congestion and the lack of open space for recreation are also common challenges.

● SPOTLIGHT

Housing the urban poor in developing world cities

Meeting the demand for housing is a challenge confronting all the developing world's large cities. This is because population growth—both from natural increase and from rural–urban migration—is greater than the growth in housing in these cities. Adequate housing is expensive due to lack of supply, and as a result, the poor are forced to crowd into already squalid informal settlements.

Added to the housing problem is the insecurity associated with the threat of eviction. Evictions often come with 'justifications': urban beautification; claims of illegal occupation of public and private land; construction of infrastructure; major international events; and political, military and ethnic reasons.

The scale of the housing problem is enormous. In developing countries, almost 30 per cent of the urban population lives in informal settlements (about 881 million people). By 2025, it is forecast that up to 1.6 billion will require adequate, **affordable housing**.

In specific locations the challenges are immense. Forty per cent of the population of Karachi, Pakistan, live in slums and squatter settlements. In Mumbai, India, 66 per cent of residents live in shanties. In Manila, Philippines, the figure is 32 per cent. In Mexico City, Mexico, it is nearly 50 per cent. In Cairo, Egypt, more than 1 million people live in the city's cemeteries. In Lima, Peru, around 55 per cent of the city's population lives in inner-city slums, and another quarter in squatter settlements. Around half a million people live and sleep on the streets in Kolkata, India; some 3.5 million people (nearly 20 per cent of the population) live in 'legal' slums, or *bustees*, and refugee settlements. In Delhi, India, 50 per cent of the city's 18 million people live in slums or 'unauthorised colonies' (squatter settlements) without civic amenities. In Zambia, the informal housing sector provides 60–70 per cent of urban housing. In Caracas, Venezuela, it is 80 per cent and up to 90 per cent in Ghana.

Informal settlements are largely unplanned. This means they lack basic services, such as water and electricity supply, roads, drainage systems, and other vital infrastructure. Residents must improvise most of these services. They dig shallow wells for water and use communal toilets, such as those shown in Figure 6.4.8. They illegally connect their homes to power supply lines. Their settlements are often flooded during the rainy season because there is no proper drainage.

For more than 50 years, governments have tried to deal with the proliferation of informal settlements in several ways. Strategies have included denial, tolerance, formalisation, demolition and displacement (see Figure 6.4.4).

Over time, however, it has been recognised that poverty and inequality cannot simply be eradicated through demolition or eviction. While efforts to accommodate and improve settlements are becoming more common, the desire for eradication persists in many cities. Forced evictions in various parts of the world are putting the rights of settlers at risk.

Many cities are looking for alternatives that formalise these areas through incremental, onsite upgrades. In addition to offering effective protection against forced evictions, it is critical to provide residents with access to basic services, public facilities and inclusive public space.

6.4.4 Simply clearing away informal settlements fails to address the causes of overcrowding and urban poverty.

Housing affordability

Accessing affordable housing is an issue in all large urban places, especially for the poor, or in the case of developed world cities, those on below-average incomes. Housing prices are largely determined by market forces. House prices and rents are highest in the most desirable and accessible parts of cities. They are lowest in those areas that are less desirable and less accessible. For the poor living in developing world cities, housing is often beyond reach. The only option is to occupy makeshift housing made from scavenged materials on unused land, which often leads to the development of vast squatter settlements. See the box, Spotlight: Housing the urban poor in developing world cities.

Issues of housing affordability are increasingly relevant, even in the Australian context. Essential workers (health professionals, teachers, police and other emergency workers) are finding it increasingly difficult to access housing near where they work. Long commutes are becoming the norm. The causes of the housing affordability crisis include a rapidly growing population, rents increasing faster than wages, and insufficient investment in social and affordable housing over many years.

Australia's National Affordable Housing Summit Group defines affordable housing as accommodation that is 'reasonably adequate in standard and location for lower- or middle-income households and does not cost so much that a household is unlikely to be able to meet other basic needs on a sustainable basis'.

Affordable housing is not 'cheap' or of a poorer standard—it is quality, fit-for-purpose housing, priced at a level that is affordable relative to the income of its occupants. It should also not be confused with **social housing**, which includes both public and community housing. Public housing is long-term rental housing, owned and managed by state government agencies. Community housing is long-term rental housing owned and/or managed by community housing organisations.

Strategies to address housing affordability include the following.

- **Voluntary agreements**—these involve property developers agreeing to include affordable housing in their developments.
- **Non-mandatory neighbourhood targets**—In the absence of mandatory controls, these are affordable-housing targets set by the relevant authorities where new developments will include a percentage of affordable housing, unless it can be proved that this renders the development unfeasible.
- **Uplift incentives**—these involve the granting of additional development rights where affordable housing or another community benefit is provided. These incentives can include a relaxation of height restrictions or floor area ratios.
- **Value capture agreements**—these involve 'capturing' a portion of increased land value, resulting from government investments in things such as transport infrastructure, which results in the rezoning of land to higher-value uses. The value created is captured and directed to the provision of a community benefit, such as affordable housing.

6.4.5 Urban congestion, Ho Chi Minh City, Vietnam

Traffic congestion

Rapid urban growth and increasing rates of car ownership in many parts of the world have resulted in urban traffic congestion becoming an acute problem worldwide (see Figure 6.4.5). Although the most obvious problem of congestion is increased travel times for passengers and freight, other consequences may be even more serious. In congested traffic, vehicles typically burn twice as much fuel per kilometre as one driven in free-flow conditions. This results in an increase in emissions of a wide range of pollutants. At high concentrations, these emissions are injurious to health. At the regional and global level, vehicle exhausts contribute to 'acid' rain and global warming. Congestion is also evident on public transport, where demand exceeds capacity.

Addressing congestion can be an expensive undertaking. Sydney, for example, has spent billions of dollars on a network of tolled motorways and new metro lines. The latter has the advantage of increasing accessibility to the CBD and the former facilitates movement between key parts of the urban area, in particular Port Botany and the airport. Stations along the metro lines become new urban centres, featuring medium- and high-density housing and commercial activities (a process sometimes referred to as **urban consolidation**, see the box, Spotlight: Urban consolidation on page 157).

The solution to traffic congestion is not simply building more roads to allow traffic to flow freely. Building new and better roads tends to generate more, and longer, motor vehicle trips. This is especially the case in the low-density, vehicle-reliant cities of North America and Australia. European cities tend to be relatively high-density, with historic, architecturally significant, centres. Road construction (other than perhaps tunnelling) is impractical in such places. Improvement of public transport is often the most appropriate response to traffic congestion; however, such infrastructure is expensive.

Urban sprawl

Until the introduction of the railways, cities remained very compact. When most people walked to work, they tended to live close to their place of employment, in rows of terraces and semi-detached housing. The increased mobility offered by railways (which were the dominant influence on the form of cities from the 1860s to around 1920) led to the development of small, nucleated, suburban areas adjacent to a railway station. Urban areas subsequently developed a star-shaped pattern. The introduction of tram systems, and later, buses, led to some infilling of areas between railway lines. Ultimately, it was the introduction of affordable cars that transformed the urban landscape. The car, and its related infrastructure, now dominates our urban places.

The arrival of cars released people from the constraints of having to live near railway lines. Its effect on the form of cities was twofold: infilling between the major transport corridors and continued growth outwards, often referred to as urban sprawl.

In Australia, widespread car ownership in the 1950s and 1960s liberated people from reliance on public transport and led to urban sprawl. As cars became cheaper and more readily available, more and more Australians were able to purchase their own detached house on its own block of land, which came with privacy and security. Until the early 1970s, the idea of the owner-occupied family home on a quarter-acre block was considered by many Australians to be the basic right of every family. Any other form of housing (e.g. apartments) was seen as temporary and inferior, rather than a permanent solution.

Today, Australians continue to live in the broad sweep of post–World War II suburbs that encircle our cities. Many young couples still migrate to the urban fringe, where house-and-land packages provide them with their first home more cheaply than elsewhere in the urban area. See the box, Spotlight: Sydney's costly urban sprawl.

Today, urban sprawl continues, albeit at a slower rate than in the latter half of the twentieth century.

Infrastructure

Providing adequate infrastructure is a challenge for all cities. In developing countries, access to basics, such as safe water, sanitation, energy and public transport, are key challenges. In developed world cities, meeting the infrastructure needs of a suburbanised population is a challenge. This includes the construction and maintenance of those amenities that people often take for granted, such as schools, hospitals, roads, bridges and public transport.

WATER

The provision of clean potable water (together with access to sanitation) is a major challenge for the rapidly growing cities of the developing world, such as Karachi, Jakarta, Dhaka, Mumbai and Chennai. Karachi supplies piped water to only 40 per cent of its population, and it is rationed to a few hours per day. The limits of this system to supply the population with water are further tested by theft. The bulk of Karachi's 'lost' water is stolen and sold to people by criminal gangs. In Jakarta, water is also stolen.

● SPOTLIGHT

Sydney's costly urban sprawl

Greenfield suburban developments—and especially those occurring in the peri-urban outskirts of cities—are expensive to service when it comes to the provision of infrastructure (see Figure 6.4.6).

Take, for example, Wilton—77 kilometres from the Sydney CBD, half an hour's drive south of Campbelltown, where Picton Road meets the Hume Motorway. There are very few jobs here, and there's even less public transport. But there are another 15 000 houses coming. A further 13 000 homes have been approved for the nearby town of Appin.

Despite efforts to slow the rate of urban sprawl, the NSW Government will need to provide amenities for upwards of 40 000 homes—potentially 120 000 people—by the time both Wilton and Appin are completed.

As of 2023, when the first home was occupied, they had to truck out effluent daily, because the suburb was not yet connected to Sydney's sewerage infrastructure.

Both developments fall well beyond Sydney's metropolitan train network. Those living there will need to rely on cars and the already congested Hume Highway (M5) link to Sydney.

A 2018 Department of Planning document laid out an ambitious vision for a Wilton town centre with shops, medium-density housing, a sports field, a potential K–12 school, and an integrated healthcare centre. Residents are still waiting.

6.4.6 New housing estate in Menangle Park, south-west Sydney an example of urban sprawl

This requires 40 per cent of the population to buy water from street vendors, and more than 75 per cent have no connection to a piped water system—they rely on groundwater extraction. In Bangkok, less than one-third of people have access to piped water.

The provision of water in developed countries can also prove problematic. Urbanisation and urban growth increase the demand for water. In some instances, meeting people's need for water is becoming a major challenge. Los Angeles, for example, which has suffered from the impacts of prolonged drought, has spent billions to enhance its ability to capture, store and recycle water. The city is heavily dependent on annual snowpack and rainfall on the Sierra Nevada mountain range, which is no longer guaranteed due to the impacts of climate change. Also, the previously reliable supply of water from the Colorado River is rapidly drying up, with the river's largest reservoir, Lake Mead, nearing dangerously low levels. Strategies such as water conservation, landscape transformation, rainwater capture, groundwater recharge and water recycling are critical to Los Angeles' future.

Cities with low rainfall, such as Dubai, rely on desalinated seawater for their water supply. In the case of Dubai, close to 99 per cent of drinking water now comes from its desalination plants. Australian cities such as Sydney, Melbourne, Adelaide and Perth have also invested in desalination plants to supplement their water supplies.

SANITATION

Sewerage infrastructure in developing world cities is often inadequate. In cities such as Manila, Dhaka and Karachi, few people living in informal housing have access to a sewerage system. In general, little of the sewage collected is treated, rather, it is left to flow untreated into local waterways. In Cairo's metropolitan region, about half the sewage produced is dumped, untreated, into open drains that empty into the Nile River. This is the same river that is a primary source of water for irrigation and domestic use. In Indonesia, the 12 500 kilograms of raw sewage generated daily by the millions of informal settlement dwellers in and around Jakarta are dumped into one of the nine rivers that flow into Jakarta Bay.

Keeping pace with the rapid rate of growth in these cities is impossible for the authorities responsible for providing water and sewerage infrastructure. Lack of adequate funding is only part of the problem. Informal settlements can become established in a matter of days on any

piece of vacant land. In such circumstances, authorities cannot plan. Communities can be established before authorities have time to provide even the most basic infrastructure.

The high cost of providing infrastructure designed to meet conventional Western standards has prompted authorities in developing countries to examine more cost-effective approaches. These include specially designed infrastructure, better suited to the immediate needs of the urban poor (see Figure 6.4.7). Instead of building water and sewage-disposal systems using conventional Western technology, low-cost systems that are based on appropriate and affordable technologies, such as hand pumps and **pour-flush toilets**, are used.

ELECTRICITY

Informal settlements are rarely connected to the electricity grid because they develop in an unplanned fashion. Instead, residents rely on other forms of energy (such as kerosene) or illegally connect their homes to nearby power supply lines. The latter is a dangerous practice, which threatens the stability of the electricity grid, and denies revenue that could be used to maintain and upgrade the grid.

In India, there are an estimated 300 million urban dwellers living in energy poverty, and most of these people rely on kerosene for lighting. Kerosene use has direct adverse effects on a person's health, safety and general wellbeing. When kerosene is burnt, it releases airborne particles, including carbon monoxide, sulphur dioxide and various nitrogen oxides. Exposure to these pollutants increases the risk of respiratory infections. In addition, people using kerosene lamps risk burns or accidental fires started by the open flame. Blazes started by kerosene are common in India's informal settlements.

6.4.7 Communal toilet facility in Taimoor Nagar, New Delhi, India. While basic, such facilities greatly enhance the wellbeing of people living in informal settlements.

SPOTLIGHT

Urban consolidation

Urban consolidation is the term applied to policies designed to increase population densities in existing urban areas, to make more efficient use of existing infrastructure, and to limit the spread of urban land uses into surrounding rural areas (urban sprawl). It involves the construction of medium- and high-density housing in already built-up areas, often on former industrial sites. It also widens the range of housing types available to urban residents. Urban consolidation is also referred to as urban intensification.

Policies promoting urban consolidation are now at the centre of ongoing political debate. Those in favour of urban consolidation see it as a means of slowing the growth of urban sprawl and of making greater use of existing urban infrastructure. They also argue that it meets the housing needs of a diverse population, promotes the use of public transport and reduces the greenhouse emissions associated with vehicle dependency. Those opposed to urban consolidation see it as a threat to the character and amenity of existing urban precincts. It is said to increase congestion, impact negatively on privacy and threatens to overwhelm existing infrastructure.

Advocates of urban consolidation highlight the impacts of urbanisation and car dependence in cities. Those opposed to urban consolidation argue that the alleged benefits of higher-density living are completely at odds with contemporary urban social life, and incapable of meeting the stated objectives of its advocates.

Urban consolidation is closely related to the processes of **urban decay** and **urban renewal**. The deterioration of the urban environment is known as urban decay. It occurs when urban infrastructure falls into disrepair and buildings are left empty for long periods of time. The redevelopment of such areas, so that they better meet the needs of people, is referred to as urban renewal. Areas subject to urban decay, such as Sydney's Rhodes (see Figure 6.4.8), have often been the target of urban consolidation initiatives.

6.4.8 Sydney's Rhodes. Built on a former industrial site and having the benefit of access to Sydney's railway network, the suburb is an example of urban consolidation.

WASTE DISPOSAL

Disposal services for solid waste are often inadequate in large cities of the developing world. The proportion of solid waste collected in Jakarta is just 25 per cent, in Karachi it is 33 per cent, in São Paulo, Brazil, 36 per cent, in Kolkata 55 per cent, and 70–80 per cent in other large cities, such as Chennai, Manila, Mexico City and Bangkok.

Providing the infrastructure for the collection and processing of solid and liquid waste is often beyond the resources of developing world cities. Initiatives promoting the recycling of waste materials contribute to a reduction in solid waste and also provide a source of much-needed income for the urban poor.

In many cities, the recycling of solid waste has become an important source of income for the poor. In Beijing, an estimated 100 000 rural migrants sort through the 20 000 tonnes of waste generated each day by the city's 20 million people, in search of any recyclable material. For this, they earn about US$50 a month, which is a small fortune compared to what they could earn working on a farm.

In developed world cities, a range of initiatives have been introduced to reduce the amount of waste going to landfill. The provision of colour-coded bins separating household waste, recyclables and green waste is the most obvious of these initiatives. Nevertheless, finding suitable landfill sites remains a major problem.

Globally, plastic waste represents a major environmental threat. Not only is it unsightly, but microplastics (the tiny plastic particles used in commercial products and resulting from the breakdown of larger plastics) can be harmful to the environment and animal health.

SPOTLIGHT

Waste pickers do the heavy lifting of recycling

Much of Mumbai's waste ends up in Dharavi, an informal settlement where thousands of recyclers live and work (see Figure 6.4.9). Each day they sort through the piles of recyclables collected from Mumbai's landfills and streets by waste pickers. In Dharavi, the waste is cleaned and separated into the different types of materials destined for a second or third life. Without this work, much of the city's rubbish would end up in incinerators, dumped in landfills or be left on the streets to be washed out into the ocean.

One such recycler is Ali Mohammad. Ali moved to Mumbai from Uttar Pradesh four years ago, in search of work. Instead, he has spent his time separating, washing and chopping plastic, which is sold on to plastic processors for a small amount of money that is used to provide a meagre living for his family.

6.4.9 Mumbai's waste pickers. The sorting and recycling of waste generates income for some of the city's poorest residents. Here, a mother and her daughter scavenge for plastic, which they sell to local recyclers.

The interdependence of rural and urban functions

Geographers recognise the interdependence of rural and urban functions. Rural places provide the water, food, minerals and energy needed to sustain urban places. They process urban pollution and provide recreation for urban populations. In Australia, they also play an important role in maintaining the bush tradition, upon which much of the Australian identity rests. In return, urban places provide rural places with markets for goods produced by farmers and graziers, much of its technology, most of the financial capital and the manufactured goods that rural populations need. Decisions made in one place will often have implications for those in the other. To understand both urban and regional places, one must understand the relationships that shape them. This interdependence can be examined in terms of environmental, economic, institutional and identity-based relationships.

Environmental interdependence

The environment we share brings urban and rural populations together. Urban run-off, for example, can impact water quality in rural places, just as agricultural run-off (often polluted by fertilisers and pesticide residues) affects recreational areas used by urban dwellers. Pollutants originating in urban places can threaten rural forests and uncontrolled resource exploitation can poison groundwater supplies. Other examples of environmental interdependence include a growing appreciation that the quality of our food and the purity of our water depends on how pollutants, whatever their source, are managed.

6.4.10 Silo art has become an important tourist attraction across Australia's grain-growing regions, including Weethalle, NSW.

Economic interdependence

Economic interdependence relates to the trade and the exchange of goods, services, labour and/or finance that occurs between rural and urban places. Tourism is an example of this interdependence. Rural communities are keen to promote themselves as tourist destinations to attract the investment and employment that tourism generates (see Figure 6.4.10). Country people visit cities to consume the experiences, goods and services they offer (see Figure 6.4.11). Coastal resorts and wine-producing regions are two examples of non-urban places that have special appeal for those living in urban places.

6.4.11 The Grand Parade at the opening of the Sydney Royal Easter Show, Homebush. The country comes to the city.

SPOTLIGHT

The Mallee's silo art trail

The Australian Silo Art movement began in Northam, WA, in 2015. There are currently 54 silo art locations on the Australian Silo Art Trail, with many more yet to come.

Victoria's Wimmera Mallee region is home to one of Australia's largest collections of silo art. The popular local tourist trail celebrates the Mallee region's people through a series of large-scale murals painted onto grain silos.

The Mallee trail has seen internationally renowned artists from Australia and across the world visit the region, meet the locals and transform each grain silo into an epic work of art, each one telling a unique story about the host location.

Institutional interdependence

Government policies, whether designed specifically for rural places or more broadly, will often reinforce rural–urban interdependence by the ways in which they are applied. General aviation policies, for example, can impact differently on rural and urban places. They may either encourage or discourage the servicing of rural places by airlines, depending on the specifics of policy settings. Decisions to invest in transport infrastructure in high-density urban places can starve rural places of funds to maintain local roads.

Identity-based relationships

Identity-based relationships remain an important feature of rural–urban interdependence. People form attachments to places, and this influences their perception of those places. It impacts on how we see ourselves and the communities in which we live. Despite the impacts of cultural integration, often facilitated by the technologies of the information age, we find that places continue to matter. Not only do family, cultural, religious and ethnic ties continue to distinguish us, they also bind us. They foster a sense of community.

The Australian bush has long played an important role in defining Australian identity. Australia was a nation founded on the romantic myth of survival, a 'grand narrative' that legitimised white Australia's dispossession of its Indigenous peoples. An identity based on the bush tradition has promoted a set of values and characteristics recognised as quintessentially Australian. These include mateship, resilience, authenticity, informality and an easy-going disposition. First Nations Australians, however, are largely excluded from this grand narrative. It was not until 2023 that the cultures that had flourished on these lands for at least 60 000 years had the opportunity to be constitutionally recognised with a constitutionally enshrined 'voice' in decisions affecting their lives. The Referendum result unfortunately failed to make this happen.

Activities

Acquiring and processing geographical information

1 Summarise the advantages and challenges of living in rural places. What additional challenges face rural settlements in developing countries?

2 Summarise the causes of urban heat islands. What air quality issues occur in developing world cities? What are their causes and impacts? Give examples.

3 What is the nature and extent of overcrowding evident in developing world cities? Give examples.

4 Describe the nature and extent of overcrowding evident in developed world cities.

5 Explain what is meant by the term informal settlements.

6 Summarise the factors that determine house prices.

7 Explain what is meant by the term affordable housing. How does it differ from social housing? Summarise the strategies used to address the challenge of affordable housing.

8 Summarise the impacts of urban congestion. How can it be addressed?

9 Explain what is meant by the term urban sprawl. Outline its origins.

10 List the key elements of urban infrastructure that prove challenging for all cities.

11 Summarise the environmental, economic, institutional and identity-based interdependence of rural and urban settlements.

Applying and communicating geographical understanding

12 Study the box, Spotlight: Rural NSW's GP crisis. Summarise the reasons for the GP shortage in rural NSW.

13 Study Figure 6.4.2. Use the information in the diagram to write a report outlining the multidimensional nature of urban poverty.

14 Study the box, Spotlight: Housing the urban poor in developing world cities. Summarise the nature and extent of the housing crisis in developing countries. How have authorities responded to the challenge?

15 Study the box, Spotlight: Urban consolidation. Summarise the process of urban consolidation and explain why it is often portrayed as a controversial response to urban sprawl.

16 In the table below, for each infrastructure-related challenge summarise the nature of the challenge and, drawing on examples given in the text, describe how it is being addressed.

Infrastructure challenge	Nature of the challenge	How the challenge is being addressed
Water		
Sanitation		
Electricity		
Waste disposal		

17 Study the box, Spotlight: Waste pickers do the heavy lifting of recycling. Outline the role played by Mumbai's waste pickers.

UNIT 6.5

Settlements and sustainability

The promotion of sustainability, while enhancing human wellbeing, is now an important objective of those responsible for the planning and day-to-day functioning of settlements. There are several conceptual frameworks that can inform our thinking about the sustainability of settlement. In this unit, we focus on smart growth strategies, new urbanism and the eco-city concept. Oslo, Norway, and Portland, United States, are used to highlight the strategies that cities are adopting to enhance sustainability.

Smart growth strategies

'Smart growth' is the term applied to a suite of policies and tools designed to encourage environmentally sustainable urban development with less dependence on cars and neighbourhoods that include a mix of land uses that reduce the need for commuting. It uses planning laws and a range of incentives and penalties to channel growth that reduces a place's ecological footprint.

Smart growth strategies can discourage urban sprawl, reduce a reliance on private transport, protect ecologically sensitive lands and waterways, and develop neighbourhoods that are more rewarding and enjoyable places to live and work. Figure 6.5.1 outlines the smart growth tools that cities use to manage urban growth and reduce sprawl.

Portland, Oregon, is an example of a US city that has adopted smart growth strategies. In Europe, authorities have been successful in discouraging urban sprawl in favour of compact cities (see the box, Spotlight: Oslo's sustainability strategies). In many European countries, governments effectively control development and impose fuel taxes to discourage car use and encourage people to live closer to work and shops. In China, the government has designated 80 per cent of the country's arable land as fundamental land. Building on such land requires government approval. Such policies hinder urban sprawl.

Land-use planning is the most used tool to determine the best present and future uses of various parcels of land. Once a plan is developed and adopted, authorities can control the uses of parcels of land within towns and cities. Zoning is employed to determine the use of land parcels, including residential, commercial, open space or mixed-use. Zoning can be used to protect areas from certain types of development. For example, Portland (see the box, Spotlight: Portland: Showcasing the smart city strategy) has used zoning to encourage high-density housing along major mass-transit corridors to reduce vehicle use.

Limits and regulations

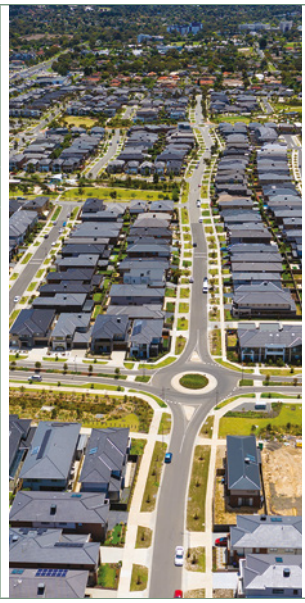
- Define and enforce outer urban growth boundaries
- Establish green belts around towns and cities
- Regulate the issuing of building permits

Land use zoning

- Promote mixed-use developments that include housing, commercial and recreational spaces
- Concentrate development along public transport corridors

Public transport

- Expand and diversify public transport options
- Promote the use of public transport by increasing motorway toll charges, lowering speed limits and reducing the cost of using public transport



Protection

- Protect existing open spaces and establish new ones
- Prohibit types of development that conflict with sustainability objectives, for example, new freeways
- Conduct environmental impact analyses

Tax-related measures

- Offer incentives to remediate and redevelop abandoned industrial sites
- Offer incentives to build affordable housing in suburban settings that include industrial and commercial land uses
- Implement CBD congestion charges
- Implement distance-based motorway tolls

Revitalisation and new growth

- Initiate urban renewal in areas subject to urban decay, such as former industrial sites and abandoned port facilities
- Develop well-planned new communities within existing urban boundaries

6.5.1 Smart growth tools

SPOTLIGHT

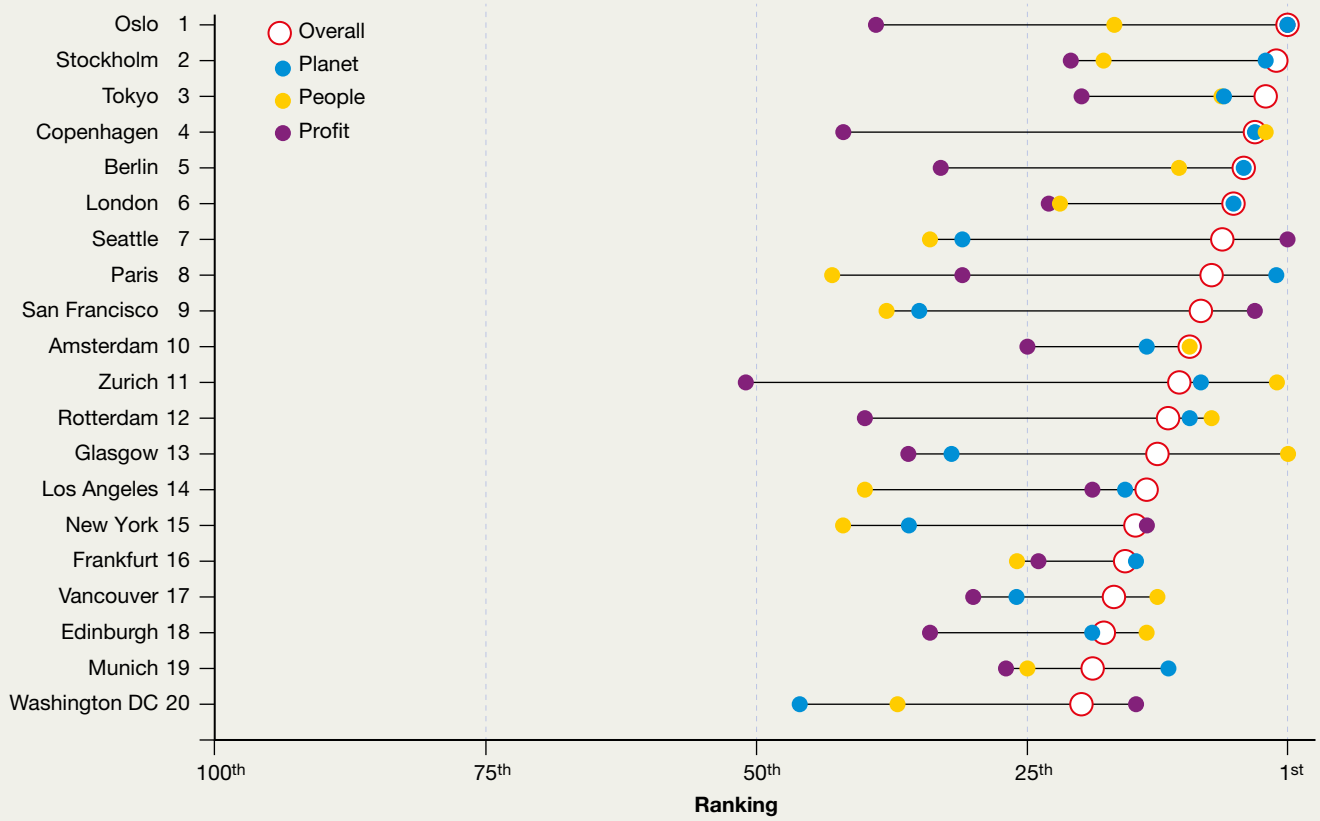
The Arcadis Sustainable Cities Index

Arcadis is an Amsterdam-based global design, engineering and management consultancy which argues that to be truly sustainable, cities must look beyond economic development to the health of their natural environment and the quality of life of the people that live there. This is not to say that economic activity is not important, but that it must serve the interests of people.

Each year, Arcadis publishes a Sustainable Cities Index. The index offers a new vision of prosperity, one that puts the planet and its people at its centre. In this index, profit is not just a measure of success, but is also a way of unlocking greater sustainability, for the planet and its inhabitants. That is, profit can—and should—be a catalyst for improvements in social and environmental wellbeing. The 2022 index (see Figure 6.5.2), is based on three measures.

- **Planet** indicators include people's immediate needs (clean air, green spaces and waste management), plans to transition to clean energy and sustainable transport, and other strategies to reduce greenhouse gas emissions.
- **People** indicators include personal wellbeing (health, education, crime), working life (income inequality and work–life balance), and urban living criteria, such as the availability and reliability of public transport, broadband and wi-fi.
- **Profit** indicators assess business environment and economic performance, including commercial transport infrastructure, overall economic performance and business-related infrastructure.

The Norwegian city of Oslo topped the 2022 index overall, ranking first in Planet, 17 in People and 39 in Profit. The top five spots of the overall index are occupied by a cluster of northern European capitals plus Tokyo, which comes in at number 3 and is the only Asian city in the top 20. There are no US cities in the overall top five and only two—West Coast cities Seattle and San Francisco—reached the top 10. Overall, while US cities dominate the Profit criteria, they do not perform well for Planet or People. Sydney ranked 33, Melbourne 60 and Brisbane 64. Sydney's ranking was helped by its high rating in the Profit criteria; however, the city rated poorly for environmental exposure and lack of bicycle infrastructure.



6.5.2 Sustainable Cities Index top 20 ranking, 2022

Did you know?

Liveability indexes, such as that published by The Economist Intelligence Unit, represent an additional insight into the sustainability of cities, to the extent that they take into account environmental factors and infrastructure. The 2023 index lists Vienna, Copenhagen, Melbourne, Sydney, Vancouver, Zurich, Calgary, Geneva, Toronto, Osaka and Auckland as the world's most liveable cities.

New urbanism

Greenfield, and some **brownfield**, developments now feature a diverse mix of detached dwellings, townhouses, duplexes and apartment buildings of various heights. They also feature communal open spaces and facilities. In the United States, such developments are described as examples of new urbanism. In Australia, many new suburban developments have embraced key elements of this approach. Other features of this approach to urban planning include:

- **walkable and bike friendly** neighbourhoods with ready access to the goods and services people use on a regular basis and access to public transport
- **diverse communities** featuring a range of age groups, socio-economic backgrounds and ethnicities, facilitated by the inclusion of social and affordable housing
- **quality urban design** featuring a range of architectural designs and inclusive recreational spaces
- **a focus on the collective rather than the individual**, with consensus-based responses to problems and planning
- **environmental sustainability** with a focus on minimising the environmental impact of urban areas through, for example, energy-efficient building codes for homes and buildings and recycling initiatives
- **smart transport** with well-designed, low-emission public transport systems linking neighbourhoods and other urban centres.

SPOTLIGHT

Oslo's sustainability strategies

Oslo (population 710 000) has implemented a range of initiatives that promote sustainability (see Figure 6.5.3). Many of these are linked to Norway's ambitious goal of over 95 per cent reduction of greenhouse gas emissions by 2030 (compared to 1990 levels). This task will be made easier by the fact that Norway produces the most renewable electricity of any country in Europe, with help from a vast supply of hydroelectricity. Specific strategies are outlined below.

- Planning has contributed to a relatively compact, pedestrian- and bike-friendly city, well serviced by public transport (see Figure 6.5.4). Communities feature a mix of residential and commercial land uses.
- Electric vehicle (EV) adoption is the key to city's success in reaching its carbon neutrality goals. Most new car sales in Oslo are now either 100 per cent EVs, plug-in EVs or hybrids. Nation-wide EV sales now account for 90 per cent of new vehicle registrations. Incentives include the ability to use bus lanes, free parking, toll exemptions and free EV charging.
- The city is increasing the number of bike lanes, mandating pedestrian and cycle-only zones around markets and green spaces, and is developing small 'pocket parks' along footpaths and bike lanes.
- The introduction of sustainable mass public transit including trams, ferries and electric buses that run directly on renewables, or are electric or electric-hybrids. All public transport will be emissions-free by 2028.
- The climate action plan for the Port of Oslo includes implementing a low-carbon contracting process and installing shore power for vessels that are docked there.

6.5.3 Oslo, ranked the world's most sustainable city by the Arcadis Sustainable Cities Index, 2022

6.5.4 Oslo's pedestrian-friendly streets

● SPOTLIGHT

Portland, USA: Showcasing the smart city strategy

Portland (population 650 000) is a port city in the state of Oregon, in the Pacific Northwest of the United States (see Figure 6.5.5). For more than 40 years, Portland has consistently ranked as one of the country's most liveable and sustainable cities.

6.5.5 Portland, USA

Since the 1970s, Portland has employed smart growth strategies and land use planning policies to better manage growth, reduce car dependence and protect green spaces. Consistent with such an approach, the city demolished a six-lane motorway (Harbor Drive)

6.5.6 Portland's Harbor Drive under construction

and replaced it with a waterfront park (see Figures 6.5.6 and 6.5.7). The demolition of Harbor Drive is widely considered a significant event in US urban planning—the first time a freeway had ever been removed without being replaced. It established Portland as a model of pedestrian- and public transport-friendly urban design.

6.5.7 Portland's Waterfront Park, an area once occupied by the six-lane Harbour Drive

Portland city authorities have employed planning policies to encourage the development of mixed-use neighbourhoods with high-density housing, shops, light industry, office buildings and access to public transport. This enables residents to meet their daily needs without needing to use their cars. Unlike most US cities, Portland has excellent light rail and bus lines and extensive networks of bike lanes and walkways.

The city's neighbourhoods feature more than 20 farmers' markets and 35 community gardens, providing fresh produce for residents.

The reduced reliance on cars has contributed to better public health outcomes, by cutting air pollution and increasing physical activity.

The city's initiatives have resulted in the recycling and composting of 75 per cent of the city's solid waste.

Portland is also the country's first city to develop a plan to reduce its carbon dioxide emissions. This includes a target to cut its per capita emissions to 65 per cent below 1990 levels by 2030, and 91 per cent by 2050.

Overall, Portland has demonstrated that it is possible to reduce a city's environmental footprint while enhancing the wellbeing of its residents.

Eco-city concept

A more progressive take on new urbanism is the eco-city concept, the basic tenet of which is that cities are for people, not cars. It holds that the failure to make cities more sustainable detracts from them being enjoyable places to live. Strategies to achieve more sustainable cities include growing as much of our own food as possible, generating our own emission-free energy, restoring the integrity of damaged local ecosystems, and processing pollutants and wastes and returning them to the ecosystems (e.g. water recycling).

Did you know?

In Australia, one train service takes an average of 578 cars off the road, reducing both congestion and emissions.

Mitigating the impact of urban heat islands

There is a growing awareness of the importance of tree cover in urban areas (see Figure 6.5.8). The benefits of urban tree cover include:

- **Natural climate control**—Trees act as natural coolers in the built environment, alleviating the heat-island effect and decreasing energy consumption for better climate change mitigation.
- **Carbon dioxide vacuum**—Trees draw on carbon dioxide from the environment for photosynthesis, to produce hydrocarbons that aid growth. Trees can also store carbon dioxide for immediate and long-term growth. Depending on its type and age, a single tree can store anywhere between one to 22 tonnes of carbon dioxide over the course of its life. That's a lot of carbon dioxide!
- **Improve health indicators**—Trees can reduce, block or buffer air, noise and water pollution, which are typically higher in cities. Making cities greener can tackle air pollution, the deadliest form of pollution.
- **Local community builders**—Access to green spaces and nature promotes emotional wellbeing and motivates people to exercise outdoors and socialise within their communities.
- **Promotes urban biodiversity**—A diverse tree cover protects biodiversity and provides a refuge for threatened wildlife.

Did you know?

Globally, cities are implementing innovative solutions to mitigate the impact of urban heat islands. In the United States, it has been discovered that painting roofs white can lower temperatures by up to 3°C. In Australia, some councils are now stipulating that roofs must be light coloured to achieve a similar result. In Europe, architects are covering roofs of buildings with plants and grasses, enabling them to reduce stormwater run-off, save energy, reduce pollution, absorb carbon dioxide, cool urban heat islands and filter pollutants. They also provide a habitat for animals.

6.5.8 Jacaranda-lined suburban street, Pretoria, South Africa

Activities

Acquiring and processing geographical information

1 Summarise the key elements of the smart growth approach to urban planning.

2 List the key elements of the new urbanism and eco-city concept approaches to urban sustainability.

Applying and communicating geographical understanding

3 Study the box, Spotlight: The Arcadis Sustainable Cities Index. List the criteria used to determine the ranking of cities.

4 Study the box, Spotlight: Oslo's sustainability strategies. Describe the strategies that enabled Oslo to achieve the Arcadis Sustainable Cities Index's world number one sustainable city ranking.

5 Study the box, Spotlight: Portland, USA: Showcasing the smart city strategy. Summarise the strategies that Portland has enacted that are consistent with the smart growth approach to urban sustainability.

6 Access the website of the Sydney City Council (or your local government area) and investigate the council's sustainability strategies. Determine whether these are a genuine attempt to achieve a more sustainable place or simply tokenistic. Use Figure 6.5.1 to guide your evaluation.

7 Write a report summarising the benefits of urban tree cover.

8 Using the sustainability checklist on page 71, evaluate the sustainability initiatives of a settlement you have studied.

CHAPTER

7 A rural place: Tamworth

The city of Tamworth (population 43 875) is a large rural service centre, serving the New England and North West regions of NSW. It is the third-largest inland city in the state. Only Wagga Wagga (population 57 010) and Albury (56 093) are larger. The next most functionally significant cities in the state's urban hierarchy are Newcastle and Sydney.

In this chapter, students examine the location and character of Tamworth, the geographical processes, both physical and human, that have shaped the identity of the city, its cultural and economic links to other places, the nature of the social economic and environmental changes affecting the city, and the responses and strategies to the challenges encountered, with a focus on sustainability.

> **Take me back to Tamworth**
>
> **Buddy Williams, Australian country musician (1918–1986)**

7.0.1 Aerial view of Tamworth, NSW

Chapter glossary

Country often used by Aboriginal and Torres Strait Islander peoples to describe a specific place to which they are connected; the concept of Country is complex and incorporates cultural, physical, linguistic and spiritual features

functional hinterland the area over which a place provides goods and services and interacts with its people

multicultural having a diversity of cultures

regional centre a regional place that serves as a focal point for regional commerce, identity and activity

rural service centre an urban place providing goods and services to a surrounding, largely rural, population

tree change moving inland to live in a country town or semi-rural setting

UNIT 7.1

The location and character of Tamworth

7.1.1 Tamworth CBD and East Tamworth from the air

Lands of the Kamilaroi people

The land on which Tamworth is located is the traditional land of the Kamilaroi people (also known as the Gamilaraay, Gomeroi or Kamilaroi) (see Figure 7.1.1). These lands extend from around Singleton in the Hunter Valley, to the Warrumbungle Mountains in the west, and up through the present-day towns of Quirindi, Gunnedah, Tamworth, Narrabri, Wee Waa, Walgett, Moree, Collarenebri, Lightning Ridge and Mungindi in New South Wales, to Nindigully in southwest Queensland.

The Kamilaroi language is classified as one of the Pama–Nyungan languages. The language is no longer spoken, with the last fluent speakers dying out in the 1950s. Today, the Kamilaroi (numbering about 13 000) form one of the four largest Indigenous nations in Australia. At the 2021 Census, the First Nations population of Tamworth was 5193 (14.7% of the city's population).

Arrival of Europeans

The explorer John Oxley was the first European to venture into the region. Oxley named the river passing through the site of Tamworth the Peel River, after British prime minister of the day Robert Peel. He noted the fertility of the region and its agricultural potential.

In 1831, the first sheep and cattle station was established, and the Australian Agricultural Company (AACo) was granted a lease of 127 000 hectares of land at Goonoo Goonoo, just to the south of the city's present-day location. In the 1830s, the AACo established a small settlement on the Peel River's south-west bank, the present site of West Tamworth. In 1850, a public town was gazetted by colonial authorities on the opposite bank of the river. This town, named Tamworth after the town in Staffordshire, England, represented in the British Parliament by Robert Peel, would quickly outgrow the AACo settlement (see Figure 7.1.2). The railway reached the town in 1878, further driving growth.

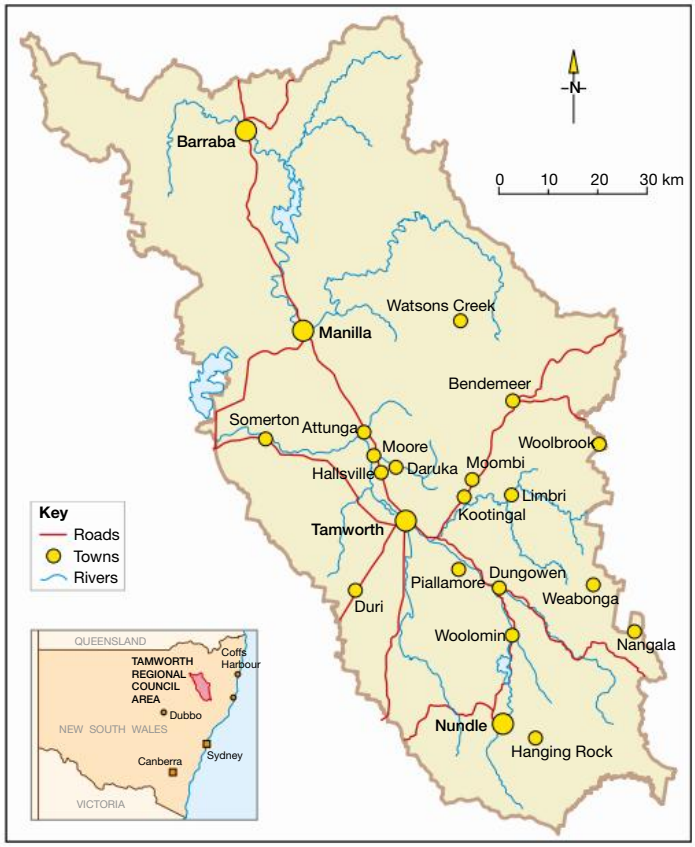
7.1.2 Tamworth's main street, Peel Street, and its former post office

Tamworth: A rural service centre

Today, Tamworth lies at the heart of one of the state's most productive agricultural regions and serves as its **rural service centre**. The principal agricultural activities in the region are cattle and sheep grazing, dairy farming, poultry raising and lucerne growing. Other, often small-scale, activities include alpaca, buffalo, goat and game fowl raising, hydroponics, wineries, and nut and olive growing. These activities are made possible by Tamworth's warm climate with hot summers and mild winters. Rainfall can occur all year round, with summer storms providing occasional heavy downpours (see Figure 7.1.5).

The Tamworth Regional Council, or local government area (LGA), incorporates an area of 9893 square kilometres and includes the surrounding towns and villages of Barraba, Bendemeer, Kootingal, Manilla and Nundle. The total population of the LGA is 63 652 (see Figures 7.1.3, 7.1.4 and 7.1.6).

7.1.3 The location of Tamworth relative to Sydney and Brisbane



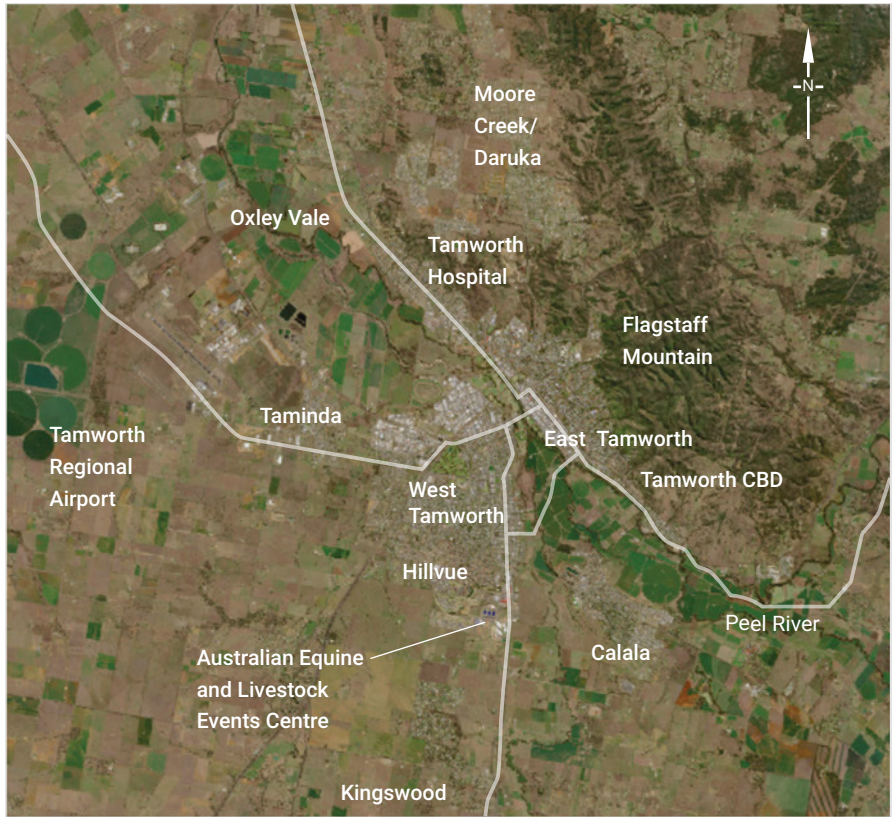
7.1.4 The Tamworth local government area

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Av. max. °C	32.9	31.7	29.4	29.6	20.8	17.1	16.4	18.4	22.0	25.6	28.6	30.6	24.9
Av. min. °C	17.6	17.0	14.5	10.1	6.1	3.7	2.2	2.7	5.8	9.7	13.3	15.6	9.9
Av. precip. (mm)	60.2	68.4	49.9	24.3	29.5	52.7	40.3	38.1	43.7	54.6	81.2	78.2	631.9

7.1.5 Tamworth climate averages

Did you know?

The Australian Agricultural Company was established by an Act of the British Parliament and incorporated by Royal Charter in 1824 for the cultivation and improvement of what was defined as 'wastelands' in the colony of New South Wales. Other purposes for the land included the production of fine merino wool for export to Great Britain.



7.1.6 Map of Tamworth showing key locations

Did you know?

On 9 November 1888, Tamworth became the first place in Australia to have electric street lighting powered by a local government-owned power station. The town was subsequently known as the 'First Town of Light'.

Location and site of Tamworth

Tamworth is located at latitude 31°05'S; longitude 150°55'E. It lies 420 kilometres north of Sydney and 574 kilometres south-west of Brisbane. It is 280 kilometres to the west of the coastal city of Port Macquarie. Armidale, the next largest city in the region, lies 105 kilometres to the north-east of Tamworth on the New England Highway, the principal inland route between the Sydney–Newcastle metropolitan areas and Brisbane.

The city itself straddles the Peel River, which is part of the Namoi catchment within the Murray–Darling basin, Australia's largest catchment. The headwater of the Peel is just south of the village of Nundle. It then flows generally north, west and north-west until it emerges into the Liverpool Plains near Tamworth. The river is joined by 13 tributaries, including the Cockburn River, and it flows into Chaffey Dam, before reaching its confluence with the Namoi River. In doing so, it drops 457 metres over its course of 210 kilometres. The river is subject to flooding. The Tamworth CBD is protected by a levy bank, while floodwaters are directed over the playing fields on the western bank of the river. Taminda, the city's main industrial estate, is subject to flooding.

While West Tamworth is relatively flat, East Tamworth is dominated by Longstaff Mountain (832 m). Oxley Scenic Lookout provides a view over the city and to the west. The city's east has a grid street pattern and has some of the city's most substantial homes. The city's CBD and its main street run parallel to the Peel River. Between the CBD and the river are the Bicentennial Gardens, the site of many of the city's celebrations, including Australia Day and country music concerts during the city's annual festival.

The city's airport, showground, racecourse and industrial estate are located on the undulating topography to the west of the Peel River.

On the outskirts of the city are several lifestyle-orientated housing estates on blocks of land larger than those typically found in city suburbs. The semi-rural setting is popular with families, early-stage retirees and city-dwellers seeking a **tree-change** lifestyle.

Character of Tamworth

Tamworth has a 'country' character. In addition to the range agricultural services it supplies to local farmers, Tamworth is, at least in the popular imagination, Australia's country music capital. The city's annual country music festival, held each January, is the second-biggest in the world after Nashville, USA (see Figure 7.1.7). The city is also considered the equine capital of Australia—a consequence of the high number of equestrian events hosted by the city's world-class equestrian centre, the largest in the Southern Hemisphere.

Beyond country music and equestrian pursuits, Tamworth has a level of cultural and economic sophistication that distinguishes it from smaller urban centres in the region (see Figure 7.1.8). For example, it offers a range of specialist medical services not typically available outside Newcastle and Sydney. It also offers a range of retail outlets that can only be sustained by a population as large as Tamworth's.

7.1.7 Tamworth Country Music Festival-goers

Social demographics

The standout demographic/social characteristic highlighted by the data in Figure 7.1.9 is that Tamworth is much less ethnically diverse than Australia as a whole. While only 66.9 per cent of the total Australian population are Australian-born, in the case of Tamworth the figure is 82.9 per cent. Where 36.7 per cent of Australians had both parents born overseas, this figure is just 11.3 per cent for Tamworth. In the case of religion, 60.8 per cent of Tamworth residents identify as Christian compared with just 43.9 per cent of the Australian population. This lack of diversity is evident in the classrooms of the city's schools, on its playing fields, in its churches, clubs and hotels, and in its streets.

Compared to the rest of Australia, the growing population of Tamworth is also more evenly spread across age groups (see Figures 7.1.10 and 7.1.11). This may be in part attributed to young adults moving away for study and work opportunities.

7.1.8 Tamworth's tree-lined main street

Taken as a whole, the city's population, and that of the surrounding area, is politically conservative. The federal seat of New England is classified as a 'safe' National Party seat, with Barnaby Joyce, the former deputy prime minister and former leader of the National Party, holding the seat with a comfortable 66.43 per cent of the two-party-preferred vote at the 2022 federal election. The seat was previously held by independent, Tony Windsor, from 2001 to 2013. In the same-sex marriage vote of 2017, in New England, the 'yes' vote secured a narrow majority of 52.5 per cent to a 47.5 per cent no vote. Just under 70 per cent of those eligible to vote did so.

Lifestyle

The lifestyle of Tamworth residents is more relaxed than that experienced by people living in large cities such as Sydney. Traffic congestion is a rarity and sports are a popular pastime. Young people enjoy greater freedom than their city-based counterparts. They can ride their bikes and gather in skate parks with fewer concerns about personal safety than those living in the suburbs of large cities. Country people are typically more down to earth and less materialistic than their city counterparts, and the entertainment they engage in is often spontaneous and participant-initiated.

While many residents participate in and benefit from, the city's notoriety as the country music and equine capital of Australia, it would be a mistake to describe these events as defining the character of the city and its residents. Tamworth's people share many of the same interests and aspirations as other Australians. This tendency is reinforced by their exposure to national and global media networks and the internet. Young people typically engage with the same popular culture as their city counterparts.

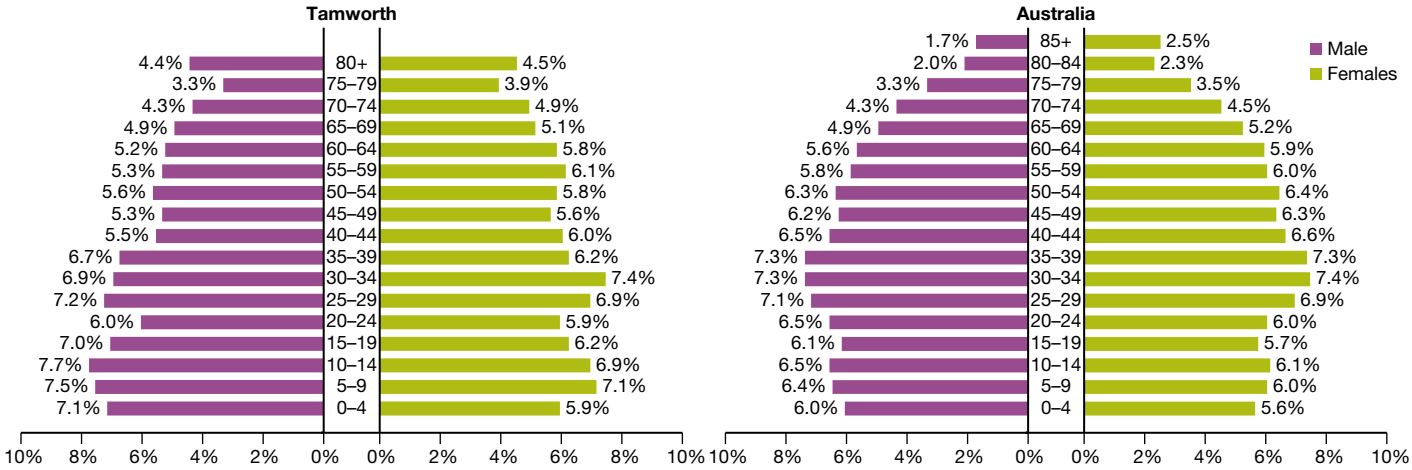
Demographic/social criteria	Tamworth	Australia
Male	48.6%	49.3%
Female	51.4%	50.7%
Median age	37	38
Indigenous Australians	14.1%	3.2%
Household data		
Av. number of children per family	1.9	1.8
Av. number of people per household	2.4	2.5
Single-parent (male) household	17.6%	19.0%
Single-parent (female) household	82.5%	81.0%
Median weekly household income	$1411.00	$1746.00
Home owned outright	30.0%	31.0%
Home owned with a mortgage	28.9%	35.0%
Home rented	37.5%	30.6%
Median monthly mortgage repayments	$1500.00	$1863.00
Av. number of vehicles per dwelling	1.8	1.8
Age structure		
Population under the age of 15 years	20.6%	18.2%
Population under the age of 20 years	27.2%	24.4%
Population 20–65 years	53.8%	58.8%
Population over 65 years	18.9%	17.2%
Marital status		
Married	41.7%	46.5%
Separated	4.0%	3.2%
Divorced	9.5%	8.8%
Widowed	6.4%	5.0%
Never married	38.5%	36.5%
Educational attainment		
Bachelor's degree or higher	15.5%	27.3%
Country of birth (top responses)		
Australia	82.9%	66.9%
England	1.1%	3.6%
India	1.1%	2.6%
China	–	2.2%
New Zealand	0.7%	2.1%
Country of birth of parents		
Both parents born overseas	11.3%	36.7%
Father only born overseas	3.7%	6.6%
Mother only born overseas	2.8%	4.9%
Both parents born in Australia	74.4%	45.9%
Religion		
Christian	60.8%	43.9%
No religion	32.8%	38.9%

Source: ABS

7.1.9 Tamworth's demographic and social profile, relative to that of Australia as a whole, 2021 Census

Year	1961	1971	1981	1996	2001	2006	2011	2014	2021
Population	19 100	22 500	29 700	32 400	32 440	33 480	36 130	41 006	43 875

7.1.10 Tamworth's population growth, 1961–2021



7.1.11 Tamworth and Australia population pyramids

Activities

Acquiring and processing geographical information

1. Identify the traditional owners of the land on which Tamworth is located. What is the extent of these traditional lands?
2. Summarise the history of Tamworth and its surrounds post-1788.
3. Summarise the agricultural land uses in the areas surrounding Tamworth.
4. Describe the key features of Tamworth's site.
5. Summarise the factors that shape the character of Tamworth.

Applying and communicating geographical understanding

6. Study Figure 7.1.3. Describe Tamworth's relative location.
7. Study Figure 7.1.4. Outline the spatial extent of the Tamworth LGA.
8. Study Figure 7.1.5 and complete the following tasks.
   - **a** Name Tamworth's warmest and coolest months
   - **b** Name Tamworth's wettest and driest months
   - **c** Describe the seasonal distribution of rainfall.
9. Study Figure 7.1.9. Write a report outlining the ways in which Tamworth's statistical profile reflects and differs from that of Australia as a whole.
10. Study Figure 7.1.11. Compare the population pyramid of Tamworth to that of Australia. In what ways are they similar and different? Speculate on the reasons for any differences.

UNIT 7.2

Geographical processes affecting the identity of Tamworth

Like all places, Tamworth's identity is shaped by its physical and cultural setting. The physical and cultural setting of a place is an important contributor to a person's, and indeed a community's, sense of place. Lots of elements contribute to the sense of place that people experience. These include the surrounding landscape, the weather, the nature of the built environment (e.g. the types of houses), elements of culture, and even things such as a place's sounds and smells. Sense of place in this context refers to the relationship between people and their spatial setting.

Physical setting

Tamworth city's physical setting is dominated by the Peel River, its flood plain and the mountain backdrop provided by Blackstaff Mountain. To the west lies undulating topography. The river and topography have shaped the city's morphology – its functional form and character. The city's CBD extends along five to six blocks that run parallel to the river. It extends for two to three blocks from the riverside Bicentennial Gardens to the New England Highway (Marius Street) and the Main North railway line (see Figure 7.2.1).

7.2.1 The physical setting of Tamworth

The Peel River flood plain, like the river, divides the city and houses many of the city's sporting fields, some of which double as camping grounds during the Tamworth Country Music Festival. To the south and south-east of the city centre, the floodplain is home to irrigated agriculture. Three bridges and a railway viaduct link two parts of the city. The New England Highway passes through the city and the Oxley Highway, which links Nevertire, Gilgandra, Coonabarabran, Tamworth and Walcha to Port Macquarie, also passes through the city.

The broader region in which Tamworth is located is dominated by agriculture, with some coalmining in the Gunnedah Basin, 80 kilometres to the west of the city. Intensive forms of agriculture are found on fields adjacent to the Peel River where irrigation is possible. More extensive forms, especially grazing, are found across the region. Industrial-scale agriculture, for example, chicken raising, is found relatively close to the city.

Cultural and social setting

As noted in Unit 7.1, Tamworth lacks the cultural diversity typical of Australia's large urban centres. This is evident in the city's streets, classrooms, places of worship, sporting teams and streetscapes. The reason for this is complex, but includes the preference of immigrants to settle where existing community-based support services are available, where employment opportunities are greatest and where previous waves of migration from a common point of origin have settled.

Tamworth is, however, still home to people from over 80 nations according to **Multicultural** Tamworth Inc., a community-based multiculturalism support group. Just over 11 per cent of Tamworth residents have both parents born overseas. Just over 25 per cent have one parent born overseas. The largest 'country of origin' group is Taiwan (2.6%) followed by Vietnam (1.6%), India (1.6%), Nepal (1.6%) and Pakistan (1.6%). For those in Tamworth who were born outside Australia, the largest 'country of birth' groups where England and India (1.1%) and New Zealand (0.7%).

The city's Fiesta La Peel Multicultural Street Festival is an example of its celebration of ethnic and cultural diversity (see Figures 7.2.2 and 7.2.3). The festival brings together peoples of many nations. The fiesta of food, flavours and cultures takes place in the city's Bicentennial Park in March (see Figure 7.2.6). Over 30 nationalities are represented within a mix of food stalls, demonstrations and performances.

7.2.2 Vietnamese food stall at Tamworth's Fiesta La Peel Multicultural Street Festival

7.2.3 Celebrating Tamworth's cultural diversity at Fiesta La Peel Multicultural Street Festival

Tamworth is often closely associated with the county music genre, an important and distinctive element of Australian popular culture (see Figures 7.2.4 and 7.2.5). Country music spans a broad range of styles, from bluegrass to folk to the more mainstream. As a genre, it has been influenced by Celtic and English folk music, the Australian bush ballad tradition, as well as US country music. Australian country music artists have been inspired by outback life, the lives of stockmen, truck drivers and outlaws. It includes songs of romance and political protest, and songs about the beauty and the hardships of the Australian bush.

The annual Tamworth County Music Festival, while not the only such festival in Australia, is the country's premier event. The festival celebrates the culture and heritage of Australian country music. During the January festival the Country Music Association of Australia holds the Country Music Awards of Australia ceremony at which it awards the Golden Guitars, and the Tamworth Songwriters Association hosts the annual Tamworth Songwriters Association Awards. Country music has been particularly popular among Aboriginal Australian and Torres Strait Islander peoples, creating a sub-genre often termed Aboriginal country music.

7.2.4 Peel Street busker

7.2.5 The life-size statues of country music performers and married couple Slim Dusty and Joy McKean in Peel Street

7.2.6 Tamworth's Bicentennial Gardens, the site of many of the city's great celebrations

The extent to which Tamworth residents engage with country music is debatable, but most recognise the economic importance of the annual music festival to the city and the extent to which it generates name recognition at a national and even an international scale.

7.2.7 The main arena of the AELEC

7.2.8 The ABCRA rodeo is one of the highlights of the Tamworth Country Music Festival.

7.2.9 House typical of those found in East Tamworth

Sporting events

Apart from the city's link with country music, the city's other most significant country-focused cultural association is that of equestrian sports and livestock-related events. The city's status as a centre for such activities was given a major boost by the establishment of The Australian Equine and Livestock Events Centre (AELEC), built for $28 million and funded by all three tiers of government: Tamworth Regional Council, and the NSW state and the federal governments (see Figure 7.2.7). Located on the southern approach to the city, the centre makes a major contribution to the economy of the Tamworth region. The centre caters for a wide range of events, including equine breeding and sporting association shows and clinics, the Tamworth Show, cattle sales, major trade shows, indoor motorcycle racing, motorcycle rallies, rodeos, corporate events and even circuses.

The AELEC is also the base of the Australian Bushmen's Campdraft and Rodeo Association (ABCRA), a non-profit equine sporting organisation formed in 1946 to coordinate and assist affiliated committees to conduct their events. In January each year, the ABCRA hosts the Rodeo, Campdraft and Challenge Sorting and Penning National Finals, held at the AELEC. The finals are a flagship event, run during the Tamworth Country Music Festival, and visitors are treated to superb displays of equine and livestock sport (see Figure 7.2.8).

Socioeconomic patterns

For many Tamworth residents, there is a perceived social divide between East and West Tamworth. Elevated East Tamworth is seen to be the city's most desirable residential area and its most affluent. The streets are wide and mostly treelined. The homes are generally substantial, located on relatively large blocks of land and many have views across the plains to the west. Many homes date from the early years of the twentieth century and are much sought after (see Figure 7.2.9).

The areas of greatest social disadvantage lie in the suburbs in the city's west. West Tamworth, for example, is identified as the most disadvantaged area in the city on the Australian Bureau of Statistics (ABS) Index of Relative Socio-Economic Advantage and Disadvantage. The index is based on indicators of disadvantage, including unemployment, low income or education levels and lack of internet access, as well as additional indicators of advantage, such as professional occupations, high income, higher education levels and larger houses.

The most recent Index of Relative Socio-economic Advantage and Disadvantage was published in 2023 (using data from the 2021 Census). The index score for various Tamworth residential precincts is shown in Figure 7.2.10. The percentile column indicates the approximate position of the specified area in a ranked list of Australia's suburbs and localities. It's meant to indicate where the area sits within the whole nation. A higher number indicates higher socio-economic status. The lifestyle estates surrounding Tamworth (Kingswood, Hallsville,

Moore Creek, Hillview and Calala) together with East Tamworth, are in the top 50 per cent of Australian residential precincts. There are, however, four residential areas that have percentiles of 10 or lower. This suggests that they are among the most disadvantaged (or least advantaged) residential areas in Australia. However, care must be taken when making generalisations based on such data. All residential areas house people who are advantaged and disadvantaged.

Residential area	2021 Index	Percentile
Kingswood	1020	69
Hallsville (Daruka and Moore Creek)	1011	65
East Tamworth	1012	65
Hillview	998	51
Calala	991	53
North Tamworth	974	43
Westdale	902	13
Oxley Vale	889	10
Tamworth (CBD area)	888	10
South Tamworth	823	3
West Tamworth	800	2

Source: ABS

7.2.10 Index of Relative Socioeconomic Advantage and Disadvantage, selected Tamworth residential areas, 2021

Activities

Acquiring and processing geographical information

1. Explain what is meant by the term sense of place. What are some of its contributing elements?
2. Describe Tamworth's physical setting.
3. Summarise the key elements of Tamworth's cultural and social setting. Speculate on how these might impact on the city's identity.

Applying and communicating geographical understanding

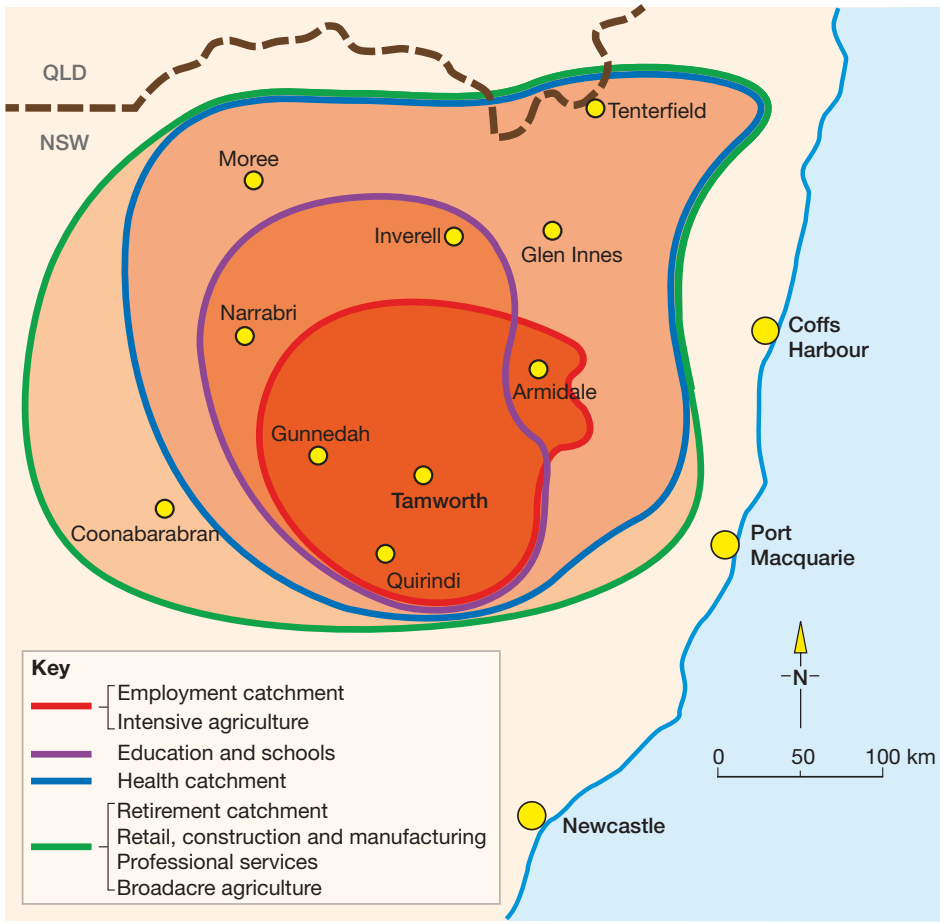
4. Hold a class discussion on the topic, 'How might Tamworth's physical setting impact on its sense of place?'
5. Study the data in Figure 7.2.10 and complete the following tasks.
   - a List the residential areas that fall in the top 50 per cent of Australia's residential precincts.
   - b List the residential areas in the bottom 50 per cent of residential precincts
   - c Kingswood has a percentile rank of 68. What does this mean?
   - d West Tamworth has a percentile rank of 2. What does this mean?
   - e Four of the top five ranked residential areas are all lifestyle-based communities beyond the city's built-up area. What does this tell us about the people living in these estates?
   - f Using Google Maps, locate each of the residential areas listed. Describe their relative location and the spatial pattern of advantage and disadvantage in Tamworth.

UNIT 7.3

Tamworth's links to other places

Tamworth has a diverse range of links with its surrounding **hinterland**, the broader region in which it is located, the state, the nation and the world. In terms of its hinterland, these links can be studied in terms of the pull factors that attract people to the city. See Figures 7.3.1 and 7.3.2.

Tamworth's **functional hinterland** extends towards the north, east and west. In the south, there is a point at which Newcastle exercises greater pulling power.



7.3.1 Tamworth's goods and services hinterlands (catchments)

While Tamworth's population has grown at a generally steady rate (see Figure 7.1.10 on page 175), the populations of the surrounding communities have declined. Manilla declined from 2550 in 2016 to 2386 in 2021. Werris Creek declined from 1572 in 2016 to 1478 in 2021. The decline or stagnation of smaller rural centres, and the growth of larger **regional centre** such as Tamworth, is reflected elsewhere in rural NSW. The declining population of these smaller towns is evident in the shrinking range of goods and services available in them. The number of shuttered shops in their main streets is the most visible impact of this trend—with small town retailers unable to compete with the pull of Tamworth.

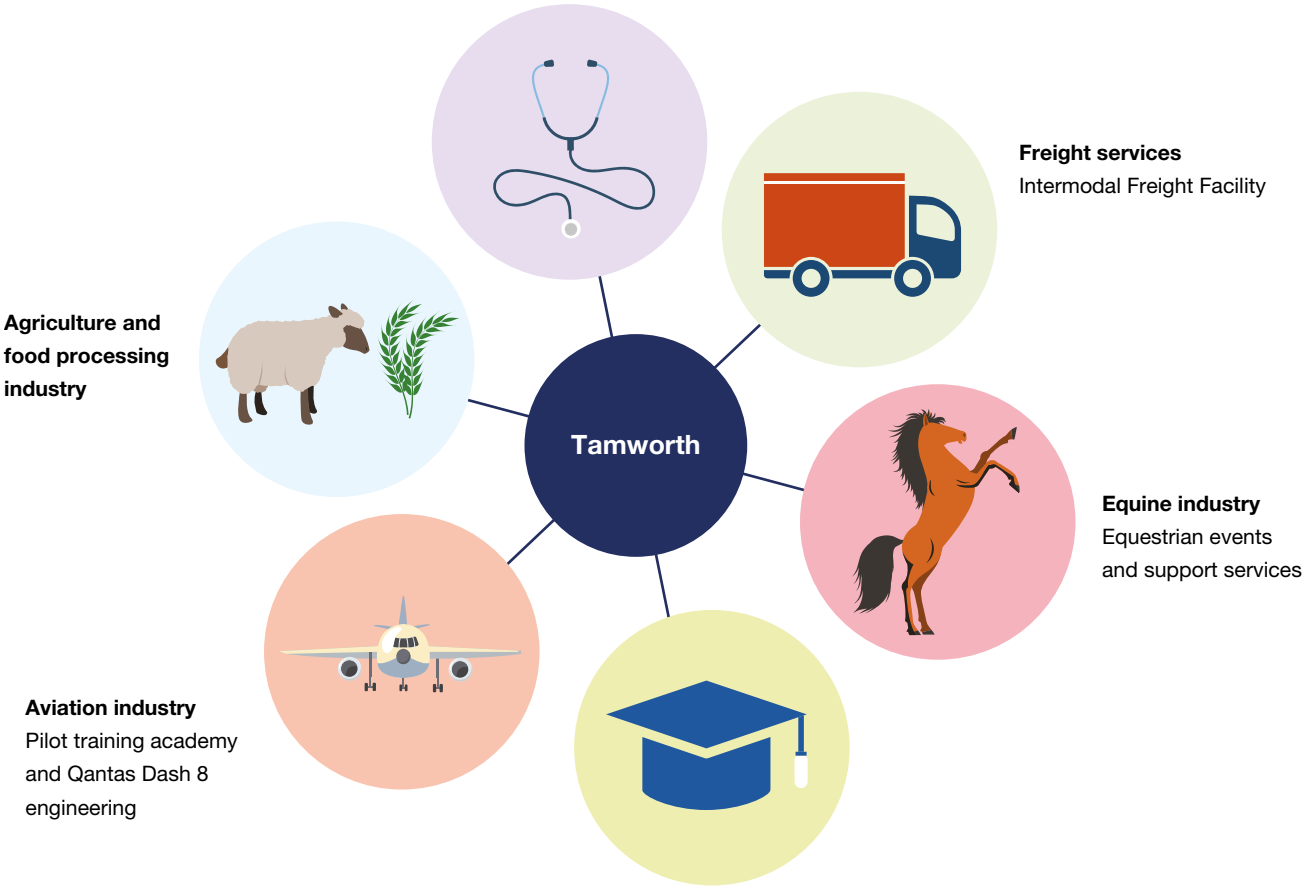
Tamworth's cultural links

Residents of Tamworth typically identify as a community based on the place in which they live (that is shared space). They may, for example, identify as being 'from Tamworth' at one level or scale, or with a particular residential precinct within or surrounding the city, for example, East Tamworth, the Kingswood Estate or Moore Creek.

Communities based on shared social organisation or interest, include Tamworth's country music and equestrian interests, sporting clubs, professional groups, schools, religions and ethnicities, to name just a few.

Tamworth's cultural links also extend well beyond those associated with country music, equestrian events, sports and other rural-based pursuits. These include, for example, the family-based links associated with the movement and settlement of school leavers to other places in Australia and further afield, for further education and work. While many still call Tamworth 'home' and return to visit family, they establish a new life elsewhere. This is often the case for young people seeking careers not offered in Tamworth.

Health care services
Tamworth Base Hospital and Cancer Centre, Tamara Private Hospital and Newcastle University Health. Tamworth Base Hospital is a regional rural referral hospital.



Freight services
Intermodal Freight Facility

Agriculture and food processing industry

Equine industry
Equestrian events and support services

Aviation industry
Pilot training academy and Qantas Dash 8 engineering

Education services
A range of public and private schools and University of New England Tamworth Campus. University of Newcastle has a strong presence in the health precinct, providing training in a number of medical fields (35 educational institutions in total).

7.3.2 Tamworth's pull factors

● **SPOTLIGHT**

Cultural links and community

An exploration of cultural links brings the concept of community into focus. A community is made up of people who have something in common. A sense of community often develops between people who share the same space (location) or have similar beliefs and interests. Geographers often distinguish between two types of communities.

- **Communities based on shared space:** examples include an urban neighbourhood or country town, in this instance Tamworth.
- **Communities based on shared social organisation or interest:** examples include people who belong to the same sporting club, profession, political party or interest group; people who speak the same language or have the same religion; and people who have the same heritage or cultural background.

Members of communities based on shared social organisation or interest often have links that go beyond a particular space. Technological advances have allowed communities based on shared social organisation or interest to interact across the globe.

Cultural diversity

Immigrants often have strong cultural links to their place of origin. While Tamworth lacks the cultural and ethnic diversity of larger Australian cities, it does, nevertheless, recognise and celebrate the diversity it has. Each year the city holds the Fiesta La Peel Multicultural Street Festival, the region's biggest annual showcase of food, craft and entertainment from across the globe. The city's Bicentennial Park comes to life for one big street party to celebrate diversity.

Aboriginal and Torres Strait Islander cultures

The city's First Nations cultural heritage is another important link. The spiritual and cultural attachment to **Country** provides an enduring link between the Kamilaroi people and the land on which Tamworth is located. For the Kamilaroi people, Country does not just mean the physical elements of the land. It includes all living things. It embraces the seasons, stories and creation spirits. Country is both a place of belonging and a way of believing. Even if Kamilaroi people live elsewhere, they retain a strong attachment to Country.

Sister cities

Tamworth Regional Council maintains sister city links with five places internationally. They are the Gore District Council, New Zealand; Chaoyang District, Beijing, China; Nashville, Tennessee, USA; Sannohe Town Council, Aomori Prefecture, Japan, and the Tamworth Borough Council, Staffordshire, England. The relationships with Gore and Nashville are based on the shared interest in country music (see Figure 7.3.3). The Sister City Committee program is designed to facilitate education and business interchange and foster national and international relationships.

7.3.3 Nashville, Tennessee, the USA's country music capital

Changing cultural links

The nature of cultural links changes over time. Advances in communication technologies have greatly extended the reach of Tamworth residents. The internet and social media enable them to maintain professional and relationship-based links with colleagues, friends and family living anywhere. It also enables them to access goods and services irrespective of where they are provided.

There are, however, examples of where the city's sense of community has been adversely impacted by change. Tamworth once had its own television station (NEN9), which commenced broadcasting in 1965. The station reinforced Tamworth's sense of community through its programming. With the aggregation of Australia's television industry, the Tamworth station was taken over by Prime Television, aligned with the Seven Network. The coverage provided by television shifted from local to national and global scales. Pay television (Foxtel) and the introduction of streaming services have reinforced this trend.

Sport is an important element of Tamworth culture, with residents and visitors participating in more than 50 different sports and recreational pursuits. Many major annual and one-off sporting events are held in the city because of its wide range of facilities and venues. The Northern Inland Academy of Sport is one important institution in the town that has helped talented sportspeople. The community-based organisation was established in 1992 with the stated aim of developing the potential of the many talented young athletes, coaches and officials across the region.

The city's sport-related infrastructure includes the Tamworth Sports Dome and the planned Tamworth Regional Aquatic and Leisure Centre. Tamworth Sports Dome is the region's premier multi-purpose indoor sports facility. It houses 7 indoor and 18 outdoor sporting courts that cater to a range of sports. The planned Tamworth Regional Aquatic and Leisure Centre is to be a fully accessible aquatic facility, combined with leisure, fitness, health and active recreation facilities. It will have the potential to host elite events at regional, state and national levels, as well as athlete development and training pathway programs.

This project is planned to be delivered in two stages. The first stage will include indoor elements and the second stage the outdoor pool and water slides.

Economic links

Tamworth's diverse economic links include those associated with the surrounding agricultural land uses, supply chains, political links and the city's road, rail and aviation links.

Agricultural goods and services

Tamworth, like many large regional centres, provides a range of goods and services that support surrounding agricultural industries (see Figure 7.3.4). Those available in Tamworth include:

- business and technical management services, including digital planning
- seed, chemical and fertiliser suppliers
- water management services
- irrigation equipment
- fencing supplies and contractors
- animal health management
- farm machinery sales and service
- banking and accounting services
- weed and pest control
- engineering services.

Agricultural goods and services contribute an estimated $75 million in value to Tamworth's economy.

7.3.4 Harvesting sorghum on a farm near Tamworth

Supply chains

Tamworth's most important economic links are those supply chains that provide the city with all the goods it needs to sustain its population. These supply chains include the goods that occupy the shelves of supermarkets, pharmacies and clothing stores. It includes the produce used by restaurants and the vehicles sold in local car yards. It includes the goods sold by retailers such as Dan Murphy's and Bunnings, and the letters and parcels delivered by Australia Post and other couriers. Most of these goods are transported by road from large distribution centres in Newcastle, Sydney, and in some cases, Brisbane. Many goods originate in places such as China, Vietnam and Malaysia.

Utilities such as electricity are drawn from the national power grid and water is piped from the city's two water storage dams.

Transport links

While Tamworth is a city in a rural setting, it's important to note that transport links play a critical role for both the city itself and the rural industries it supports.

Road and rail links

Tamworth and its surrounding region are served by two major highways. The first of these is the New England Highway, an 883-kilometre-long highway running from Hexham in Newcastle to Yarraman, north of Toowoomba, Queensland. The highway is part of Australia's National Highway system and forms part of the inland route between Brisbane and Sydney. The second is the Oxley Highway, which extends 645 kilometres from Port Macquarie through Tamworth to Gunnedah, Coonabarabran and Gilgandra to Nevertire.

Finally, the North Western Line offers passenger rail transport between Sydney and Armidale via Tamworth. The NSW TrainLink passenger train splits at Werris Creek with one half heading west towards Narrabri.

The development of the Tamworth Intermodal Rail Line involves the reactivation of five kilometres of the non-operational rail line between West Tamworth and Westdale. The reactivation will provide rail access for the planned Tamworth Freight Rail Facility, which

7.3.5 Tamworth Regional Airport

aims to encourage new industry developments, facilitate economic growth and support the shift in moving freight from road to rail.

Aviation links

Tamworth is also home to Tamworth Regional Airport (see Figure 7.3.5). Several daily return services provide links to Sydney, Brisbane, Melbourne and the Sunshine Coast. The latter two destinations were added in 2023 with the launch of Bonza, a low-cost airline.

Tamworth Regional Airport, owned and operated by Tamworth Regional Council, is a major economic entity. The airport is home to the QantasLink Dash 8 heavy maintenance division (see Figure 7.3.6), Sigma Aviation, Aviskills, the Civil Aviation Safety Authority's regional office, and International Flight Training Tamworth College, which houses BAE Systems and CAE Australia Flight Training. Tamworth Airport is also the northern base of the Hunter Region Westpac Life Saver Rescue Helicopter Service. CAE Tamworth is a campus-like training facility capable of accommodating 231 students. The academy offers training pathways for Australian and international airlines, combining ground-based courses with high-quality flying instruction.

Did you know?

At the state level, Tamworth is one of the few electorates with a consistent willingness to give independent politicians a go. Since 1970, the city has been represented at state level by Noel Park (National Party, 1973–91) Tony Windsor (Independent, 1991–2001), John Cull (National Party, 2001–03), Peter Draper (Independent, 2003–11) and Kevin Anderson (National Party, 2011–present). The same applies at the national level with Tony Windsor, the independent local member (2001–13) followed by Barnaby Joyce (National Party, 2013–present).

Political links

Tamworth's political links are with Sydney's Macquarie Street, the term widely used to denote the NSW Government, and the federal government in Canberra. Tamworth hosts the regional offices of many state and federal government agencies.

7.3.6 QantasLink Dash 8 maintenance facility at Tamworth Regional Airport

Activities

Acquiring and processing geographical information

1 Summarise the impact of Tamworth's growth on smaller surrounding towns.
2 Differentiate between communities based on shared space and those based on shared social organisations or interests.
3 Summarise the ways in which the people of Tamworth identify with a community based on shared space.
4 List some of the ways the people of Tamworth identify with a community based on shared space.
5 Outline Tamworth's cultural links and how these have changed over time.
6 Describe Tamworth's sporting links.
7 Outline the city's links to the agricultural sector.
8 Explain the nature of Tamworth's supply chain links.
9 Describe Tamworth's road, rail and aviation links.

Applying and communicating geographical understanding

10 Study Figures 7.3.1 and 7.3.2. Write a report outlining the links Tamworth has with other places within the region in which it is located.

UNIT 7.4

Change in Tamworth: Challenges and responses

Change, and how places respond to the challenges it presents, are of particular interest to geographers. In this unit, the focus is on cultural/social change and economic and environmental change as they impact Tamworth.

Cultural and social change

Key elements of Tamworth's dynamic cultural and social identity include its embrace of country music and sport, the city's political and social conservatism, the growing appreciation of its First Nations cultural heritage and the implementation of strategies that seek to address Indigenous disadvantage.

Cultural identity

Tamworth is widely known as Australia's country music capital. This brand or label represents both an opportunity and a challenge for Tamworth.

The annual Tamworth Country Music Festival takes place for 10 days in mid- to late January. The festival is the second biggest country music festival in the world. It showcases Australian and international country music artists, who perform live shows 24 hours a day. Authorities estimate that 100 000 people travel to Tamworth for the festival, with around 70 000 staying for the festival's duration. A festival highlight is the prestigious Golden Guitar Awards. Related attractions, including the big Golden Guitar sculpture (see Figure 7.4.1), the Country Music Wax Museum and the Hands of Fame Park, attract visitors to the city throughout the year. The festival injects an estimated $60 million into the local economy annually and comes on top of the busy Christmas/New Year trading period.

7.4.1 Tamworth's Golden Guitar landmark

The strong identification of Tamworth with country music, however, can create challenges for its cultural identity. For example, it can limit the scope for cultural diversification through other events, with country music overwhelming other opportunities to promote the city as a destination for other cultural events. The label does, however, represent a major economic opportunity and bolsters the city's status as a tourist destination.

Sporting events are also a strong part of the Tamworth cultural identity and an important economic driver. In addition to the range of equestrian events, as noted in Unit 7.2, various sporting codes conduct state-wide competitions and carnivals in the city. These events bring participants and their supporters to the city from throughout the region and the state. The events are a major boost to the city's hospitality sector.

The challenge for the city is to promote year-round tourism and expand the calendar of major events. Building the infrastructure needed to attract such events has been a major focus of authorities. The Tamworth Regional Entertainment Conference Centre and the AELEC are the two most notable examples of such infrastructure (see Figure 7.4.2).

7.4.2 Oblique aerial photograph of the AELEC

Political and social conservatism

Conservative social and political worldviews are evident at several levels in Tamworth. In December 2006, the Tamworth Regional Council voted six to three to reject an offer from the federal government to take part in a 12-month trial rural refugee resettlement program. Most of these refugees were to be Sudanese, escaping civil war in their homeland. Then-Tamworth mayor, James Treloar, made several disparaging claims regarding refugees. The decision focused national and international media attention on the city. The public outrage unleashed by the mayor's comments and the summary nature of the decision forced a reversal of the decision one month later. Tamworth subsequently participated in the resettling program.

At a public meeting, the extent of the cultural/social divisions was on open display. One person argued that they did 'not want the refugees coming and drinking our water supply or taking our jobs'. By way of contrast, another resident noted that racism was clearly on show. He noted that '… these are people escaping war and persecution. I'm sickened by the lack of compassion.'

Since then, however, the city has undergone a dramatic shift in thinking, welcoming migrants from more than 80 countries. More than 300 asylum seekers and refugees have been resettled in the city. Many have been helped by Multicultural Tamworth Inc., a volunteer organisation established to help migrants and refugees settle into life in the city. The city's churches have actively raised funds to support the resettlement of refugees.

In the 2023 Indigenous Voice referendum, Tamworth's federal local member, Barnaby Joyce, was a leading advocate for the 'No' vote. A forum, conducted in Tamworth's Town Hall, featured Pauline Hanson, leader of Pauline Hanson's One Nation, and former right-wing shock jock, Alan Jones, as speakers. All 800 tickets to the free event were snapped up online. Members of the local First Nations community staged a silent protest outside the venue. Tamworth voted 75 per cent against the proposed constitutional amendment and only 25 per cent in favour.

Celebrating the region's First Nations peoples

One of the most notable social changes taking place in Tamworth is the increasing appreciation of the city's First Nations culture and heritage. The Tamworth Regional Council's Reconciliation Action Plan aims to encourage greater understanding, acknowledgment, respect, inclusion and opportunities for the Aboriginal and Torres Strait Islander people of the Tamworth Region.

7.4.3 Co-chairs of the 2023 NAIDOC committee, Councillor Marc Sutherland and Kaliela Thornton at the NAIDOC Opening Ceremony, 2023. NAIDOC week occurs in Australia each year in July and celebrates the history, culture and achievements of Aboriginal and Torres Strait Islander peoples.

Specific community events celebrated include NAIDOC (National Aborigines and Islanders Day Observance Committee) Week and National Reconciliation Week. National NAIDOC Week celebrations are held across Australia in the first week of July. The purpose of the week is to recognise and appreciate the histories, cultures and achievements of Aboriginal and Torres Strait Islander peoples. It is an opportunity for all Australians to learn about First Nations cultures and histories and participate in celebrations of the oldest, continuous living cultures on Earth.

Tamworth's NAIDOC activities include the NAIDOC March and Family Fun Day with workshops, performances, craft exhibitions and children's activities (see Figure 7.4.3). National Reconciliation Week takes place from late May to early June. These dates commemorate two significant milestones in the reconciliation journey—the successful 1967 referendum and the 1992 High Court Mabo decision. Tamworth's ceremony includes a traditional smoking ceremony and flag-raising, followed by local entertainment. Thousands gather each year to participate in the celebrations. The Tamworth Regional Gallery showcases the work of local First Nations artists throughout the year.

Tamworth Local Aboriginal Land Council is a key player in promoting cultural recognition. The Council is committed to pursuing genuine recognition of the truth of Australia's history. Its stated objectives are based on a recognition that Aboriginal people are the original owners of the land and that this special position must be recognised and celebrated. In doing so, it invites the wider community to share in Aboriginal culture and facilitate better relationships between Aboriginal people and the general community.

In 2021, Marc Sutherland was the first First Nations Councillor elected to the Tamworth Regional Council.

Closing the gap on Indigenous disadvantage

At the 2021 Census, Tamworth's First Nations community numbered 8021 people. Of these, 7705 identified as Aboriginal, 102 as Torres Strait Islander, and 218 identified as both Aboriginal and Torres Strait Islander. The median age of the First Nations population was 21, compared with the non-indigenous population median of 37 years. Some 36.5 per cent of the First Nations population was under the age of 15 years of age, compared with 20.7 per cent for the rest of the LGA population. This makes it a relatively young population. At the other end of the age profile, just 6 per cent of the First Nations population was over 65 years of age, compared with the non-indigenous figure of 18.8 per cent. Differences in life expectancy are one possible reason for this difference.

The median income for First Nations households was $1422 (marginally above the non-indigenous median income of $1416). However, there is a significant difference in personal weekly median incomes ($596 versus $755) and median family incomes ($1464 versus $1821). Most (55%) First Nations people lived in rented accommodation. The non-indigenous rent-dependent figure was 31.1 per cent. The rest, either owned their home outright (13.8%) or owned a home with a mortgage (27.6%). This compares with the non-indigenous figures of 33.6 per cent and 31.3 per cent respectively. Full-time First Nations employment was 52.6 per cent compared with the non-indigenous LGA figure of 60.1 per cent. First Nations unemployment stood at 11.2 per cent compared with 4.5 per cent for non-indigenous people. On all measures, First Nations Australians living in the LGA are disadvantaged, compared with non-indigenous residents (see Figure 7.4.4).

INDIGENOUS HEALTH

Australia-wide data reveals the health-related inequalities experienced by First Nations Australians. While death rates of Aboriginal and Torres Strait Islander peoples have been falling in most age groups over the past 10 years (with the median age at death increasing from 56.5 in 2010 to 61.0 in 2020), there still exists a gap in life expectancy. First Nations Australian men can expect to live 71.6 years, and women 75.6 years. This compares poorly with the life expectancy for the rest of the Australian population of 81.2 for males and 85.3 for females. Bridging this gap is a pressing social challenge.

Criteria	First Nations Australians population	Non-indigenous population
Age		
0–14 years	36.5%	20.7%
15–24 years	19.0%	11.8%
65 + years	6.0%	18.9%
Median age	21	37
Highest level of education		
Bachelor's degree or above	4.9%	15.0%
Year 12	11.8%	11.6%
Year 10	21.0%	16.3%
Year 9 or below	17.3%	10.7%
Labour force participation		
In the workforce	59.5%	59.5%
Not in workforce	38.4%	33.2%
Employment status		
Employed full-time	52.6%	60.1%
Employed part-time	29.6%	29.7%
Away from work	7.0%	5.7%
Unemployed	11.2%	4.5%
Median weekly income		
Personal	$596.00	$755.00
Family	$1464.00	$1821.00
Household	$1422.00	$1416.00
Housing tenure		
Owned outright	13.8%	33.6%
Owned with mortgage	27.6%	31.3%
Rented	55.0%	31.1%

Source: ABS

7.4.4 First Nations census snapshot, Tamworth Regional Council area, 2021 Census

Tamworth Aboriginal Medical Service-Aboriginal Corporation (TAMS-AC) is one strategy that seeks to address the health issues facing First Nations Australians in this region. TAMS-AC is an Aboriginal community-controlled health service provider delivering culturally appropriate preventive primary health care services. These are designed to improve individual healthcare outcomes for the Aboriginal and non-Aboriginal communities of the city and region. The services offered by the TAMS -AC clinic include access to experienced GPs, health assessments, chronic disease management, childhood vaccinations, women's health assessments, skin cancer checks, wound dressing, ear health and sexual health care.

The physical and mental health of Tamworth's First Nations population, like that of First Nations people generally, is closely linked to their social and emotional wellbeing. This wellbeing is a holistic concept encompassing the connection to land, culture, spirituality and ancestry. Significantly, disruptions to family and kinship connections, including inter-generational trauma, have been linked to the increased incidence of suicide in First Nations communities. Maintaining a connection to Country is, therefore, central to First Nations wellbeing.

INDIGENOUS EMPLOYMENT

The unemployment rate for First Nations Australians living in Tamworth is higher than that of the non-indigenous population and disproportionally impacts the young. The Aboriginal Employment Strategy (AES), a national Aboriginal recruitment and group training company, brokers employment opportunities for First Nations Australians, including those living in Tamworth. It also works to promote successful career outcomes through mentoring, coaching, training and specialist support.

Economic change

Like many of Australia's regional centres, Tamworth has been subject to the impacts of economic change. The city was, for example, well-known as a specialist vehicle manufacturing centre. In the 1990s, Ansair established a bus body-building factory in Tamworth to assemble Scania and Volvo buses for Brisbane Transport and the NSW State Transit Authority. Another firm, Jakab Industries, built buses, ambulances and postal vans, utilising imported engine-mounted chassis, between 1973 and 2002.

The challenge today is to promote economic opportunities for unskilled and semi-skilled workers. This is especially important for new entrants into the city's workforce, including those school leavers who are not going on to tertiary study.

The enterprises located in and around the city include both the traditional agribusinesses serving the agricultural sector and those focused on urban needs (see Figure 7.4.5). Many of these firms successfully compete with their state and national-level competitors.

Industry	Percentage of workforce
Retail trade	13.9%
Health care	12.5%
Manufacturing	10.5%
Construction	10.0%
Education and training	7.2%
Public administration	7.1%

7.4.5 Main employment industries, Tamworth, 2021

Food processing

Food processing businesses are important contributors to the Tamworth economy, and a potential source of growth. The city is classified as a medium-sized poultry-producing centre. Baiada Poultry, a privately-owned company, has a major presence in Tamworth. The company, which has an Australian market share of more than 20 per cent, supplies the Lilydale Select and Steggles brands to food retailers, including Coles, Woolworths, IGA, Aldi, McDonald's, KFC, Red Rooster, Nando's and Subway. The company's operations include broiler and breeder farms, hatcheries, processing plants, feed milling and protein recovery.

Baiada's Tamworth-based operations include a highly automated, technologically advanced, processing plant. It also operates an energy-efficient protein recovery plant in the city. Approximately 70 per cent of its chickens' weight is sold as meat products. The remaining 30 per cent, such as the bones, feathers and intestines, are recycled into by-products, such as high-protein pet food.

Another food-related enterprise is the Japanese-owned Allied Pinnacle flour mill in West Tamworth. The company recently closed its dextrin (a corn-based food supplement that prevents dietary fibre deficiency) and caramel colour production plant in East Tamworth, after shutting down its starch and gluten production on the site in 2017. These were considered non-core businesses and financially unviable—another example of economic change.

Teys Australia, a meat-processing company, operates a processing plant in Tamworth. The company is Australia's second-largest meat processor and exporter, with export operations in 40 countries. Thomas Foods International, an Australian family-owned company based in South Australia, also operates a meat processing plant on a site adjacent to the Teys plant.

Tamworth's connection to the national gas grid is expected to encourage other food manufacturers to locate in the city.

Manufacturing

Tamworth has a small and specialised manufacturing sector, mostly supporting the agribusiness or food processing sectors. Apollo Engineering, for example, specialises in manufacturing industrial cleaning equipment for both the national and international markets and recently expanded into the manufacture of food waste processing machines. In doing so, it operates an advanced precision manufacturing workshop using highly automated processes, including collaborative robotics and the latest in laser cutting technology. Like many Australian firms, Apollo has struggled in recent years to find skilled tradespeople. The firm recently employed several Zimbabwean migrant workers and will need more skilled migrants as it continues to diversify and grow. Apollo is also focused on reducing its carbon footprint. It recently installed a 99-kilowatt solar power system to supplement its workshop electricity requirements.

Like all regional centres, Tamworth competes with other regional centres for employment-generating enterprises. Providing affordable, accessible and serviced industrial land is one of the principal ways in which it can compete (see the box, Spotlight: Tamworth Global Gateway Park). Another such activity is the nearby Hunter Land's Tamworth Industrial Park. Like the Global Gateway Park, the 120-hectare site is located close to Tamworth Airport and the new Intermodal Hub.

SPOTLIGHT

Tamworth Global Gateway Park

Key to the city's future economic sustainability are its employment-generating initiatives. Among the most significant of these is the Tamworth Regional Council's development of a multi-stage enterprise park and logistics project. To be known as the Tamworth Global Gateway Park (TGGP), the master-planned enterprise park will cater for both industrial and business development on a 246-hectare site at the western edge of the city, adjacent to the city's airport.

Labelled the 'economic engine room' of the north of the state by its proponents, the TGGP will also be home to a purpose-built intermodal rail freight terminal. This premier freight and logistics hub will have access to the Port of Botany and the Port of Newcastle. The TGGP will also have direct heavy vehicle access to the Oxley Highway.

Business case modelling for the project estimates that the TGGP has the potential to create over 3000 jobs over the next 20 years, once fully developed.

Healthcare sector

Attracting, and retaining, healthcare professionals is a challenge for all regional centres and country towns. Regional centres, such as Tamworth compete with Sydney and Newcastle for doctors and other healthcare professionals. Promoting the lifestyle benefits of a regional centre is one of the strategies used to attract providers. The sector's expansion is driven by the city's population growth and the difficulties experienced by people living in smaller urban centres in accessing medical care. Tamworth Base Hospital is the largest medical facility in Northern NSW and provides a wide range of medical services (see Figure 7.4.6).

7.4.6 Tamworth Base Hospital

The hospital's $211 million redevelopment, along with a $31.6 million grant for a regional cancer centre, were linked to an agreement reached by then-prime minister Julia Gillard and local Independent MP Tony Windsor. It followed Windsor's decision to provide parliamentary support to the minority Gillard Labor government. The Commonwealth Goverment contributed $120 million and the NSW Government contributed $91 to the project. The redevelopment was completed in 2016.

Retail sector

Tamworth provides retail services for the North West region. Discount department stores (Big W, Kmart and Target) have dominated the city's retail sector since the closure of the Myer-owned Grace Bros. Department Store in 2003 and Treloars, a locally owned department store, in 2011. The presence of these major national discount retailers has had a detrimental impact on the range of goods available in small towns throughout the region. Residents of these towns are increasingly drawn to Tamworth where there is greater consumer choice. Specialist retailers provide some consumer choices beyond the mid-market discount department stores. Increasingly, however, consumers can access a wider range of goods via online shopping. This could potentially impact the viability of local retailers.

The majority of Tamworth's large format retailers are found clustered on the southern approaches to the city. Outlets such as Harvey Norman, Boating Camping Fishing, Sleep City, Pet Barn, Fantastic Furniture and The Good Guys service an area extending well beyond the city's boundaries. Residents living in towns and villages throughout the North West travel to Tamworth to purchase major household goods.

Housing

An important driver of economic growth is Tamworth's rate of population increase, currently relatively strong at 1.2 per cent a year. Meeting the diverse housing needs of its population is a major challenge. Housing affordability is also an issue, but fortunately house prices are, for the most part, considerably lower than in the capital cities. This has, in recent years, acted as a pull factor in attracting new residents to the city.

Economic sustainability

Tamworth city is an important commercial centre, servicing a large population that extends well beyond the LGA. It is well serviced by road, rail and air networks that link the region to the north coast of NSW and the major urban centres of Newcastle, Sydney and Brisbane. The city is well positioned to develop economically. The challenge is to do this sustainably.

Tamworth's retail industry is the biggest employer, followed by manufacturing and health services. The industries with the largest number of businesses are property and business services, agriculture and construction, closely followed by finance and insurance services (see Figure 7.4.7). With such a diverse economy, agriculture, education, transport and aviation are major industries.

Occupations (top responses)	Tamworth	Australia
Professionals	18.5%	25.8%
Labourers	15.4%	8.2%
Technicians and trade workers	13.7%	11.9%
Community and personal service workers	13.4%	10.6%
Clerical and administrative workers	11.4%	13.0%
Managers	10.1%	14.6%
Sales workers	9.4%	8.0%
Machinery operators and drivers	6.6%	6.0%

Source: ABS

7.4.7 Occupation distribution, Tamworth, 2021.

Future growth opportunities

The key drivers of future growth include the following.

- The rise of the digital economy is changing the way people work. When people can work remotely, they prioritise lifestyle over the need to live near their place of employment. While the online marketing of goods and services extends the reach of Tamworth-based providers, it also provides consumers with choices well beyond those available in the city. A local accountant, for example, can provide business advice and taxation services to individuals and businesses anywhere in Australia. Local manufacturers can sell their goods to a national and indeed global market. Tamworth consumers can purchase clothing and footwear from retailers anywhere in the world, bypassing local retail outlets.
- The ageing of the population is driving a growing demand for a range of health and other ageing-related services. Safe and accessible dwellings, movement networks and public facilities will become increasingly important to meet the needs of all age groups and support active ageing.
- The growth of the sharing economy is leading to the emergence of new businesses that are disrupting old modes of business and changing how we consume. This, in turn, has increased pressure for the provision of flexible zoning and greater support for the sharing economy. The sharing economy involves the sharing of resources, often through online or mobile platforms. Key examples of the sharing economy include ridesharing, short-term rentals, co-working spaces, and grocery and food delivery services.

Environmental sustainability

The nature of, and proximity to, the natural environment is one of the principal lifestyle attractions of Tamworth. Engagement with the natural environment is a major drawcard for those engaged in **tree change** moves. The environmental challenges are, however, significant. In addition to waste disposal (which, in practice, reflects that of all Australian urban centres), climate change and water security represent major challenges.

Waste disposal

Tamworth, like other Australian urban centres, acts to reduce its environmental footprint. Tamworth Regional Council operates a total of 11 waste management facilities in the LGA—four landfills and seven rural sites. The landfills receive and bury garbage onsite, while the seven rural sites operate as waste transfer stations where garbage and recycling are collected in large bins and transported back to Tamworth for final disposal or recycling.

Recycling is encouraged in the city and residents are provided with red, yellow and green waste bins that facilitate resource recovery. The Community Recycling Centre caters for residents wanting to dispose of hazardous wastes, including vehicle batteries, fluorescent tubes or globes, e-waste, used motor oil, paint, ink cartridges and mobile phones. Collected garden organics are reprocessed into mulch and compost, and available for purchase. Concrete is reprocessed into road base and drainage rubble, and is also available for purchase. Other recyclables (including aluminium, steel, paper and cardboard) are sent to processing facilities around the country.

The city's domestic and industrial wastewater is transferred to, and treated at, the Westdale Wastewater Treatment Plant and then transferred to the Effluent Storage Dam (ESD) at the Effluent Reuse Farm (ERF) for use in farm irrigation, using a process known as controlled access spray irrigation. Emergency discharges can occur via an effluent overflow channel to the Wallamore Anabranch, where it is discharged.

Climate change and Tamworth's water security

Based on long-term observations (1910–2011), temperatures recorded at Tamworth, and the surrounding region, have been increasing since around 1970, with higher temperatures experienced in recent decades. The warming trend projected for the city and region is large compared to natural variability in temperature and is of a similar order to that projected for other NSW regions.

The region currently experiences considerable rainfall variability across seasons and from year to year, and this variability is also reflected in the projections.

Maximum temperatures in the region are projected to increase by 0.4–1.0°C in the period 2000–39 and by 1.9–2.7°C by 2070. Minimum temperatures are projected to increase by 0.5–1.0°C. Minimum temperatures are projected to increase by 1.6–2.7°C in the short term and by 1.6–2.7°C by 2070. The number of hot days will increase, and the number of cold nights will decrease. Rainfall is projected to decrease over most of the region in winter, but increase in autumn. Average fire weather is projected to increase in summer, spring and winter, while severe fire weather days are projected to increase in summer and spring. Extreme weather events will occur more frequently and their severity will increase.

Securing Tamworth's water supply is critical to its sustainability of the city. Droughts are projected to occur more frequently and their impacts become more severe. Water security is, therefore, a critical environmental issue for the city. During the most recent drought, Tamworth came perilously close to running out of water and had severe restrictions in place.

Two dams, managed by WaterNSW, Chaffey and Dungowan, supply the city (see Figure 7.4.8). Chaffey Dam is a relatively small, 100-gigalitre, state-owned dam on the Peel River, upstream of the city of Tamworth. The dam's purpose includes flood mitigation, irrigation, water supply and water conservation. Dungowan Dam's capacity is just 6.3 gigalitres. A third water source, the Paradise Drift Wells, adjacent to the Peel River, is reserved for emergency use only.

In recent years, the federal member for New England, Barnaby Joyce, has championed the rebuilding of the Dungowan Dam and the construction of a new pipeline to Tamworth's Calala Water Treatment Plant. The proposal involves the partial decommissioning of the existing Dungowan Dam and the construction of a new $1.27 billion, 22.5 gigalitre dam, approximately 3 kilometres downstream from the existing dam site, along with the replacement and upsizing of the existing Dungowan Pipeline. Joyce argued that a new dam would enhance town water security for a growing Tamworth, stimulate the local economy, generate new investment opportunities for the region, and help protect the region's $2.5 billion agricultural industry in a warming climate.

7.4.8 Chaffey Dam, the principal source of Tamworth's water supply

The proposal has, however, met with considerable opposition. Infrastructure Australia rated the project a 'low priority' given its cost and the fact that the dam would not necessarily increase water supplies for the city in a future drought. Other non-infrastructure solutions, including demand management and water use efficiency measures, combined with more targeted, small-scale supply solutions, such as recycled wastewater for industrial users, could be a more efficient means of addressing Tamworth's water supply issues.

Activities

Acquiring and processing geographical information

1 Summarise the ways in which Tamworth's status as Australia's country music capital represents both a challenge and an opportunity.

2 Together with country music, sport is another opportunity for Tamworth. How can the success of sport be maximised?

3 Summarise the nature of the social and political conservatism evident in Tamworth. To what extent has this been challenged?

4 List the ways in which Tamworth's First Nations peoples are celebrated.

5 Summarise the ways in which First Nations disadvantage is being addressed in Tamworth.

6 Describe why Tamworth is well positioned to develop economically. What are the drivers of growth?

7 Summarise the impact of economic restructuring on Tamworth.

8 Summarise the key features of Tamworth's food processing industries.

9 Name the focus of Tamworth's manufacturing sector.

10 Summarise the key features of Tamworth's retail sector and its impact on smaller retailers.

11 Explain why housing acts as a pull factor in terms of population growth.

12 Describe how the city's waste is managed.

13 Outline the anticipated impacts of climate change on Tamworth and the surrounding areas. What is being done to mitigate these impacts?

Applying and communicating geographical understanding

14 Study Figure 7.4.4. Write a report describing the demographic and social characteristics of Tamworth's First Nations population compared to its non-indigenous population.

15 Study Figure 7.4.5. Compare the employment structure of Tamworth to what you know about that of Australia as a whole. What does this data tell us about the economy of the city?

CHAPTER

8 An urban place: Darling Harbour Precinct

Technological, economic and social change are three of the key drivers transforming urban places. There is no better example of this than the transformation taking place in the urban precincts surrounding Sydney's Darling Harbour: Walsh Bay, Barangaroo, Cockle Bay, Darling Square and Pyrmont-Ultimo. This was an area once dominated by industry, warehouses, railway goods yards, port facilities and the homes of those who worked there. Today the area features parklands, an extension of the CBD's financial district, vibrant performing arts and entertainment precincts, luxury residential towers, convention and exhibition facilities, casinos, luxury hotels and a range of recreational spaces. It is also a popular tourist destination.

The processes of urban decay and renewal are evident in the changing morphology of the area. Key technological drivers were changes in shipping and cargo handling. Vessels increased in size and became more highly specialised. Containerisation replaced long-established cargo-handling practices. Key economic changes were shifts from labour-intensive manufacturing to a service-based economy and Sydney's emergence as a world city and global financial centre. Key social factors driving change include a growing preference for high-density living close to the city centre.

In this chapter, students investigate the areas surrounding Darling Harbour as an example of an urban place. What these areas have in common is that they were once dominated by port-related infrastructure. Students will study the location and character of the place, the geographical processes that have shaped the identity of the place, its links to other places, and the responses and strategies adopted to meet the challenges faced by the area, including sustainability.

> **Jack Lang gave Sydney the Harbour Bridge. Joe Cahill gave Sydney the Opera House. And I gave Sydney Barangaroo.**
>
> **Paul Keating, former prime minister of Australia**

8.0.1 Barangaroo, Darling Harbour at dusk

Chapter glossary

functional obsolescence the reduction of a structure's usefulness or desirability because of an outdated design feature that cannot be easily changed

morphology the functional form and character of an urban place

ria a waterway formed by the partial submergence of a river valley

social sustainability the notion that a community develops social processes and structures that not only meet the needs of its current members but also the ability of future generations to enhance their own wellbeing

urban decay where a previously functioning city, or part of a city, falls into disrepair

urban renewal the redevelopment of an urban area

UNIT 8.1

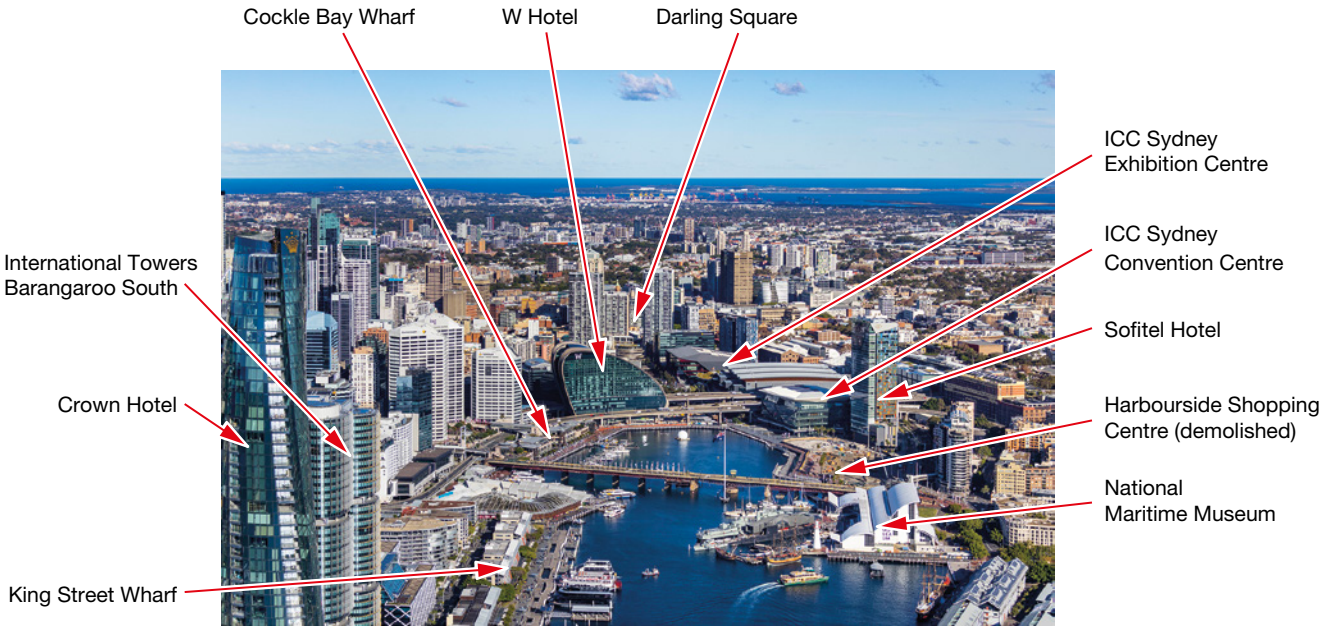
The location and character of Darling Harbour Precinct

Darling Harbour is located just to the west of Sydney's CBD and to the east of the Ultimo-Pyrmont peninsula. It extends northwards from near Chinatown and Haymarket to Cockle Bay, Barangaroo (formerly Millers Point) and Walsh Bay, where it merges with the much larger Port Jackson (Sydney Harbour) (see Figures 8.1.1 to 8.1.3).

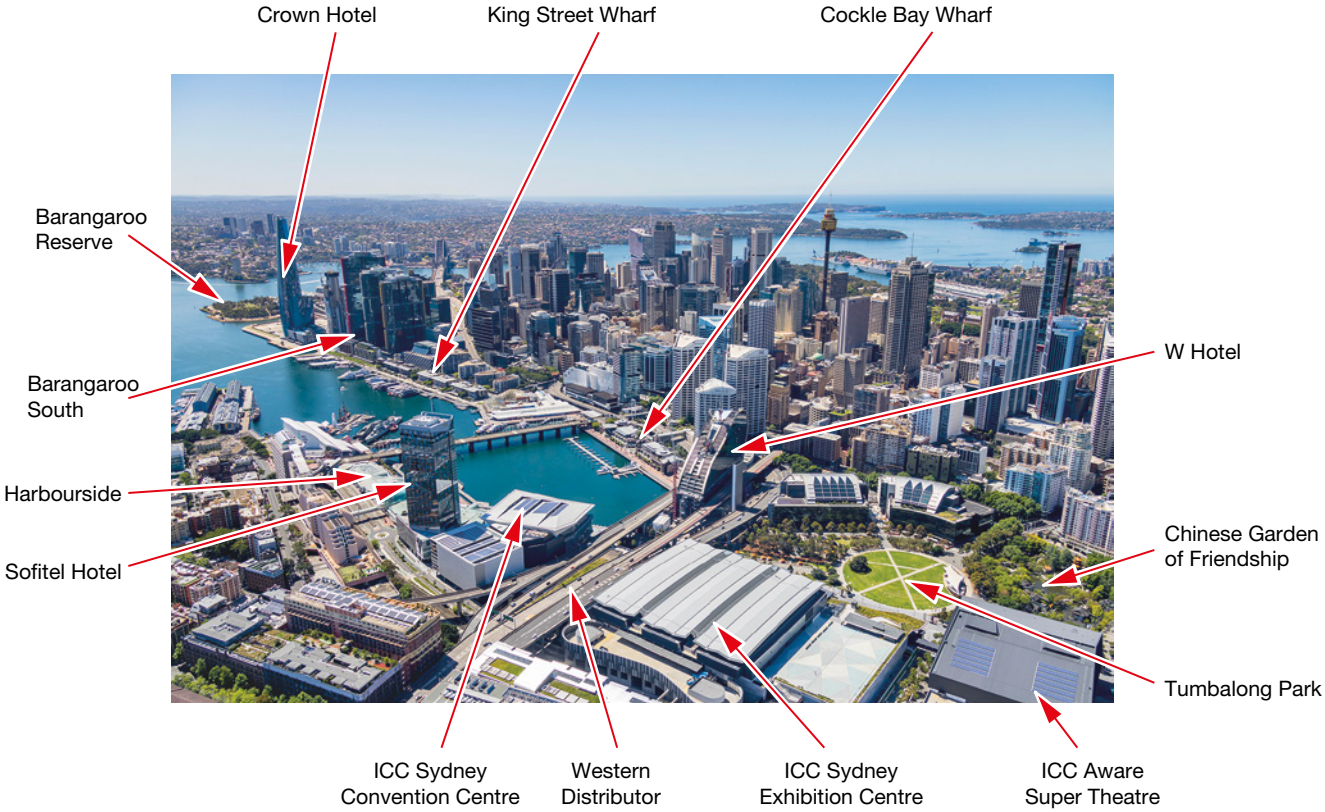
8.1.1 Map of the component parts, or urban precincts, around Darling Harbour

Did you know?

Darling Harbour is named after Lieutenant-General Ralph Darling, who was Governor of New South Wales from 1825 to 1831. The first Europeans named it Long Cove, then Cockle Bay, but it was renamed in 1826 by the sitting governor, who decided to name it after himself. The name Cockle Bay has recently been restored for the section of Darling Harbour south of the Pyrmont Bridge.



8.1.2 Oblique aerial photograph of Darling Harbour, from the north, 2023



8.1.3 Darling Harbour, including Barangaroo and Sydney's CBD, from the west

Component parts

The area surrounding Darling Harbour features several distinct urban precincts, each with its own **morphology**—its functional form and character. These include Walsh Bay, Barangaroo, King Street Wharf, Cockle Bay, Darling Square and Pyrmont–Ultimo.

Walsh Bay

With its historic finger wharves and warehouses, Walsh Bay is now a popular residential and cultural precinct featuring apartments, theatres, restaurants, cafes and a hotel. Important cultural institutions located in its heritage finger wharves include the Sydney Theatre Company, Australian Chamber Orchestra, Bangarra Dance Company, Bell Shakespeare, Sydney Dance Company and Gondwana Choirs (see Figure 8.1.4).

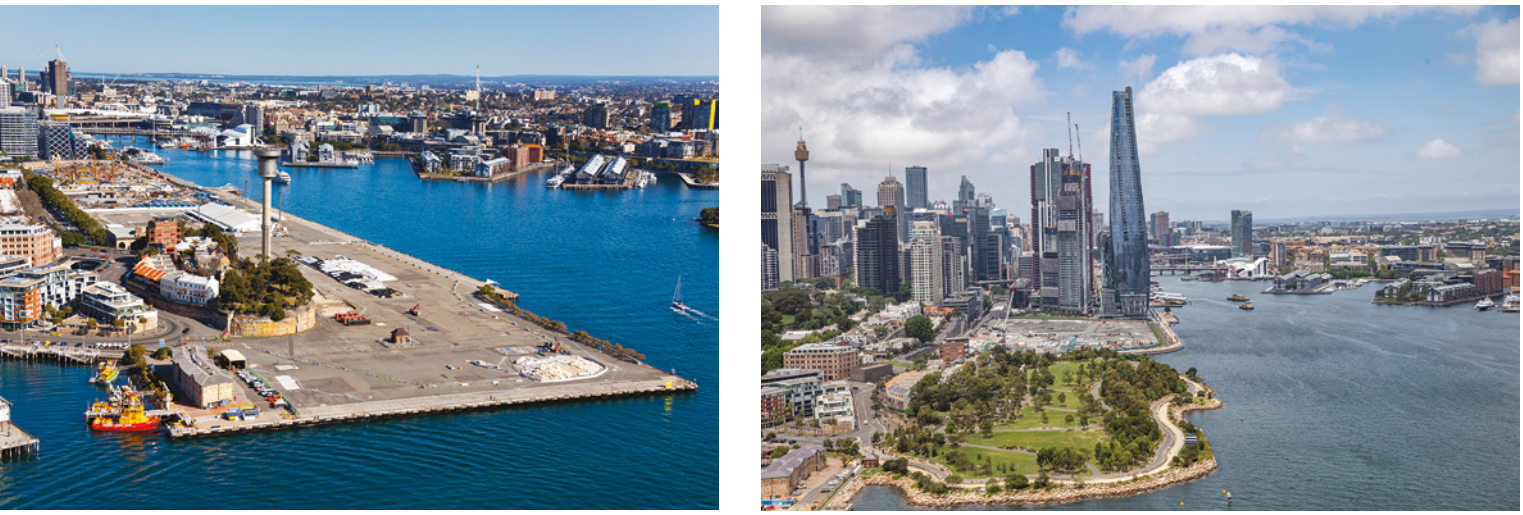
8.1.4 The Walsh Bay Arts Precinct demonstrates adaptive re-use of the obsolete finger wharves.

Did you know?

Barangaroo is named after the second wife of Bennelong, a man who played a vital role in Governor Arthur Phillip's attempts to establish links with the Aboriginal population. Bennelong relayed messages between the colony's administrators and the local Aboriginal groups. Apart from being the wife of Bennelong, Barangaroo (a member of the Cammeray clan) was an important figure in her own right. Settlers described Barangaroo as someone with great presence and authority.

Barangaroo

In 2003, the NSW State Government determined that the site, which was being used as a container terminal (see Figure 8.1.5), should be transformed into a new waterfront precinct complete with parklands, residential towers, waterfront restaurants and a new commercial precinct. The latter would enhance Sydney's status as Australia's financial capital and a world city. The site's plans located the high-density commercial component of the project clustered at the southern end of the site (see Figure 8.1.6), with Barangaroo Reserve (see Figure 8.1.5, right) at the northern end and a medium-density multi-use development and parkland occupying the centre of the site. A resort hotel (Crown Casino) and metro station were subsequently added to the project.



8.1.5 Barangaroo: before and after redevelopment, in 2012 and 2022

8.1.6 Barangaroo South, the high-density section of the area

King Street Wharf

The Sydney Aquarium and Wildlife Sydney, Darling Harbour's oldest attractions, stand on the oldest wharf in the area, Market St Wharf. The wharf was built in the 1820s to receive produce destined for the Sydney Markets. Beyond Market St Wharf to the north is the King St Wharf area. The complex opened in 2001 with restaurants and commercial areas on the waterfront, and business and residential developments behind (see Figure 8.1.7).

8.1.7 King Street Wharf waterfront

Did you know?

During the Great Depression, the eastern part of Darling Harbour (now known as Barangaroo) was known as the Hungry Mile, a reference to the waterside workers who desperately searched for work on the wharves.

Cockle Bay

Much of the infrastructure in the area generically referred to as Darling Harbour is located on land surrounding Cockle Bay and an area extending to the south towards Haymarket. The NSW Railways central marshalling yards and freight consolidation centre once occupied much of the site (see Figure 8.2.3, page 206). The site was largely abandoned and derelict by the late 1980s. The Wran Labor Government initiated the site's redevelopment to coincide with Australia's Bicentenary celebrations. The pedestrian-friendly redevelopment included the Sydney Convention and Exhibition Centre and the Harbourside Shopping Centre (1988), an IMAX theatre (1996), Sega World Sydney (1997) and Cockle Bay Wharf, a waterfront precinct featuring restaurants, pubs, clubs, cafes and function venues (1998).

Only the Chinese Garden of Friendship and Tumbalong Park remain as originally conceived in 1988. All other infrastructure has been demolished and replaced, or are, as in the case of Cockle Bay Wharf, subject to a redevelopment proposal. Today, the site is home to the International Convention Centre, ICC Sydney, which houses a convention centre, an exhibition centre and theatre, two 5-star hotel towers (one with the IMAX theatre complex); a commercial office tower; and the Cockle Bay Wharf restaurant complex (see Figures 8.1.8–8.1.11).

8.1.8 ICC Sydney: International Convention Centre and the 5-star Sofitel Hotel

8.1.9 ICC Sydney Exhibition Centre

8.1.10 ICC Sydney Darling Harbour Theatre

8.1.11 Cockle Bay Wharf and the new W Hotel

Darling Square

Darling Square (see Figure 8.1.12) is a new residential and commercial precinct in Sydney's Haymarket. The precinct was built on the site of the old Sydney Entertainment Centre (completed in 1983) and its multi-storey car park. It was developed in stages between 2016 and 2019. Today it is home to 4200 residents and the workplace for 2500 people. There are 1500 apartments and accommodation for 1000 students in several towers of varying heights. At ground level, more than 60 shops, bars and restaurants line new streets and laneways. Twenty-five per cent of the area is open space, including a town square at the heart of the development. A tree-lined pedestrian boulevard links Darling Square to the ICC Sydney and Cockle Bay. Darling Square is an example of both urban consolidation and renewal. Demographic and social change are driving demand for inner-city living.

8.1.12 Darling Square

Pyrmont–Ultimo

The opening of the first Pyrmont Bridge in 1858 made the Pyrmont Peninsula more accessible. The inclusion of a central swing span on the bridge allowed ships to pass through to access the upper reaches of Darling Harbour. Pyrmont-Ultimo was once a key component of Sydney's industrial waterfront, with wharves, shipbuilding yards, factories and vast woolstores. The area's decline started in the post-World War II period, when factories closed and residents moved to the suburbs. Ultimo Powerhouse closed in 1963 and the Colonial Sugar Refinery, located at the northern end of the peninsula, closed in 1995. Ultimo (and adjacent Surry Hills) was once the centre of Australia's footwear and clothing industry.

In 1991, Prime Minister Bob Hawke's federal Labor Government initiated the Better Cities Program to rejuvenate the area (see Figure 8.1.13). Within a year, the City West Development Corporation was established. In 1999, this responsibility was transferred to the Sydney Harbour Foreshore Authority and consolidated with Property and Development NSW (now Property NSW).

Almost all industrial functions have been replaced by high-rise residential developments and warehouse conversions, commercial office space (occupied by corporations such as Vodaphone, Network 10, Accenture Australia and Google). Pyrmont is also home to The Star entertainment complex, hotels and institutions such as the National Maritime Museum. Towards Ultimo are the Powerhouse Museum, headquarters of the Australian Broadcasting Corporation (ABC), major educational institutions, including University of Technology Sydney (UTS), and more high-density residential towers.

8.1.13 Oblique aerial photograph of the Pyrmont–Ultimo peninsula, viewed from the north

Demographic and social characteristics

While the urban precincts surrounding Darling Harbour are often known by their functional form or as popular tourist destinations, social and demographic factors also strongly contribute to the character of these places. The ethnic diversity in this part of Sydney is something that distinguishes the area from the rest of Australia.

Darling Square–Haymarket population profile

Darling Square–Haymarket's demographic and social profile differs from that of the Australian population, as revealed by the 2021 Census. Many of these differences can be accounted for by the number of international tertiary students living in the area.

The area's population profile is disproportionately young, with the 25–39 age group comprising 54.7 per cent of residents, compared to the Australia-wide average of 21.6 per cent. This high representation of students is mirrored by the proportion of the population engaged in tertiary education: 49.4 per cent compared to the national average of 23.3 per cent. The residents of Darling Square–Haymarket are more educated than the Australian average, with 43.7 per cent of the area's population having earned a bachelor's degree, compared to the national average of 26.3 per cent. Individual incomes are lower than the national average, but household incomes are higher. Lower incomes can be accounted for by the area's large student population, with the most cited workplaces being cafes and restaurants. Significantly, 38.6 per cent are employed as professionals and managers, which is about the same as for the rest of the Australian population. Car ownership is low, with 58.5 per cent of people not owning a vehicle. Almost all residents live in apartments (98.8%) (see Figure 8.1.14). Residents are more likely to be married than single, and couples without children outnumber those with children (68.6% to 17.0%).

8.1.14 Apartment blocks like these are the most common type of housing in Pyrmont, with more than 90 percent of the population living in apartments.

Significantly, the area is more ethnically diverse than the Australian population. Only 13 per cent of residents are Australian-born, with Chinese-born representing 21.4 per cent of the population. Residents with both parents born overseas account for 84.2 per cent of the population (see Figure 8.1.15).

Pyrmont population profile

Like Darling Square, Pyrmont is socially and demographically different to Australia as a whole. Its population is disproportionately young, with 37.8 per cent being in the 25–39-year-old age group, compared to the Australian average of 21.6 per cent. Its population is also more educated, with 36.9 per cent having earned a bachelor's degree or higher. An above-average 67 per cent of people are employed, with professionals and managers overrepresented. They also, on average, have higher incomes and are among the least car-dependent people in Australia. Like Darling Square, almost all of the population lives in apartments (93.7%). Many people walk to work. Residents are more likely to be single than married, and couples without children outnumber those with children. Pyrmont is more ethnically diverse than the Australian population. Only 40.7 per cent of residents are Australian-born with Chinese-born representing 6.2 per cent of the population. Almost 63 per cent of the population have both parents born overseas. Residents are also less religious than the rest of the Australian population.

Social/demographic characteristic	Darling Square–Haymarket	Pyrmont	Australia
Population structure			
Percentage of population aged 25–39 years	54.7%	37.8%	21.6%
Ethnic diversity			
Country of birth: Australia	13.0%	40.7%	66.9%
Country of birth: China	21.4%	6.2%	2.2%
Both parents born overseas	84.2%	62.8%	36.7%
Employment			
Labour force participation	56.4%	67.0%	61.1%
Professionals	26.6%	37.2%	24.0%
Managers	12.0%	21.8%	13.7%
Education			
Engaged in tertiary study	49.4%	36.9%	23.3%
Bachelor's degree or higher	43.7%	51.8%	26.3%
Medium income			
Personal income	$758.00	$1297.00	$805.00
Family income	$1916.00	$3035.00	$2120.00
Household income	$1937.00	$2422.00	$1746.00
Family type			
Couple without children	68.6%	57.9%	33.8%
Couple with children	17.0%	27.6%	43.7%
Housing type			
Apartments	98.8%	93.7%	14.2%
Semi-detached	0.4%	5.7%	12.6%
Household type			
Family household	47.6%	57.4%	70.5%
Single person household	27.5%	32.9%	25.6%
Group household	22.9%	9.6%	3.9%
Mode of travel to work			
Car	7.4%	12.8%	52.7%
Walk to work	16.4%	10.9%	2.5%
Work at home	31.4%	52.4%	21.0%
Vehicle ownership			
No vehicle	58.5%	28.3%	7.3%
Two vehicles	32.7%	15.1%	36.3%
Religious affiliation			
No religion	40.1%	43.6%	38.4%
Religious affiliation stated	59.9%	56.4%	61.6%
Largest stated religion	Buddhism (27.7%)	Catholic (18.6%)	
Marital status			
Never married	25.8%	48.0%	36.5%
Married	65.5%	37.9%	46.5%

Source: ABS

8.1.15 Selected demographic and social indicators. Source: ABS

Activities

Acquiring and processing geographical information

1. Describe the location of the Darling Harbour urban precincts.
2. Who is Darling Harbour named after?
3. List Darling Harbour's key urban precincts. What are the key features of each?
4. Summarise the distinctive key social and demographic characteristics of the principal population components of Darling Square–Haymarket and Pyrmont.

Applying and communicating geographical understanding

5. Study Figure 8.1.1. List and describe the location of the area's key precincts.
6. Study Figures 8.1.2 and 8.1.3. List the key elements of the precincts.
7. Study Figure 8.1.5. Describe the physical changes made to these sites between 2012 and 2022.
8. Study Figure 8.1.15. Write a report outlining the extent to which Darling Square–Haymarket and Pyrmont differ from, or reflect, the profile of Australia as a whole.

UNIT 8.2

Geographical processes affecting the identity of Darling Harbour Precinct

Places are shaped by both physical and human processes. The way these interact determines the place's physical form and character.

Physical processes

The waterway around which the urban precincts of Darling Harbour are located was formed when rising sea levels flooded the river valley carved out by the Parramatta River some 6000 years ago. The area's geology, topography and maritime setting are important contributors to its character and its culture of place. These factors have also played a decisive role in shaping its morphology.

The distinctive sandstone of the area dates from between 190 and 225 million years ago, during the Triassic period. This was a time when ferns were Earth's dominant plant life, reptiles were becoming dinosaurs and mammals did not yet exist.

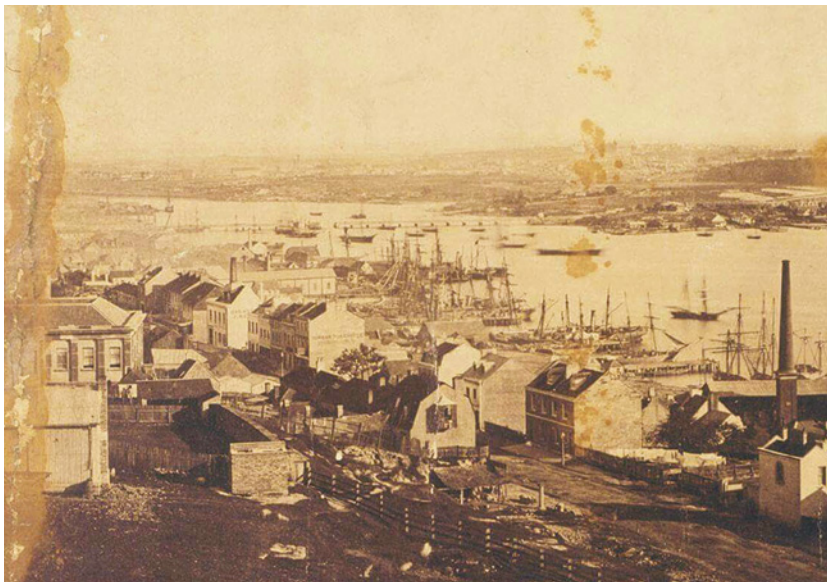
During the Triassic, the continent of Australia was part of the Gondwana supercontinent, and the Sydney region was a freshwater lake. Across millions of years this lake slowly filled with sediment, which washed into it from the area where Broken Hill now stands. Gradually, layer upon layer of sediment compressed into sandstone and shale. From 2 to 12 million years ago, the sedimentary rock strata were slowly uplifted by tectonic forces deep within Earth's crust.

As the Hacking, Georges, Parramatta and Hawkesbury rivers and their tributaries flowed across this uplifted plateau, they gradually cut deep V-shaped valleys. When sea levels rose to their present level, the valleys drowned, forming **rias**. This is how Sydney Harbour (Port Jackson) formed.

Humans have transformed this area's physical form many times since the founding of Sydney in 1788. The eastern and western sides of Darling Harbour were once prominent headlands, and the exposed sandstone shoreline was indented with several small bays. The land sloped quite steeply towards ridges aligned north to south. The highest point of the city-side of Darling Harbour was around 39 metres above sea level.

There were also parts of the area dominated by depositional material (silt, clay and sandy deposits) and shallow mudflats. These were especially common towards the head of the waterway in the south. See Figures 8.2.1 and 8.2.2.

Much of the area is located on reclaimed land. In the 1960s, Darling Harbour was largely occupied by finger wharfs (See Figure 8.2.6, page 207). In the case of Barangaroo, the infilling provided a base for the concrete apron on which a container terminal was to operate until it closed in 2006. The mudflats in the south were also gradually reclaimed. In the mid-1920s, fill sourced from the construction of Sydney's underground railway was used to reclaim



8.2.1 Darling Harbour, 1859

8.2.2 Sandstone cut on site was used to reconstruct the headland at the northern end of Barangaroo.

the mudflats. Much of this reclaimed area would eventually accommodate the NSW Railways central marshalling yards and freight consolidation centre—a site now occupied by Tumbalong Park and ICC Sydney (International Convention and Exhibition Centre) (see Figure 8.2.3).

8.2.3 The mudflats at the southern end of Darling Harbour were reclaimed in mid-1920s to accommodate the NSW Railways central marshalling yards. Today it is the site of Tumbalong Park and ICC Sydney: International Convention and Exhibition Centre.

Barangaroo's harbourside setting shapes its character and functional form (the type and arrangement of land-uses included). At the northern end of the site huge sandstone blocks were used to restore the area to how it looked in the 1800s, with a tree-covered headland and harbour inlet. Elsewhere, the constructed (or built) elements of the precinct take full advantage of the harbour setting. The precinct's public domain lines the waterfront with parklands, plazas, restaurants, bars and cafes. The commercial office towers, the Crown Hotel and Resort, and the area's residential components all take advantage of the spectacular harbour views on offer.

Human processes

First Nations peoples

The foreshore precincts of Port Jackson have been the Country of the peoples of the Eora Nation for thousands of years. In particular, the Eastern Sydney basin is Country for three key groups within the Eora Nation: the Cadigal, Wangal and the Cammeraygal peoples (see Figure 8.2.4). The Cadigal people lived on the land on which inner Sydney is now located, including the eastern shore of Darling Harbour. The lands of Wangal people included the Pyrmont Peninsula on the western side of the waterway. These groups lived off the land's bounty and took spiritual strength from it. The Cadigal and Wangal groups often camped close to the shoreline, especially during summer when fish and shellfish formed the basis of their diet. The shores of Darling Harbour were an important source of cockles and oysters.

8.2.4 Walsh Bay-based Bangarra Dance Company maintains First Nations peoples' attachment to place.

Colonisation disrupted the relationship between these peoples and their Country, but their connection to the area is ongoing. During the redevelopment of the city's foreshore precincts, hundreds of First Nations Australians acquired new skills enabling them to secure well-paid employment.

Technological change

The changing morphology of Darling Harbour reflects, at least in part, the changes in the technology of shipping and cargo handling.

The first significant change in shipping technology occurred with the introduction of sail-powered clipper ships in the 1840s and 1850s. These vessels were the peak of sailing ship technology. Clipper ships were built for speed, with a streamlined hull and a large sail designed to catch even the slightest breeze.

By the 1870s, clippers were being replaced by steam-powered vessels, which averaged faster speeds than the clippers. While some vessels initially combined both sail and steam, eventually steam triumphed. In the second half of the twentieth century, steamships were replaced by diesel-driven vessels. Over time, these vessels have grown and become highly specialised in terms of the cargo they are designed to carry.

The technology of cargo handling on the waterfront has also changed over time. Before the introduction of containerisation in the 1950s, goods were mostly carried as general cargo. They were delivered to the dock by horse-drawn dray (see Figure 8.2.5), rail or, later, motorised trucks, in advance of the arrival of the ship and stored in warehouses (see Figure 8.2.6). When the vessel arrived, the cargo was moved from the warehouse to the wharf and was then loaded on board using either the ship's cranes or those installed dockside. The unloading of vessels was the reverse of the loading operation.

8.2.5 Ships being unloaded at Millers Point in the 1920s.

8.2.6 Oblique aerial photograph of Darling Harbour from the north, 1937, showing the infrastructure indicative of past technologies in shipping and cargo handling

Urban dynamics

The transformations taking place in the areas around Darling Harbour is an example of the process of **urban renewal**. In the case of the area's residential components, we can also add the process of urban consolidation. Together, these processes are transforming Sydney. The dynamics principally responsible for these processes are economic, social and demographic change.

Urban renewal, as the redevelopment of an urban area, is a response to the process of **urban decay**, where a functioning part of a city falls into disuse and disrepair. This was certainly the case in the earlier phase of the area's redevelopment post-1970s. Significantly, this is not the case in the most recent phase of the area's development and the Barangaroo transformation.

The driving factor behind the redevelopment of Sydney's exhibition and convention infrastructure in Darling Harbour was to remain internationally competitive in the keenly contested convention and exhibition industry. In the case of Darling Square, the urban environment (once dominated by Sydney Entertainment Centre and the associated multi-storey car park) was still functional and in a good state of repair prior to its demolition and transformation into a new residential and commercial neighbourhood. The decisive factor in this instance was the need to provide housing close to the city centre. In the cases of the Sega World and IMAX sites, the Harbourside Shopping Centre and potentially the Cockle Bay Wharf site, the driving factor was the greatest commercial return possible from the redevelopment.

Political drivers

Political interventions, beginning with the Wran Labor Government in the mid-1980s, have been critical to the redevelopment of the areas around Darling Harbour. Two major events, the Bicentenary of European settlement in 1988 and the 2000 Sydney Olympic Games, proved decisive in focusing the government's attention on redeveloping this largely unused area adjacent to the city's CBD.

Beyond the redevelopment of the Darling Harbour Precinct surrounding Cockle Bay, the government also played a decisive role in the redevelopment of Barangaroo and Darling Square. In the case of Barangaroo, companies using the Millers Point facility were notified that the NSW Government had designated the site for redevelopment into parklands and commercial space in 2003. The site's maritime role ended in 2006 when container handling was transferred to Port Botany. Between 2005 and 2012, the site was the subject of an international design competition and the development of a concept plan. An agency of the NSW State Government, the Barangaroo Delivery Authority, managed the site's redevelopment. The Authority, established in early 2009, coordinated the redevelopment of the entire 22-hectare site. In late 2009, the government announced that Lendlease was to develop Barangaoo South.

Controversially, in 2012, then-premier Barry O'Farrell accepted an unsolicited approach from Crown Limited to develop a hotel, casino and entertainment complex on land set aside for open space in Barangaroo Central. Critics claim the complex's approval was an example of a political intervention in urban planning.

In the case of Darling Square, the availability of the Entertainment Centre site for redevelopment was a result of the political decision to redevelop Sydney's entertainment and convention infrastructure. The plan to include a large-scale entertainment venue in the new complex rendered the existing Entertainment Centre obsolete. The transformation of the area into Darling Square, a high-density residential precinct, is an example of urban consolidation, which involves increasing population densities in an urban area to make more efficient use of existing infrastructure, and to limit the spread of urban sprawl.

Government has played an important role in providing utilities and public infrastructure, including the Barangaroo Metro Station, harbourside promenades and parklands. The Barangaroo Reserve is the most significant open space area, a six-hectare artificially re-created headland park at the northern end of Barangaroo.

Economic drivers

Sydney's CBD is Australia's financial and business capital. It contains a high proportion of regional headquarters for national and multinational companies. With a workforce of close to 300 000 people and an employment density of more than 80 000 jobs per square kilometre, central Sydney has one of the world's highest density CBDs. The CBD accounts for just under 9 per cent of national GDP. In terms of output per square metre, it is the densest producer of economic output in the Southern Hemisphere. The CBD has some of Australia's highest-paid workers, particularly in the areas of finance and professional services, and is the largest commercial office market in Australia.

Other contributors to Sydney's status as a world city include its highly skilled and multilingual workforce, advanced business and IT infrastructure, sound regulation and an attractive lifestyle. Lifestyle is an important factor for corporate executives considering where to move.

The city's emergence as a world city and global financial centre was underpinned by the introduction of Australia's superannuation guarantee, introduced by the Keating Labor Government in 1992. This vast pool of money (valued at $3.5 trillion in mid-2023) is the fourth largest such pool in the world. Such vast sums need to be managed, which proved an attraction to some of the biggest names in the global financial sector.

Meeting the commercial office space needs of the firms in the finance sector was a motivating factor behind the redevelopment of Barangaroo South and the King Street Wharf precincts. Firms located in the towers of Barangaroo South include Westpac, KPMG, Lendlease, Gilbert & Tobin, Swiss Re, HSBC, Servcorp, Marsh & McLennan Companies and PwC.

Functional obsolescence and the desire to achieve a greater economic return for such well-located land have driven the almost total redevelopment of the area over the past decade or so. Sega World (demolished in 2008) was replaced with commercial office space. The Sydney Convention and Exhibition Centre (demolished in 2013) was replaced by the ICC Sydney (see Figure 8.2.7), and a 5-star hotel tower. The IMAX Theatre (demolished in 2016) was replaced by a 5-Star W Hotel (see Figure 8.2.9). Harbourside Shopping Centre (demolished in 2023) is being replaced with a new Harbourside mixed-use precinct and residential tower (see Figure 8.2.8). Finally, a development proposal has been lodged to replace Cockle Bay Wharf with a mixed-use complex, including an office tower.

Harbourside Shopping Centre

Sydney Convention Centre

Sydney Exhibition Centre

Imax Theatre

Sega World

8.2.7 Darling Harbour, 2007

8.2.8 Computer-generated image of the redeveloped Harbourside shopping complex

8.2.9 Darling Harbour's W Hotel and new IMAX theatre

The demand for high-quality office space was one of the factors underpinning the NSW Government's decision to redevelop the sites lining the eastern side of Darling Harbour. The ability to stage major events is one criterion used to measure a city's international status. This informed the government's decision to create ICC Sydney. Close to half of all international visitors to Australia come to Sydney first. This underpinned the government's decision to facilitate the tourist-focused elements of the Darling Harbour area.

Demographic and social drivers

The need for urban consolidation in Sydney has been apparent for some time. The NSW Government anticipates that the city's population will increase to 8 million by 2050 (up from the current population of 5.3 million). This level of growth on the periphery of the metropolitan region is not feasible, as the cost of providing the necessary infrastructure would be prohibitive. Infilling is the only feasible option. Higher density living, especially in areas close to public transport nodes, is inevitable.

Inner-city living is increasingly attractive for a range of demographic groups, including young professionals, couples without children and downsizing baby boomers. Driving this trend are several demographic and social factors. These include changing lifestyle choices and changes to the life-stage cycle brought about by the later age of marriage and longer life expectancy.

The later age of marriage and more de facto and same-sex relationships have increased the demand for inner-city apartments, especially among young professionals, while reducing the demand for detached, suburban-based dwellings. The median age of marriage in 2021 was 32.1 years for males and 30.5 years for females. This is well up on the median age in 1993 (27.0 years for males and 26.4 years for females). The average age at which women have their first child has increased from 27.5 years in 1990 to 29.7 years in 2021. Twenty-eight per cent of women will not have children. One-fifth (22%) of people aged 20–29 years are living in de facto relationships. Delayed childbearing and the growing diversity of household types increase the range of housing types demanded by people in their 20s.

Those in the later stages of life are also developing a preference for medium and high-density living. With life expectancy now stretching to the mid-80s, Australians are enjoying 25–30 years in retirement. Many are electing to downsize from detached suburban dwellings to apartments, townhouses or villas. What they seek is a more flexible lifestyle, unencumbered by the responsibilities of maintaining a detached dwelling with a garden.

These demographic and social changes underpin the demand for apartments throughout Darling Harbour's urban precincts. Affordability, however, varies significantly. Apartment prices range from $140 million for a nine-bedroom penthouse in the One Sydney Harbour tower, in Barangaroo, to a (relatively) more affordable $1.3 million one-bedroom apartment in Darling Square (see Figure 8.2.10).

8.2.10 Darling Square high-density apartment towers and civic centre

Activities

Acquiring and processing geographical information

1 Summarise the physical processes responsible for the formation of Darling Harbour.

2 Describe the origins of the area's distinctive sandstone geology.

3 Describe the original physical form of the area.

4 Summarise how people have impacted the physical form of land surrounding Darling Harbour.

5 Describe First Nations people's relationship with the area around Darling Harbour.

6 Explain how changes in the technology of shipping and cargo handling led to the decline of Darling Harbour's maritime functions.

7 Summarise the urban dynamic impacting the morphology of the area. What factors proved important in the most recent wave of development in the Cockle Bay/Darling Harbour Precinct?

8 Summarise the political interventions that proved decisive in the area's transformation.

9 Explain how economic factors have driven the transformation of the area.

10 Define functional obsolescence and explain its impact on the developments within the precincts around Darling Harbour.

11 Explain how demographic and social changes are reflected in the developments taking place within the area. List these changes.

Applying and communicating geographical understanding

12 Study Figures 8.2.1, 8.2.2, 8.2.3 and 8.2.6. Describe the nature of the physical environment evident in the historical artefacts.

13 Study Figure 8.2.5. Describe the cargo-handling techniques evident in the photograph.

14 Study Figure 8.2.6. Describe the nature of the port-related infrastructure evident in the photograph.

15 Study Figure 8.2.7. Compare the infrastructure that was demolished with the infrastructure that replaced it, as illustrated in Figures 8.1.8 to 8.1.11.

16 Using news media sources, research the debate surrounding the development of Central Barangaroo, the final element of the area to be developed. What are the arguments for and against it?

17 Conduct a class debate on the topic, 'The replacement of still functional infrastructure is a waste of resources and runs counter to the principles of sustainability'.

UNIT 8.3

Darling Harbour Precinct's links to other places

The areas around Darling Harbour are among the most culturally, economically and politically connected places in Australia. These links are associated with the area's role as a tourist, convention and exhibition destination, the ethnic diversity of its residential precincts, and its role as a hub for some of the biggest firms in the national and global finance and business services sector of the economy.

8.3.1 The Sydney Monorail opened in 1988. It closed and was then demolished in 2013.

Accessibility

Accessibility to the precincts around Darling Harbour has always represented a challenge for urban planners. Accessibility has been hindered by the congested roadways of the CBD and inner-city and the pre-existing Western Distributor, which links the Harbour and ANZAC bridges. Pedestrian access was, at best, indirect. Early attempts to improve accessibility included the construction of the Sydney Monorail loop in 1988 (see Figure 8.3.1), linking Darling Harbour with the CBD and the construction of a pedestrian ramp from Market Street to the historic Pyrmont Bridge, which closed to traffic in 1981. Later attempts to enhance accessibility included the construction of the light rail linking Darling Square and Pyrmont with Central Station and the inner-west (Dulwich Hill), the opening of the Wynyard Walk pedestrian tunnel, linking the CBD and Wynyard Station to South Barangaroo, the opening of Barangaroo Metro Station in 2024 and the introduction of ferry services (see Figure 8.3.2). All served to enhance the area's links with the CBD and other parts of the city.

8.3.2 Computer-generated image of Barangaroo Metro Station

Cultural linkages

Given the ethnic diversity of these urban precincts, it is not surprising that there should be important cultural linkages with other countries, especially China. There are also cultural links associated with the large student population, especially in Darling Square. Throughout Darling Square and the adjacent Chinatown are outlets selling and providing the ethnically-based goods and services demanded by the area's population (see Figures 8.3.3 and 8.3.4). These include Asian grocery stores, restaurants and traditional Chinese medicine practitioners.

The parklands, playgrounds, pedestrian plazas, harbourside promenades, restaurants and bars in these precincts are important recreational resources for the city, attracting the residents of the high-density residential towers of the area, other Sydney residents and tourists from around Australia and the world.

Darling Harbour has an important part in many of Sydney's major celebrations, including New Year's Eve, Australia Day and the annual Vivid festival (see Figures 8.3.8, page 214). On a smaller scale, its restaurants and bars are popular destinations for revellers celebrating milestones, such as the end of school, engagements and weddings, and corporate Christmas parties.

8.3.3 Retail outlets in Darling Square

8.3.4 Sydney's Chinatown

Economic links

The urban precincts surrounding Darling Harbour play an important role in Sydney's emerging status as a global financial and business services centre, due to their proximity to the city's CBD, along with the NSW Government's decision to develop Barangaroo South as an extension of the city's financial district (see Figures 8.3.5 and 8.3.6). In the three towers of Barangaroo South (International Towers 1–3) are the offices of the biggest names in the sector. They include HSBC, the giant British bank; Baker McKenzie, one of the world's largest law firms; the Industrial and Commercial Bank of China (ICBC); PwC, the British multinational professional services firm; BT Financial Group; Westpac and St George banks; KPMG, a multinational professional services network; Lendlease/Capella Capital, the Australian-based global construction and real estate group; the Suncorp banking group; and a range of telecommunications companies, IT providers, media firms, law firms and gig economy firms such as Menulog.

8.3.5 International Towers 1–3, Barangaroo South

8.3.6 Waterfront restaurants and promenade, Barangaroo

In the adjacent King Street Wharf area are offices of the Macquarie banking group and the Commonwealth Bank has large offices in Cockle Bay (Darling Harbour) and Darling Square.

All these form part of the global network of financial and business service providers. In some instances, they are locally based firms; in others, they are regional headquarters, and some are the Australian offices of multinational companies.

The highly competitive global exhibition and convention market is worth an estimated US$85 billion per year (see Figure 8.3.7). To be competitive, host cities need accessible, state-of-the-art facilities at an attractive destination. Each Australian capital city, and some regional centres, have convention and exhibition centres. The original Sydney convention and exhibition infrastructure, opened in 1988 had, by 2013, been eclipsed by newer facilities in cities such as Melbourne. The state government's decision to rebuild the facility was, therefore, a business decision. The economic activity generated by conventions and exhibitions was a motivating factor.

8.3.7 The economic activity generated by conventions and exhibitions makes an important contribution to Sydney's economy.

In 2022, ICC Sydney hosted 18 international conventions, 106 national conventions, 54 exhibitions, and 84 live entertainment events, with the latter attracting 360 000 patrons. Such events generate demand for travel, hotel accommodation and restaurant meals.

Tourism is an important economic driver. More than 16 million domestic and international tourists visit Sydney in a typical year, boosting the economy by more than $20 billion. Of these visitors, an estimated 4.8 million visit the Darling Harbour Precinct. In addition to the area's hotels and casinos, attractions include the Sea Life Sydney Aquarium and Wild Life Sydney Zoo, the National Maritime Museum, Chinese Garden of Friendship, IMAX Theatre, Barangaroo Reserve and Tumbalong Park. Thousands from all over the country, and the world, gather here for events such as News Year's Eve and the Vivid Festival (see Figure 8.3.8).

8.3.8 Vivid Festival, Darling Harbour

Political links

As noted in Unit 8.2, governments (both federal and state) and their various agencies have played, and will continue to play, a decisive role in the development of urban precincts around Darling Harbour. It was government intervention that initiated the redevelopment of the area, and more recently, the rebuilding of its key elements. Governments also invested in the provision of public infrastructure that underpinned the investment decisions of the private sector. Governments have also been at the centre of some of the controversies involved in the area's redevelopment, including the inclusion of Crown Casino, hotel and resort in South Barangaroo and the redevelopment of the Powerhouse Museum.

Activities

Acquiring and processing geographical information

1 Summarise the factors that hindered accessibility to Darling Harbour Precinct in the past. How has the issue of accessibility been addressed?

3 Identify the cultural links the Precinct has with other places.

4 Summarise the nature and extent of the economic links evident in Darling Harbour Precinct and the surrounding areas.

5 Identify these urban precincts' principal political links.

Applying and communicating geographical understanding

6 Using the internet, research any planned political interventions that will impact the urban precincts surrounding Darling Harbour. Write a paragraph on your findings.

7 Investigate former prime minister Paul Keating's role in the development of Barangaroo.

UNIT 8.4

Strategies for environmental and social sustainability

To develop the areas surrounding Darling Harbour, the government required companies to implement a comprehensive range of environmental and **social sustainability** strategies.

Environmental sustainability initiatives

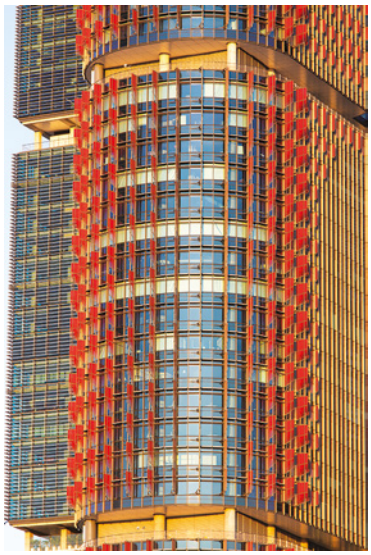
Across the Darling Harbour urban precincts, sustainability is an important factor. Barangaroo South, for example, had an impressive range of sustainability targets. This included the aim of being Australia's first carbon-neutral community, making a net contribution to Sydney's water supply, minimising the amount of waste sent to landfill and maximising the project's social legacy.

Such initiatives are important because buildings account for 30–40 per cent of the world's electricity use and solid waste generation. They are responsible for 38 per cent of all carbon emissions and 12 per cent of the world's water use. Better building and place design can reduce these impacts.

Strategy: Carbon neutrality

Barangaroo South became a carbon-neutral community through clever design of buildings and public spaces, as well as working with tenants to minimise their energy consumption.

Barangaroo South has impressive Green Star ratings. These certifications, from the Green Building Council of Australia, rate buildings against criteria that include energy efficiency, the quality of the indoor environment, accessibility to public transport, water use, the nature of the materials used in construction, ecological impacts, emissions and the degree of innovation. Barangaroo South's three commercial towers have achieved 6-star Green Star Ratings, the highest rating. The precinct has also achieved a 6-star Green Star Community rating. Residential buildings have achieved a 5-star Green Star rating for multi-unit residential design. Green Star-certified buildings typically produce 62 per cent fewer greenhouse gas emissions and use 66 per cent less electricity than average Australian buildings. Green Star buildings use 51 per cent less water than average buildings and recycle 96 per cent of their construction demolition waste, compared to the average recycling rate for new construction projects of only 58 per cent.



8.4.1 The solar shading system fixed to the facades of the three commercial towers, features a system of vertical and horizontal rod-mounted panels that reduce solar heat gain, lower air-conditioning requirements and reduce glare, while maximising natural daylight into the office spaces.

Strategy: Water positive

In developing Barangaroo South, the construction giant Lendlease committed to developing a net water-positive development. Water used onsite is processed in the water treatment plant located in the basement of the towers. Additional water is collected from offsite sources and processed through the recycled water plant, meaning that Barangaroo South can treat more water than is used onsite. Cleaned and processed water is used for toilet flushing and irrigation in the precinct. Rainwater tanks are also located in almost all the buildings onsite, and collect and reuse rainwater for cleaning and irrigation.

Strategy: Energy efficiency

The buildings of Barangaroo South include many energy-efficient design features. These include a vertical shading system that minimises radiant heat reaching the building's facades, a centralised energy-saving cooling system that draws cool water from Sydney Harbour to air-condition the buildings, renewable energy infrastructure in the form of 6000 square metres of solar panels, and multiple public transport, pedestrian and bike-based transport options (see Figures 8.4.1 and 8.4.3). Additionally, the three towers are aligned east-west to minimise exposure to the sun during the hottest part of the day (see Figure 8.4.2).

8.4.2 The east-west alignment of the towers helps keep the buildings cooler in summer

8.4.3 Barangaroo South seawater cooling plant

Strategy: Lighting and renewable energy generation

All lights in the precinct are LEDs—a highly energy-efficient form of lighting.

Six thousand solar panels installed on the roofs across the precinct provide enough energy to offset the amount consumed by the public domain lighting, the water recycling plant and equipment.

Strategy: Sustainable travel

Limited onsite car parking in Barangaroo South reflects its target of just 4 per cent of journeys taken to Barangaroo being by car. Storage for more than 1100 bikes is provided in the site's shared basement and on racks in the public domain. Multiple bike and walking paths into and around the precinct also make it easy for visitors and workers to access the precinct on foot or by bike (see Figure 8.4.4). The opening of the Metro in 2024 has improved accessibility and helped further reduce vehicle emissions.

8.4.4 Connections such as Wynyard Walk encourage the use of public transport, cycling and walking.

Strategy: Water management

Barangaroo South features precinct-wide infrastructure that manages stormwater, rainwater, recycled water, heating and cooling needs. Built into Barangaroo South is the ability to harvest rainwater from all building roofs. This equates to a total rainwater tank capacity of 188 500 litres. The water recycling plant can clean and recycle all water used onsite and has the capacity to process up to one million litres of wastewater each day. The treated water is used for toilet flushing and irrigation. Other water-saving initiatives include the installation of highly water-efficient fixtures and appliances that further reduce the volume of water used in the precinct.

Strategy: Waste minimisation

During the construction phase, Barangaroo South diverted 97 per cent of construction waste from landfill. On completion, the target is at least 80 per cent waste diversion from landfill. This is well above the Sydney CBD average of 52 per cent.

To achieve this, the precinct is designed to make it easier for tenants to separate a minimum of five different waste streams. The onsite waste management systems also allow for the collection and reuse or recycling of 18 different waste streams.

● SPOTLIGHT

Darling Square sustainability strategies

Darling Square was designed and promoted to be eco-friendly. Car access is restricted to enhance air quality, reduce carbon dioxide emissions and provide pedestrian-friendly spaces at street level (see Figure 8.4.5). Energy-efficient building design reduces the running time for air conditioners and heaters. Energy-efficient lighting is used in public spaces. Onsite car sharing is provided, and an active urban lifestyle is promoted through the provision of cycling facilities in public spaces and buildings. Additionally, all apartments include water-efficient fixtures, fittings and appliances. Smart water metering (a water meter that automatically tracks and records the amount of water you use in your home) is used throughout. A multiple green star rating was awarded for the five buildings within the precinct.

8.4.5 Providing landscaped, pedestrian-friendly spaces at street level is an important consideration in areas dominated by high-density residential towers.

This means that tenants in the precinct can use the central waste management systems for e-waste, printer cartridges, batteries, furniture and electronics, and other resources to be recycled or re-used.

Food retailers in the precinct are required to only use compostable (plant-based) takeaway packaging. This is processed onsite along with the food waste, and then taken offsite for processing into fertiliser and green energy. These approaches mean that Barangaroo can re-use or recycle much of the waste generated in the precinct.

Strategy: Environmental protection

Prior to the redevelopment of Barangaroo South, the site had to undergo remediation. Previous land uses, including a gasworks, had left a legacy of significant environmental degradation and contamination. Before any construction could commence, a clean-up of toxic black tar and asbestos was undertaken. The first stage of remediation began in 2011 and took over five years to complete.

In evaluating the effectiveness of these strategies, the Australian Government's Climate Active program noted that the International Towers of Barangaroo South are 100 per cent carbon neutral. Globally, they were the first buildings ever to achieve a perfect Global Real Estate Sustainability Benchmark (GRESB) resilience score of 100 per cent, reflecting the climate resilience strategies incorporated in the design, construction and operation of the buildings. The National Australian Built Environment Rating System (NABERS) assigns the towers six out of six stars for waste, energy, and water management, and six stars for the quality of the indoor environment.

● SPOTLIGHT

ICC Sydney sustainability strategies

ICC Sydney achieved Gold Certification under the US Green Building Council for LEED (Leadership in Energy and Environmental Design). In doing so, it sought to save 20 per cent of greenhouse gas emissions above the Building Code of Australia standard and aimed for a 14 per cent reduction in water use. It also uses solar hot water in its commercial kitchens, and is home to the first community-funded solar energy project in Australia, which allows members of the public to buy shares in a social venture that owns the building's roof-top solar array. The solar array produces approximately 5 per cent of the energy required for the venue. In 2020, ICC Sydney won an international sustainable development award in recognition of its successful waste management approach for exhibitions.

Social sustainability

The NSW Government has required corporations involved in the redevelopment of the urban precincts surrounding Darling Harbour to initiate a range of community-based programs aimed at providing a lasting social legacy These include lifelong learning programs, culture and identity initiatives, human and community services, active and healthy living programs and community investment initiatives.

Such programs and initiatives contribute to what is known as social sustainability—the idea that a community develops social processes and structures that not only meet the needs of its current members, but also enables future generations to enhance their wellbeing too.

Examples include:

- a requirement to provide a skills-based learning legacy extending well beyond the construction phase of the project, especially for First Nations Australians who have acquired skills that significantly enhanced their employability
- skills-based training for apprentices
- public art installations and an events calendar that enhances Sydney's status as being one of the world's most liveable cities
- the provision of affordable housing opportunities, albeit in adjacent suburbs
- a range of healthy living opportunities that have the potential to shape and enrich people's lives
- the provision of services needed by workers, residents and visitors, including childcare and health-related services
- the implementation of place activation strategies that involve promoting diverse human activities in a place
- enhancing the precinct's public domain so that there are places to sit and relax, small stages for performances, play equipment, public art installations, trees and garden beds, and free wi-fi.

Activities

Acquiring and processing geographical information

1 List the sustainability strategies adopted in the development of Barangaroo South.

2 Define social sustainability and outline some of the initiatives used to promote it in the urban precincts around Darling Harbour.

Applying and communicating geographical understanding

3 Write a report outlining the sustainability strategies initiated in the development of Barangaroo South.

4 Study the boxes, Spotlight: Darling Square sustainability strategies and Spotlight: ICC Sydney sustainability strategies. Summarise the eco-friendly strategies promoted by the developers of these precincts.

CHAPTER

9 A city outside Australia: New York City

New York City, also referred to as NYC, New York or The Big Apple, is one of the world's best-known urban places. It is a place of great economic and cultural authority. It is one of the world's largest megacities (as defined by the UN) and is one of just three or four cities at the top of the world city hierarchy, the others being London, Tokyo and perhaps Paris.

New York City's economic and cultural authority spans a range of sectors. It plays a central role in the global economy, especially in its influence on global financial markets. Its cultural authority spans the entertainment, sporting, and media sectors, and those focused on education, research, health care and life sciences. As home to the headquarters of the United Nations, New York plays an important role in international diplomacy. If the New York City metropolitan area was a country, it would be the eighth-largest economy in the world. The city's gross annual city product exceeded US$678 billion in 2022.

In this chapter, the focus is on the character and spatial dimensions of New York City; the geographical processes shaping the city and how these have changed over time; the challenges of living in the city; and the ways these challenges are being addressed to promote sustainability, improve people's quality of life, and reduce spatial inequality.

> **New York is not a city. It's a world.**
>
> **Iman, Somali-US model, actress and entrepreneur**

9.0.1 New York City

Chapter glossary

absolute poverty where household income is below the level necessary to afford basic food and shelter

amenity those things that make a place pleasant to live in

borough an administrative division

economic restructuring a significant and enduring change in the nature and structure of an economy

functional differentiation the physical and spatial characteristics that give an area its primary identity; how the functions of one neighbourhood are different from another

gentrification the process whereby the character of a poorer urban area is transformed by wealthier people moving in, improving housing and attracting new businesses, sometimes displacing current inhabitants in the process

globalisation the growing interdependence of the world's economies, cultures and populations, brought about by cross-border trade in goods and services, technology, and flows of investment, people and information

heat island effect an urban area that is significantly warmer than its surrounding areas due to human activities

inner mixed zone (IMZ) the older inner-city neighbourhoods that lie on the fringes of the CBD

megalopolis a very large, heavily populated urban complex

metropolitan area a city and its densely populated surrounding areas

neighbourhood a geographically localised community within a larger urban space

relative poverty where household income is a certain percentage below median income

suburbanisation a population shift from central urban areas to the suburbs

urban form the physical elements that structure and shape a city, including land uses, building types, streetscapes and public spaces

woke the term used to denote an awareness of, and being actively attentive to, important facts and issues, especially those related to racial and social justice

UNIT 9.1

The spatial dimensions and character of New York City

Like all large cities, New York City has faced a range of urban challenges, many of which are associated with periods of rapid growth and economic change. New York City became an industrial powerhouse in the nineteenth century, as the United States transitioned from an agricultural to an industrial economy (see Figure 9.1.1). The rapid population growth accompanying this transition contributed to the emergence of a range of urban problems, including overcrowded slums, inadequate sanitation, water shortages and pollution. Much of this population growth was driven by immigration. New York City attracted, and continues to attract, migrants from around the world. All seek a better way of life for themselves and their children. As a result, New York City's ethnically diverse population is one of its defining characteristics.

9.1.1 New York City, a place of great economic and cultural authority

9.1.2 New York City is located on the east coast of the USA.

More recent challenges stem from the restructuring of the city's economy—a transition from one based on industry to an information and services-based economy. These challenges include congestion, social inequality and housing shortages. Geographers seek to understand the morphology of cities such as New York City. By investigating a city's functional form and character, and the processes involved, we are better placed to propose and assess initiatives that enhance sustainability and liveability.

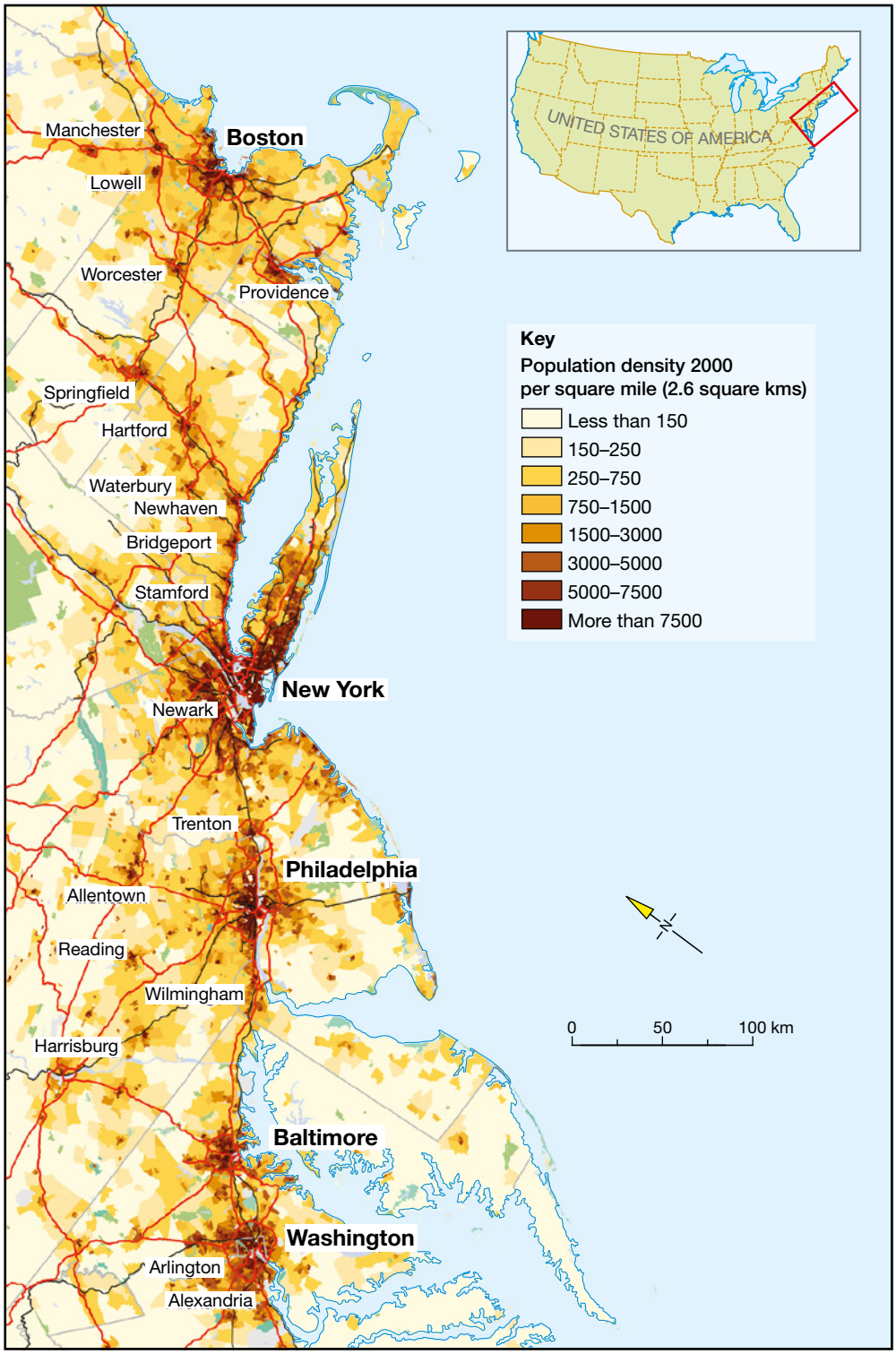
Location and spatial extent

New York City (latitude 40° 40'N, longitude 73° 50'W) is located on the east coast of the United States, where the Hudson River enters the Atlantic Ocean (see Figure 9.1.2). It lies at the southern end of New York State, and it forms the geographical and demographic centre of both the New York **metropolitan area** and the larger northeast **megalopolis**.

The New York metropolitan area includes New York City, Long Island, the Mid and Lower Hudson Valley in the state of New York; the six largest cities in the state of New Jersey (Newark, Jersey City, Paterson, Elizabeth, Lakewood and Edison); and six of the seven largest cities in the state of Connecticut (Bridgeport, Stamford, New Haven, Waterbury, Norwalk and Danbury). In terms of area, it is the largest metropolitan area in the world. The New York metropolitan area covers 34 494 square kilometres (about half the size of Tasmania).

The northeast megalopolis takes in the vast metropolitan areas extending from Boston in the north down through New York City

and Philadelphia to Baltimore and Washington DC in the south (see Figure 9.1.3). The Boston–Washington DC area (often referred to as BosWash) is home to more than 52.3 million people. The northeast megalopolis covers 145 557 square kilometres.



9.1.3 The northeast megalopolis

9.1.4 New York City's five boroughs

9.1.5 Annotated satellite photograph of New York City

9.1.6 This iconic perspective of New York City's Manhattan Island shows one of the most densely settled places on Earth.

New York City is composed of five **boroughs** (administrative divisions): the Bronx, Brooklyn, Manhattan, Queens and Staten Island (see Figures 9.1.4 and 9.1.5). Each borough is also a county of New York State. Queens and the Bronx are also known as Queens County and Bronx County. The other three counties have a different name from their borough name: Manhattan (New York County), Brooklyn (Kings County) and Staten Island (Richmond County). In total, there are 62 counties in the state of New York.

The organisation and extent of New York City, as defined by its five boroughs, is best understood a political definition, as it describes the distinct divisions by which the city is governed. In fact, the metropolitan area extends well beyond the five boroughs, as do the city's commuting zones.

Jersey City, in the state of New Jersey, houses some 292 500 people just across the Hudson River from Manhattan (see Figure 9.1.6).

Site of New York City

Much of New York City is built on the three islands of Manhattan, Staten Island and western Long Island (Brooklyn and Queens). Land is scarce, which has led to high population density and the quest to build ever taller buildings. Only the Bronx forms part of mainland United States.

The city is dissected by the Hudson and East rivers, which flow into the Atlantic Ocean. The city's access to the sea and deep waters made it inevitable that it would develop into a major port. Today, New York City is a global maritime hub.

Manhattan is 21.6 kilometres long and about 3.7 kilometres wide at its widest point. Except at its northern and southern tips, the borough's avenues run roughly north-south, and streets run east-west. Fifth Avenue divides the island into east and west sides and plays an important role in determining Manhattan's addresses. The Museum of Modern Art (MoMA), for example, lies to the west of Fifth Avenue on 53 Street, hence it has the address of 11 W 53rd Street. East-west streets are numbered sequentially from lower Manhattan northward.

Much of New York City is spread across the undulating Atlantic coastal plain, with generally flat land across much of the urban area. To the city's west lie the Appalachian and Catskill mountains, which are barriers to inland development. They have, however, become major catchment areas for New York City's water supply.

Over time, developments in bridge and tunnelling technology, and the construction of freeways, have allowed for the outward expansion of the urban area. The rivers, which

The Big Apple

New York City is sometimes called the Big Apple. The name's origin is from the term applied to the prizes awarded at horse-racing events in the 1920s. The term meant 'the ultimate prize' or 'the best'. Musicians and journalists started using the name when referring to New York City. Tourism authorities officially adopted the term in 1971 to boost tourism.

SPOTLIGHT

The founding of New York City

From its first sighting by Italian explorer Giovanni da Verrazzano in 1524, New York's harbour was a prize all the great European powers sought to control. The Dutch first sent traders to the area in 1621 and named the settlement they established, New Amsterdam. The English displaced the Dutch in 1664 and renamed the colony New York. The name was retained, even after the English lost the colony in 1783, at the end of the War of American Independence.

In the nineteenth century, New York grew rapidly and became a major port, which, in turn, fostered the development of manufacturing (see Figure 9.1.7). Trade and commerce became the city's principal focus and great fortunes were made.

In 1898, Manhattan joined with the four outer boroughs to form what was then the world's second-largest city. Only London was larger.

The city's population grew rapidly during the nineteenth century, from 79 000 in 1800 to 3 million in 1900. Much of this growth was driven by immigration. This mix of cultures enriched the city and became one of its defining qualities.

9.1.7 Illustration of Manhattan, looking north, in 1873

once represented physical barriers, were spanned. The opening of the Brooklyn Bridge in 1868, for example, led to the development of Brooklyn and areas beyond. The construction of New York City's subways in the early twentieth century facilitated the development of the outer boroughs. It also resulted in the development of centres of economic activity throughout the five boroughs and beyond (see the box, Spotlight: New York City subway). Eight bridges (including the Brooklyn, Williamsburg, Queensboro, Manhattan, George Washington and Verrazzano Narrows) and four tunnels (the Holland, Lincoln, Queens Midtown and Brooklyn Battery) now play a critical role in maintaining a functioning city.

Much of the city's topography bears the imprint of human intervention, with substantial land reclamation taking place along the island's waterfronts since colonial times. Reclamation is most notable in Lower Manhattan with modern developments like Battery Park City. Elsewhere, much of the city's natural variations in topography have been erased. While the West Side of Manhattan retains some hilliness, especially in Upper Manhattan, the East Side has been extensively flattened. Some areas are low-lying and subject to flooding during storm surges.

SPOTLIGHT

New York City subway

First opened in 1904, the New York City Subway is one of the oldest public transport systems in the world, and one of the most patronised (see Figure 9.1.8). Its 399 kilometres of track and 472 stations catered for 5.6 million passengers each weekday in 2022, making it the seventh-busiest rapid transit system in the world. Of the 28 routes or services, 25 pass through Manhattan.

The efficiency of the subway system, combined with the lack of parking in Manhattan, helps to explain why per capita car ownership in New York City is well below the national average. The subway is a key factor in the sustainability and liveability objectives of New York City.

9.1.8 In high-density cities such as New York City, mass transit systems play a critical role in the functioning of urban areas.

Did you know?

The factors that contribute to the character of a place include its location, topography, physical geography, land use, the built environment and infrastructure, and its demographic and economic characteristics.

The character of New York City

New York City is a global financial centre and a major hub for business and commerce. As a world city, it is one of the globe's most important centres for banking and finance, trade, transportation, traditional and new media, advertising, legal services, accounting, insurance, retailing, theatre, fashion, the arts and sport. Many of the world's largest TNCs are headquartered in New York City. These include American Express, Citigroup, JP Morgan Chase, Goldman Sachs, Morgan Stanley, News Corporation, Viacom and Warner Media.

New York is also one of the world's major tourist destinations. Popular attractions include Broadway shows, Times Square, Central Park, the Statue of Liberty, shopping on Fifth Avenue, the site of the former World Trade Center and its 9/11 Memorial Museum. The city's world-famous museums are also popular with tourists and include the Metropolitan Museum of Art, MoMA, American Museum of Natural History, and the Whitney, Frick, Neue Galerie and Guggenheim art museums.

New York's defining characteristic is its cultural diversity. It's a city where you can find people from almost every country, culture and tradition, and who, together, constitute the heart and soul of arguably the most dynamic city on the planet. This cultural diversity is evident in the city's food, art, theatre, music, literature and its **neighbourhoods**.

Throughout its history, New York City has been a major point of entry for immigrants. The term 'melting pot' was coined to describe densely populated immigrant neighbourhoods on the Lower East Side. Today, ethnic communities are found throughout the New York metropolitan area, often forming distinctive neighbourhoods with cultural characteristics reflecting the mix of ethnicities found in the area.

Did you know?

Politically, New York City is among the most progressive of all US cities. In the 2020 presidential election, the Democratic candidate (Joe Biden) gained 76.19 per cent of the city's vote compared to just 22.7 per cent for the Republican candidate (Donald Trump). At the city level, the Democratic Party holds most public offices. Sixty-eight per cent of registered voters in the city are Democrats. There are pockets of Republican support in some of the wealthier parts of Brooklyn and Queens, and suburban Staten Island is a stronghold of Republican support. The last time a Republican candidate for president received a majority of votes in New York City was 1924.

New York City's climate

New York City has a humid subtropical climate. This typically gives the city cool, wet winters and hot, humid summers, with plentiful rainfall all year round. The city is prone to extremes. Snowfalls are infrequent, occurring on average only 12 days per year. It can, however, be heavy when it occurs. The city can also experience strong winds, given its proximity to the Atlantic Ocean.

New York's distinctive neighbourhoods

New York's 250 neighbourhoods reflect many of the city's unique characteristics, with Manhattan (one of the city's five boroughs) having 53 discrete neighbourhoods, each with its distinct character.

Manhattan's neighbourhoods

Some of Manhattan's best-known neighbourhoods include:

- those popular with tourists. For example, Times Square and the Theater District, Midtown, Lower Manhattan, Soho and West Village
- chic residential and commercial neighbourhoods, for example, Upper East Side, Upper West Side and West Village
- principally residential neighbourhoods, for example, East Village, Lower East Side, Greenwich Village, Chelsea and Tribeca.

Some districts derive their identity from past land uses. The Meatpacking District, for example, was once home to hundreds of meatpacking plants and slaughterhouses. Today it is a bustling high-end retail, dining and residential area. Other districts derive their character from the immigrants who settled there. These include Chinatown in Lower Manhattan (see Figure 9.1.9), Little Italy and the Lower East Side, a neighbourhood founded by the first Italian immigrants to come to New York.

9.1.9 Manhattan's Chinatown

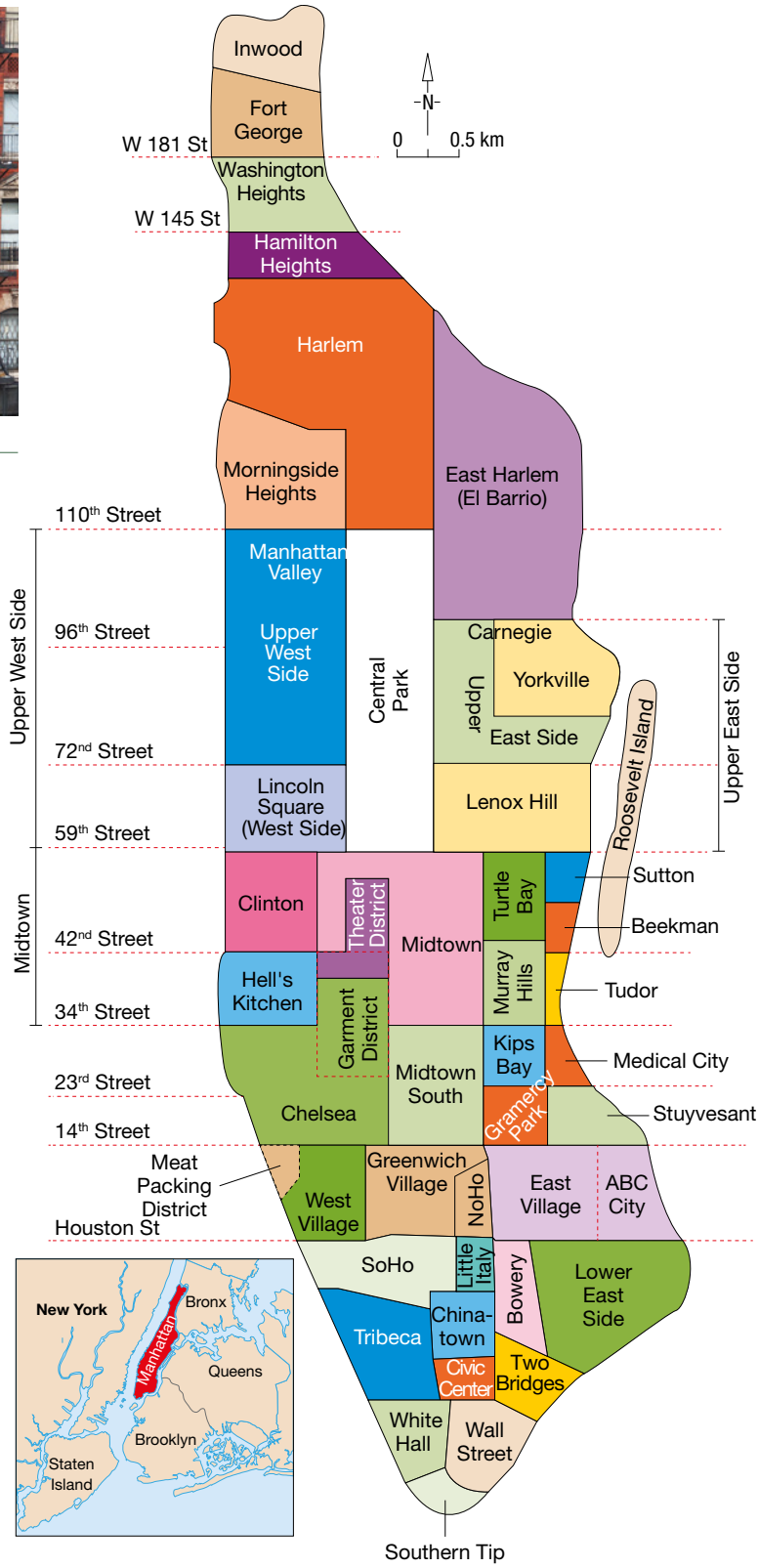
The Hell's Kitchen neighbourhood, located on the western side of Midtown was, until the 1970s, home to poor, working-class Irish Americans. Today, the area has a large LGBTIQA+ population and is home to many LGBTIQA+ bars and businesses. It is also popular with fledgling and working actors, given its proximity to the Theater District.

Harlem, to the north of Central Park, has long been associated with the city's African American population and culture. Today, trendy eateries, stylish clubs and hip bars make for an energetic nightlife scene.

Businesses are concentrated in the Financial District, at the southern end of Manhattan, and in Midtown. Midtown is also home to some of the city's best-known buildings, including the Empire State Building, the Chrysler Building, the United Nations headquarters, Grand Central Terminal and the Rockefeller Center. It is also home to several prominent tourist destinations, including Broadway and Times Square (see Figure 9.1.13).

Manhattan's striking skyline is arguably the most famous in the world. The construction of the city's famous skyscrapers, made possible by the invention of the hydraulic lift, is driven by its high population density and limited space for development. Developers have traditionally looked to build upwards rather than outwards to make the most of the available land. The latest trend, driven by developers looking to profit on incredibly high property prices, is the construction of pencil towers—very tall, thin buildings.

Each of the other four boroughs that make up New York and their districts/neighbourhoods has its own distinctive character (see Figure 9.1.10).



9.1.10 Manhattan's neighbourhoods

● SPOTLIGHT

Central Park

New York's Central Park is world-famous. It is located between the Upper West and Upper East sides of Manhattan and stretches from 59th Street in the south to 96th Street in the north. Work started on the 4.6 square kilometre park in 1858, to address the recreational needs of the rapidly growing city.

The original purpose of the park was to provide urban dwellers with an experience of the countryside, a place to escape from the challenges of urban life, and to engage with nature and fellow New Yorkers (see Figure 9.1.11).

Today the park continues to meet these needs, as well as newer forms of recreational activities. With 42 million visits a year, Central Park is one of the most visited urban parks in the world.

The park's designers, Frederick Law Olmsted and Calvert Vaux, sought to incorporate a variety of landscapes and experiences, including sweeping lawns, picturesque woodlands, meandering streams and broad lakes (see Figure 9.1.12). All of this can be experienced by moving through the park along winding paths, a carriage drive and a horse-riding path. Over time, additional features have been added to the park, including baseball and soccer fields, a carousel, two ice-skating rinks, a zoo, formal gardens, commemorative monuments and concert and theatre venues.

In addition to diverse recreational facilities and experiences, Central Park provides a range of ecological and environmental benefits. Its more than 18 000 trees cool and clean the air, and the park provides a habitat for a variety of wildlife.

9.1.11 Oblique aerial photograph of New York City's Central Park, looking towards the northern end of Manhattan from above Midtown

9.1.12 Central Park in autumn

9.1.13 Times Square, is the entertainment heart of Manhattan and New York City more generally.

Brooklyn's neighbourhoods

Brooklyn lies to the south and east of Manhattan across the East River. It has the largest population of the five boroughs and is the second-most densely settled urban area in the United States after Manhattan. In recent decades, Brooklyn has become a fashionable destination for those who can't afford the high cost of housing in Manhattan. As a result of the **gentrification** taking place, house prices in many of Brooklyn's 77 neighbourhoods have increased dramatically.

Many of Brooklyn neighbourhoods are closely identified with a particular culture or ethnicity, thereby exhibiting a high degree of concentration of certain ethnic groups. The south-west half of Brooklyn is more ethnically diverse, although it contains few African American residents; the north-east section is mostly African Americans and Latino Americans. Overall, African Americans account for 26.7 per cent of the borough's population, the Jewish community 22.4 per cent, Latino Americans 18.9 per cent and Asian Americans 13.6 per cent. European Americans account for 35.4 per cent of the population.

Queens's neighbourhoods

Queens, located on Long Island, is the largest borough by area and the second-most populous after Brooklyn. The borough is often described as one of the most ethnically diverse urban areas in the world. It is a patchwork of 91 unique neighbourhoods. Queens residents often identify more closely with their neighbourhood than with the borough or city. Flushing, for example, has a large and growing Asian population. Elsewhere are neighbourhoods with large Greek, Italian, Latino, Indian, Guyanese, and Central and South American populations.

Queens has the most diversified economy of the city's five boroughs. Key areas of employment include health care, retail trade, manufacturing, construction, transportation, and film and television production. Queens is home to two of the three major NYC area airports, JFK International and LaGuardia. Attractions include Flushing Meadows Park—home to the New York Mets baseball team and the US Open tennis tournament.

Bronx's neighbourhoods

The Bronx is the fourth largest borough by area, the fourth largest by population and third in terms of population density. It has at least 50 neighbourhoods and is home to a large Latino American population—54.8 per cent of its 1 472 654 people in 2020. Parts of the Bronx are among the poorest neighbourhoods in the United States.

In the latter half of the twentieth century, parts of the Bronx experienced a sharp decline in population, liveable housing and quality of life. The South Bronx experienced severe urban decay and social unrest. Beginning in the late 1990s, population growth returned and today some parts of the borough are home to upper- and middle-class neighbourhoods. Despite some interventions to enhance the liveability of the borough, it continues to have the highest rate of poverty in the city. Poverty-related social problems persist. These include high rates of violent crime, substance abuse, overcrowding and substandard housing conditions.

Staten Island's neighbourhoods

Staten Island, with 62 neighbourhoods and a population of 500 000, is the least populated of the five boroughs. Like the other boroughs, however, there are high concentrations of people based on their ethnicity. Most of the borough's African American and Latino American residents live in the north. Other neighbourhoods are home to Russian, Polish, Sri Lankan and Jewish American communities.

In recent times, artists and musicians have moved to Staten Island's North Shore because of its proximity to Manhattan and affordable spaces to live and work. Staten Island is an attractive place to live. Its slower pace of life, quiet neighbourhoods, sandy beaches, green space and easy commute to Manhattan are major attractions. The borough is connected to Lower Manhattan via the Staten Island Ferry.

There are few, if any, cities that can match New York City's energy, fast pace of life, buzzing traffic, 24-hour hustle and bustle, ever-changing skyline and creative spirit evident in all aspects of life. Together, these make NYC one of the most vibrant places on Earth. New York is literally, a city that never sleeps.

A word about terminology

The authors recognise the importance of culturally appropriate terminology and sensitivity to the perspectives of people from diverse cultural backgrounds.

In this chapter, we use the terms Black and African American in the discussion of New York and its communities. African Americans are American-born people of African descent. Black is more inclusive and is often preferred by people who do not identify as African and/or American, or can't trace their lineage back to Africa. This may include Americans who identify as African, Afro-Caribbean, Afro-Latino, and many other races and ethnicities.

Identifying as Black in the United States isn't just about ethnicity, it refers to an entire culture. In this way, those who identify as African Americans are part of Black culture. The term Black is said to encompass all non-white people, to emphasise the common experience of systemic racism.

The term Black is now widely used in US media and popular culture, and even in government, but it is always used with care. The term is never used as a noun. The Associated Press style guide, for example, stipulates that Black should always be used in 'a racial, ethnic or cultural sense, conveying an essential and shared sense of history, identity and community among people who identify as Black, including those in the African diaspora and within Africa.'

For a long time after the first Europeans arrived on the Australian continent, they referred to First Nations Australians as 'the blacks'. Media headlines and stories used this term as a way of conveying a perceived superiority. Changes to the use of the term began in the twentieth century and now the term is considered highly offensive. The term Black is not intended to be and should not be used when talking or writing about First Nations Australians.

SPOTLIGHT

NYC's Black neighbourhoods

New York's Black community is a multicultural one, and comprises American-born African Americans and immigrants (and their descendants) from Africa, the Caribbean (in particular, Jamaica, Trinidad and Tobago, Barbados, Guyana, Belize, Grenada and Haiti) and Latin America.

Many of the city's Black residents live in the boroughs of Brooklyn, Queens, The Bronx and in the neighbourhoods of northern Manhattan. Specific neighbourhoods with high numbers of African Americans include Brooklyn's Bedford–Stuyvesant, Manhattan's Harlem and the neighbourhoods of Eastern Queens and The Bronx. The highest concentration of Black New Yorkers is in Bedford–Stuyvesant (see Figure 9.1.14). These neighbourhoods were the birthplace of urban Black culture.

African American culture and identity—a blending of native African cultures of West Africa and Central Africa with European cultural traditions—first developed during the period of slavery in the US southern states. For many years, African American and white American cultures developed separately, due to the legacy of slavery, segregation and racial discrimination.

Significantly, Christianity plays a defining role in African American culture. Seventy-nine per cent of African Americans identify religion as 'very important' in their life, compared to 56 per cent of the wider US population.

Eighty-three per cent of Black Americans identify as Christian, including 45 per cent who identify as Baptist.

Today, African American traditions flourish as a dynamic innovative presence, especially in the fields of music, dance, art, literature, fashion, religion and cuisine, and is a defining feature of the NYC's Black neighbourhoods. It is also apparent that African American culture and identity have had a profound impact on American culture, as well as globally.

9.1.14 Street life in Bedford–Stuyvesant, one of New York City's vibrant Black neighbourhoods.

Activities

Acquiring and processing geographical information

1 Explain why New York City is defined as both a mega city and a world city. Why is it considered a place of such great economic and cultural authority?

2 Summarise how the challenges facing New York City have changed over time. What have been the key drivers of growth?

3 Describe the climate of New York City.

4 Define the term morphology. Why do geographers study the morphology of cities such as New York City?

5 Describe the location and spatial extent of New York City.

6 Summarise the key features of the site of New York City. What led to the outward expansion of the city? How have the interventions of people affected the city's site?

7 List the factors that contribute to the character of place of New York City.

8 Summarise the role of neighbourhoods in defining the character of New York City.

9 Explain why the city is so ethnically diverse.

10 Explain why New York City has so many skyscrapers.

11 Explain how the character of each of New York City's boroughs differs.

Applying and communicating geographical understanding

12 Write a paragraph explaining why New York City is described as being among the most progressive US cities.

13 Study Figure 9.1.3. Describe the spatial extent of the northwest megalopolis.

14 Study Figure 9.1.4. Write a sentence describing the sites and relative locations of the five New York City boroughs.

15 Access Google Earth. Familiarise yourself with the geography of New York City. Locate the features shown in Figure 9.1.5.

16 Study the box, Spotlight: The founding of New York City. Summarise the origins of New York City.

17 Study the box, Spotlight: New York City subway. Explain why the subway is so central to the effective functioning of New York City. How does the subway contribute to the sustainability of New York City?

18 Study Figure 9.1.10. Locate the Manhattan neighbourhoods mentioned in this unit.

19 Study the box, Spotlight: Central Park. Summarise how the park has changed over time. What purpose does it serve? What are its ecological and environmental benefits?

20 Study the box, Spotlight: NYC's Black neighbourhoods and complete the following tasks.

- **a** Identify the sub-groups of New York City's Black population.
- **b** Describe the spatial distribution of NYC's Black neighbourhoods.
- **c** Where and when did urban Black American culture develop? In what ways is it evident and what impact has it had?
- **d** Describe the nature of the relationship between Black American culture and Christianity.

UNIT 9.2

New York City's urban morphology

Urban morphology is the study of **urban forms** and of the agents and processes responsible for their transformation over time. Urban form refers to the main physical elements that structure and shape the city, including land uses, building types, streetscapes and public spaces.

The morphology of New York City, like that of Sydney and the world's other great port cities, has been transformed over time by technological advances in shipping and cargo handling. Ever larger and increasingly specialised vessels, and the introduction of containerisation in the 1970s, made most of the city's existing port infrastructure (wharves, railway goods yards and associated warehouses) obsolete. Large tracts of waterfront land were abandoned in the 1970s and 1980s, making it available for urban renewal initiatives.

The process of **economic restructuring** has also impacted the morphology of the city. This restructuring resulted in labour-intensive industrial processes and manufacturing moving to low-cost developing countries. Over time, this gap in the city's economy was replaced by the growing knowledge and service sectors. This resulted in the obsolescence of the old industrial districts and the creation of demand for space in new technology parks or repurposed buildings close to the city centre.

These processes complicated the morphology of cities. The distinct zoning of urban activities, once characteristic of cities, has given way to more integrated forms of urban land use. For example, it's not unusual to find service providers and information industries located within mixed residential and commercial neighbourhoods.

The large distribution centres, which play such an important role in the modern economy, are typically located on greenfield sites in outer urban areas with good transport links. Imported goods are unloaded from ships in vast container terminals and then transferred to distribution centres before being transported to the points at which they are purchased by consumers or used in other industrial processes.

It is, however, still possible to identify a degree of **functional differentiation** in the neighbourhoods of New York City. We can, for example, identify the two principal commercial centres, the Financial District and Midtown, the transitional neighbourhoods surrounding them and those that are primarily residential. We can also identify those areas that remain industrial in nature.

For the sake of clarity, we will focus this discussion on Manhattan. The same processes operate in the other boroughs to a greater or lesser extent.

Central business districts

Accessibility has been the principal factor in determining the location of New York City's two CBDs, both of which are in Manhattan. These are the Financial District and Midtown.

Midtown CBD

Midtown extends from the southern edge of Central Park, or 59th Street (see Figure 9.2.1). Its southern boundary is not well defined, but is somewhere from 34th to 14th Street. The Financial District occupies the southern tip of Manhattan, the site of the original Dutch settlement.

Midtown has a high level of accessibility. It is where all the major rail and bus routes converge. Grand Central Terminal, Penn Station and the Port Authority Building bus terminal are all located in Midtown. The functions served by Midtown are different to those of the Financial District. Midtown is dominated by retail, entertainment and the media (see Figures 9.2.2 to 9.2.5). This is where you find big department stores such as Saks Fifth Avenue, Macy's, Nordstrom, Bloomingdales and Bergdorf Goodman, and the luxury retailers of Fifth Avenue. Midtown is also where you find Times Square, the Broadway Theater District and Madison Square Garden.

The US broadcaster NBC Universal is based in Rockefeller Plaza, and News Corporation is on the nearby Avenue of the Americas. Other media and entertainment providers based in Midtown include CBS Corporation, Paramount, Time Warner and The New York Times, Univision Communications and Marvel Entertainment. Popular retailers headquartered in Midtown include Calvin Klein, Polo Ralph Lauren and Foot Locker. Other corporate headquarters include those of Citigroup, Colgate-Palmolive, Deloitte, Estée Lauder, JP Morgan Chase, MetLife, Morgan Stanley, and pharmaceutical giant, Pfizer.

CBDs are not confined to Manhattan. Each of the boroughs has several smaller business districts serving the surrounding neighbourhoods. There are also numerous shopping malls meeting the needs of people living in the city's boroughs and the metropolitan area beyond the city's boundaries.

9.2.1 Oblique aerial photograph of Midtown.

9.2.2 Fifth Avenue is home to the world's greatest luxury retailers, including Louis Vuitton and Prada. It has the world's most expensive retail rent.

9.2.3 The Rockefeller Center is a complex of 19 commercial buildings, covering the area between 48th Street and 51st Street and Fifth and Sixth Avenues in Midtown Manhattan. The 14 original Art Deco buildings were commissioned by the Rockefeller family. The Center is one of NYC's most popular tourist attractions.

9.2.4 Saks Fifth Avenue, one of New York City's most fashionable department stores, mounts a spectacular light display each Christmas.

9.2.5 New York City's Time Square

9.2.6 Oblique aerial photograph of New York City's Financial District, located on the southern end of Manhattan

The Financial District

The Financial District is a relatively compact neighbourhood with an irregular street pattern (see Figure 9.2.6). The size of the area has resulted in intense competition for land. This has resulted in the vertical zonation of functions within the skyscrapers that dominate the area.

The World Trade Center, devastated by the terrorist attacks of September 11, 2001, once dominated the area. The Center's Twin Towers, which both exceeded 400 metres in height, collapsed after being struck by hijacked aeroplanes piloted by terrorists. Ultimately, 2753 deaths (excluding those of the terrorists) were attributed to the attack. Memorial fountains on the footprint of the Twin Towers, a moving underground museum and the 541-metre Freedom Tower now occupy the site (see Figure 9.2.8).

The Financial District is home to the offices and headquarters of many of the city's major financial institutions, including Wall Street's New York Stock Exchange and the Federal Reserve Bank of New York (see Figure 9.2.7). New York City is widely regarded as the most financially powerful city and the leading financial centre of the world.

9.2.7 The New York Stock Exchange on Wall Street in the Financial District

9.2.8 One of two September 11 memorial fountains and the Freedom Tower in the background

Inner Mixed Zone

Adjacent to the city's two CBDs is an area referred to as the **inner mixed zone (IMZ)**. The IMZ is made up of the older inner-city neighbourhoods that lie on the fringes of the CBD. This zone of transition between the mainly commercially focused CBD and residential areas features a mix of land uses, including some office and retail functions, apartment buildings, restaurants and the services needed by residents.

To the south of Midtown Manhattan are the transitional neighbourhoods of Chelsea, Gramercy and Flatiron. To the west is the Theater District and Hell's Kitchen. Chelsea, while traditionally residential, has experienced a degree of gentrification in recent decades. The vast garment warehouses in the west of the neighbourhood near the Hudson River have, in many instances, been converted into commercial office space, fashionable boutiques, art galleries (there are more than 200), antique stores and loft-style apartments.

The neighbourhood remains primarily residential, with a mix of tenements, apartment blocks, city housing projects, townhouses and renovated rowhouses. Social inequalities are evident and there is a widening income gap between the wealthy, living in luxury apartment buildings, and the poor, living in housing projects. The many retail businesses in Chelsea reflect the ethnic and social diversity of the population. The area has, for example, a large LGBTIQA+ population. Twenty per cent of those living in the neighbourhood are LGBTIQA+ couples.

The neighbourhoods of Gramercy and Flatiron were largely residential, characterised by fashionable townhouses occupied by the wealthy. Today, boutiques, trendy cafes and high-rise apartments dominate a stretch of lower Fifth Avenue. The Theater District extends from Fifth Avenue and the Avenue of the Americas (an area still dominated by CBD-like commercial activities) to the Hudson River in the west. Broadway and Times Square dissect the neighbourhood. As the name suggests, the area houses numerous theatres where patrons can see all the great musicals and plays (see Figure 9.2.9). The Theater District also houses recording studios, record label offices, theatrical agencies, television studios, restaurants and movie theatres.

9.2.9 There are currently 41 theatres operating on Broadway.

Hell's Kitchen was, until the 1970s, home to poor and working-class Irish Americans. Beginning in the 1980s, the area became increasingly gentrified, which drove up housing prices and led to the flight of the poor and working class. Today, the area provides transport, medical and warehouse infrastructure support to the business district of Manhattan. It is also known for its extensive selection of multicultural restaurants, delicatessens, bars and associated nightlife. The area is popular with New York City's gay community.

Just to the north of the Financial District are the transitional neighbourhoods of SoHo (south of Houston Street) and TriBeCa (triangle below Canal Street). Once an industrial area, SoHo was threatened with demolition in the 1960s, until activists drew attention to the neighbourhood's unique cast-iron architecture. The area was saved, and artists began to move into the restored buildings. High-end galleries, cafes, shops and then boutiques followed (see Figure 9.2.10). As rents rose, many artists were priced out of SoHo and moved to TriBeCa. Expensive loft apartments in renovated warehouses and attractions such as the High Line continue to transform the neighbourhood.

9.2.10 People queue for Japanese pancakes on a Saturday in SoHo, New York

The gentrification and urban renewal taking place throughout Manhattan is a product of the trend towards city living, evident since the 1990s. Spurred on by a chronic shortage of affordable rental accommodation in the more desirable neighbourhoods, tens of thousands of young, middle-class professionals have moved into and developed once unloved neighbourhoods. This, in turn, increased rents in the gentrifying neighbourhoods, forcing out poorer residents, reducing diversity and changing the mix of small businesses found there. This renewal stands in stark contrast to 1970s, when people fled the city for detached housing in the suburbs on the outskirts of the metropolitan areas. Back then, New York City was perceived to be dirty and crime-ridden. Today, city living is back in favour. Being close to work and all that city living offers is now a preferred lifestyle, especially for young professionals.

Residential zones

While people reside in all of New York City's neighbourhoods, some places are more readily recognisable as residential areas. The Upper West Side and Upper East Side are best known for their wealthy residents, living in a mix of classic brownstone row houses and upscale apartment buildings (see Figures 9.2.11 and 9.2.12). There are also fancy restaurants and exclusive boutiques frequented by the rich locals. Both neighbourhoods house some of New York City's most famous institutions. The Upper East Side is home to cultural institutions that include the Metropolitan Museum of Art and the Solomon R. Guggenheim Museum. The Upper West side is home to the American Museum of Natural History and the Lincoln Center for the Performing Arts.

9.2.11 The Upper West Side is one of New York City's wealthiest neighbourhoods.

9.2.12 Residential brownstone row houses on the Upper East Side

9.2.13 Veselka, an iconic Ukrainian restaurant in the East Village

East Village, in lower Manhattan, is a densely settled residential area famous for its nightlife music venules, bars and performance spaces (see Figure 9.2.13). The birthplace of American punk rock, the neighbourhood continues to attract an eclectic mix of residents. Gentrification of the area has led to an influx of posh cocktail lounges and hip restaurants, which often stand side-by-side with vintage clothing shops and tattoo parlours.

Today, Greenwich Village is an expensive residential neighbourhood, with tree-lined residential streets and well-patronised cafes, bars and restaurants (see Figure 9.2.15). This is quite a change from the 1960s when the area was at the centre of the city's counterculture movement. The widespread gentrification and commercialisation of the area over time has resulted in it being ranked among the 10 most expensive residential areas in the United States by median housing price. The Meatpacking District and West Village are generally considered sub-areas of Greenwich Village.

The Meatpacking District, once home to meatpacking plants, as the name suggests, is now a hip commercial area (see Figure 9.2.14). It's home to the Whitney Museum of American Art, high-end designer clothing stores and a stretch of the High Line Park (see Figure 9.2.16). Its cobblestone streets are filled with trendy restaurants and clubs housed in the area's historic industrial buildings.

9.2.14 The Meatpacking District. The onetime industrial area is now a fashionable neighbourhood featuring a mix of land uses.

9.2.15 Restaurant in Greenwich Village

9.2.16 New York City's High Line. The popular attraction is a 2.33 km elevated linear park and rail trail developed on a former New York Central Railroad spur on the west side of Manhattan.

The Lower East Side, once known for its gritty alleyways and tenement-style buildings, is now home to an increasing number of upscale apartments and chic boutiques. At night, young people are drawn to the area's trendy bars, music venues and restaurants. The rate of gentrification of the area recently prompted the National Trust for Historic Preservation to place this neighbourhood on their list of America's Most Endangered Places. The neighbourhood's Jewish heritage is still apparent in the neighbourhood, especially in its remaining kosher delis and bakeries.

Special purpose zones

There are several special-purpose zones in New York City. The most significant of these is the United Nations precinct in Turtle Bay on the East River (see Figure 9.2.17). The complex consists of several structures, including the Secretariat, Conference and General Assembly buildings and the Dag Hammarskjöld Library. The complex has served as the headquarters of the UN since 1951. Other special purpose zones include the John F. Kennedy and La Guardia airports, both of which are in Queens.

Did you know?

Between 1881 and 1914, some two million Jews immigrated to the United States from Europe. About 75 per cent of them settled in New York City, most of those on the Lower East Side. In the period 1900–1910, almost 500 000 residents of the Lower East Side were Jewish, making this the largest Jewish community in the world at the time.

9.2.17 The United Nations Headquarters, Manhattan, seen from the East River

9.2.18 Barclays Center in Brooklyn, the home of the Brooklyn Nets basketball team

Recreational spaces

New York City has 113 square kilometres of parkland. This includes Central Park, Prospect Park, Flushing Meadows Corona Park and Forest Park. The largest is Pelham Bay Park, followed by the Staten Island Greenbelt and Van Cortlandt Park.

Sporting venues are spread throughout the city and are accessible by public transport. They include Citi Field stadium (home of the New York Mets baseball team) and the USTA Billie Jean King National Tennis Center which hosts the US Open tennis tournament, both located within Flushing Meadows Corona Park, Queens. Yankee Stadium, in the Bronx, is another significant sporting venue, as is the Barclays Center in Brooklyn, the home of the Brooklyn Nets basketball team (see Figure 9.2.18).

Industrial zones

Economic restructuring and competing land uses have driven industry away from the city's core. To protect existing manufacturing areas, industrial zones were established across the city in 2006. Examples include Hunts Point (Bronx), Jamaica (Queens), North Shore (Staten Island) and the Brooklyn Navy Yard (Brooklyn). The latter ceased being a military facility in 1966 and is now an industrial centre occupying 121 hectares along Brooklyn's waterfront. The Yard is now home to over 450 businesses related to manufacturing, design and technology. These businesses employ more than 11 000 people and generate over US$2.5 billion per year in economic impact for the city.

Activities

Acquiring and processing geographical information

1 Define the term urban form.
2 Summarise the processes transforming the morphology of New York City.
3 Explain what is meant by the term functional differentiation.
4 Describe the locations of New York City's two CBDs. How are they functionally different?
5 Explain what is meant by the term inner mixed zone. What are its key features? How have they changed over time?
6 Explain the process of gentrification.
7 Briefly describe the diverse character of Manhattan's neighbourhoods.
8 Describe the purpose of special purpose zones.
9 List some of New York City's famous recreational and sporting places and facilities.
10 Describe how the location of the city's industrial zones has changed over time. What has been the city's response?

Applying and communicating geographical understanding

11 Using Google Earth, explore some of the neighbourhoods mentioned in this unit. Use Google Street View to investigate the nature of the streetscapes and architecture of the selected neighbourhoods.

UNIT 9.3

The changing demography of New York City

New York City is the most populous city in the United States, with a population of 8 804 190, according to the 2020 US Census. This is an increase from 8.2 million in 2010, 8.0 million in 2000; and 7.3 million in 1990. The city grew by 7.7 per cent (629 057 people) in the period 2010–20, a faster pace of growth than the rest of the country (7.4%). New York City remains the largest city in the United States, with more than twice the population of the second-largest city, Los Angeles.

Population changes in the city

Figures 9.3.1 and 9.3.2 show the growth of New York City's population since 1900. The city's population grew rapidly in the first few decades of the twentieth century, more than doubling between 1900 and 1930, from 3.4 million to 6.9 million. This period experienced high levels of immigration, domestic in-migration, and natural increase (births minus deaths).

In the 1930s and 1940s, the population continued to grow, although more slowly, rising to just short of 7.9 million in 1950. Population growth during this period was in large part due to domestic migration from the southern states and Puerto Rico, as immigration slowed. In the middle of the twentieth century, the city's population growth stalled.

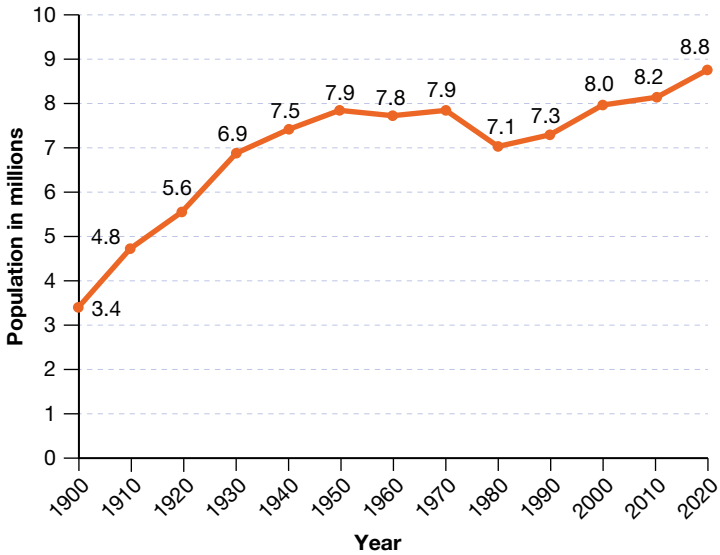
The city experienced a small population decline in the 1950s, as large domestic outflows to newly formed suburbs were only partially offset by domestic in-migration and a high natural increase from the baby boom.

In the 1960s, international immigration began to increase again after an overhaul of the country's immigration laws in 1965, and the city returned to modest growth, just surpassing the 1950 population.

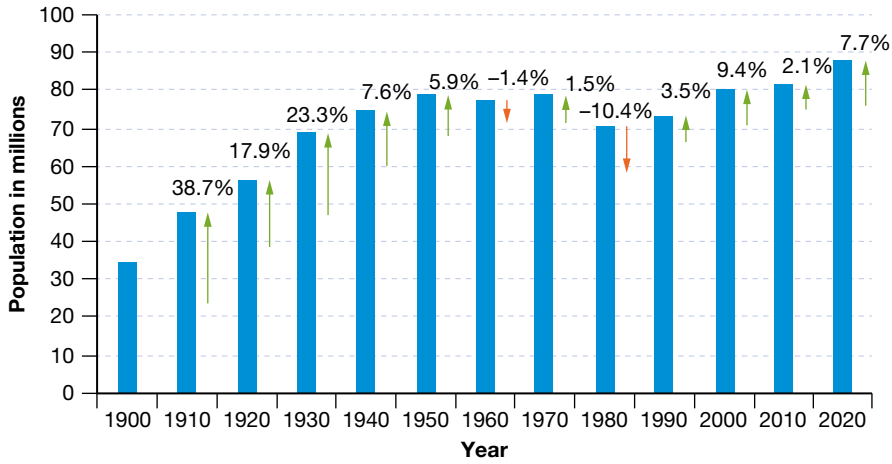
In the 1970s, growing immigration was insufficient to offset large domestic outflows, leading to substantial population losses. The population stood at approximately 7.1 million in 1980, only slightly higher than a half-century earlier.

The population rebounded in the 1980s as natural increase grew, immigration increased, and domestic outflows slowed.

The city's population has grown steadily since the 1980s, driven, in part, by the gentrification of neighbourhoods and large-scale urban renewal projects within the five boroughs, especially Manhattan and Brooklyn.



9.3.1 New York City's population growth, 1900–2020



9.3.2 Percentage change in population, New York City, 1900–2020

Population changes in the boroughs

The population growth experienced in the 2010–20 period was not evenly experienced across the city (see Figure 9.3.3). Brooklyn grew at the fastest rate, 9.2 per cent, adding 231 374 people from 2010, and reaching a population of 2 736 074 in 2020. It has continued to be the most populous borough. The Bronx finally surpassed its 1970 population peak, reaching a record population of 1 472 654 in 2020. Its population grew by 6.3 per cent. Queens reached a new record population of 2 405 464 in 2020, a gain of 7.8 per cent. In the same period, the population of Manhattan increased by 6.8 per cent, while Staten Island grew at the slowest pace, at 5.8 per cent.

Borough	Population 2010	Population 2020	Population increase	Rate of increase (%)
Brooklyn	2 504 700	2 736 074	231 374	9.2
Queens	2 230 722	2 405 464	174 742	7.8
Manhattan	1 585 873	1 694 251	108 378	6.8
Bronx	1 385 108	1 472 654	87 546	6.3
Staten Island	468 730	495 747	27 017	5.8

Source: US Census

9.3.3 Population change by NYC borough, 2010–20

Within boroughs, the growth was also uneven. Manhattan's neighbourhoods, for example, saw a mix of dramatic population increases, moderate growth, and even some significant declines. Several neighbourhoods with substantial levels of new construction led the borough in population growth, including Chelsea–Hudson Yards (see the box, Spotlight: Hudson Yards), Hell's Kitchen and the Financial District–Battery Park, each with a gain of over 13 000 residents. Harlem (North), the Upper West Side–Lincoln Square and Midtown South–Flatiron–Union Square were not far behind, each with a gain of at least 7000 residents. Washington Heights (North and South) and Inwood, located at the far northern end of the borough, experienced substantial population declines, with Washington Heights (South) losing 5400 residents. Rising rents are seen as the principal reason for the declining numbers of the largely Dominican community, who were partially replaced by newly arrived white residents.

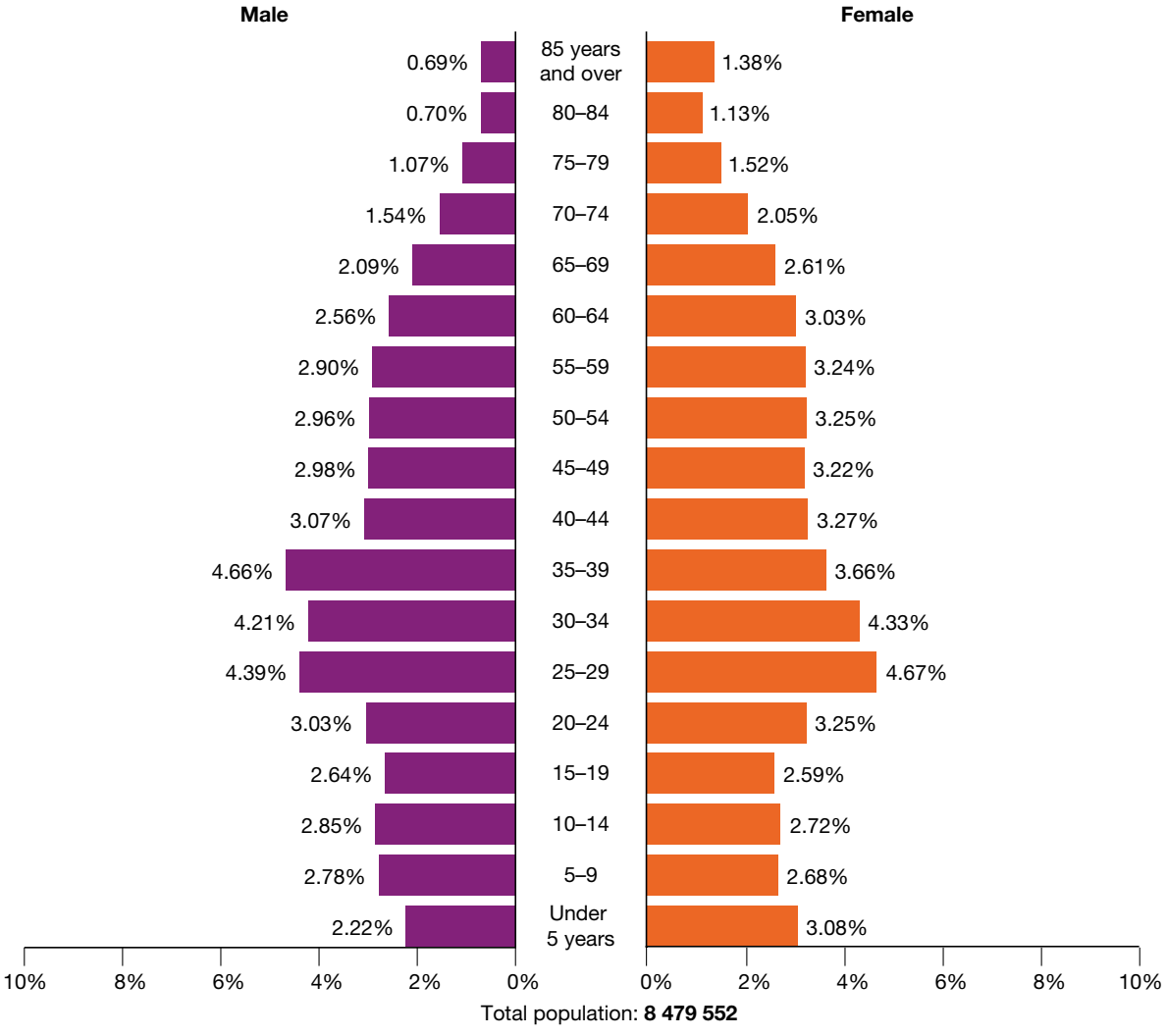
Demographic change in the city

The age/sex structure of New York City also provides insights into its changing demographics. Like many cities in the developed world, New York City has an ageing population due to longer life expectancies and a declining fertility rate (as indicated by the narrowing base of the pyramid. As the population pyramid (Figure 9.3.4) illustrates,

the birth rate is relatively low, with the percentage of 25– to 39-year olds increasing. This is best accounted for by young adults choosing to live in the city for work or tertiary education. It is also the age group most likely to arrive in the United States as immigrants.

2020 US Census Bureau data reports:

- between 2010 and 2020, New York City's median age increased from 35.6 to 38.2 years
- 16.3 per cent of the population is under the age of 15 years
- 3.9 per cent of the population is 80 years or older
- 14.8 per cent of the population is 65 years or older
- 65.3 per cent of the population is between the ages of 20 and 65
- the 30–34 age group is the largest, followed by the 35–39 age group
- females make up 52.3 per cent of the population.



9.3.4 Population pyramid, New York City, 2020

● SPOTLIGHT

Hudson Yards

Hudson Yards is an 11 hectare, US$25 billion urban renewal project in Manhattan (see Figure 9.3.5). It is being built between the Chelsea and Hell's Kitchen neighbourhoods. On completion, 13 of the 16 planned buildings on the West Side of Midtown South will occupy a platform built over the West Side Rail Yard. The first of its two phases, opened in 2019, consists of a public green space and eight structures that contain apartments, a hotel, office buildings, a shopping mall and a cultural facility. The second phase will include more apartments, an office building and a school. In the condominium towers, available apartments start at US$4.3 million and go up to US$32 million for a duplex penthouse. The development, and adjacent projects, now house 25 000 New Yorkers.

9.3.5 The Hudson Yards development is the largest urban renewal project in Manhattan.

Population density and cultural diversity

New York's two key demographic features are its population density and cultural diversity.

Population density

The city's population density of 11 232 people per square kilometre makes it the densest of any US metropolitan area (see Figure 9.3.6). Manhattan's population density is 28 872 per square kilometre. This compares with a Sydney-wide population density of 433 per square kilometre and its inner-city density of 8040 per square kilometre.

The city's high population density has both advantages and disadvantages. It encourages the use of public transport, but also concentrates pollution. New York City's public transport use is the highest in the United States, and fuel consumption is well below the national average, making the city the most energy efficient in the country. New York City is the only locality in the United States where more than half of all households do not own a car. Parking space is at a premium, especially in Manhattan.

The city's per capita greenhouse gas emission levels are relatively low, at 7.1 metric tonnes per person, compared to the national average, of 24.5 metric tonnes. New Yorkers are collectively responsible for one per cent of the nation's total greenhouse gas emissions while accounting for 2.7 per cent of the nation's population. The average New Yorker consumes less than one-quarter of the electricity used by a resident of Dallas. Population concentrations do, however, concentrate pollutants. Managing pollution, together with landfill waste and sewage, are the main challenges facing city authorities.

Other challenges associated with high-density living include congestion, lack of open space and overshadowing.

Borough	Population	Population density (per km^2)
Bronx	1 472 654	13 482
Brooklyn	2 736 074	15 227
Manhattan	1 694 263	28 872
Queens	2 405 464	8542
Staten Island	495 747	3327
NYC Total	8 804 190	11 234

Source: US Census 2020

9.3.6 Population density of New York City's five boroughs.

Cultural diversity

Throughout its history, New York City has been an important entry point for immigrants entering the United States.

Driven by a need to access existing culturally-specific support networks and services, immigrants are often drawn to the ethnic enclaves or neighbourhoods housing those who have preceded them, just as many immigrants to Australia are. As a result, New York City has a patchwork of neighbourhoods closely identified with people from a shared ethnic or cultural background. This is evident in the streetscapes of these neighbourhoods—the restaurants and retail outlets, the dress of the residents, and the cultural institutions important to a particular group, especially places of worship and the other venues in which people interact.

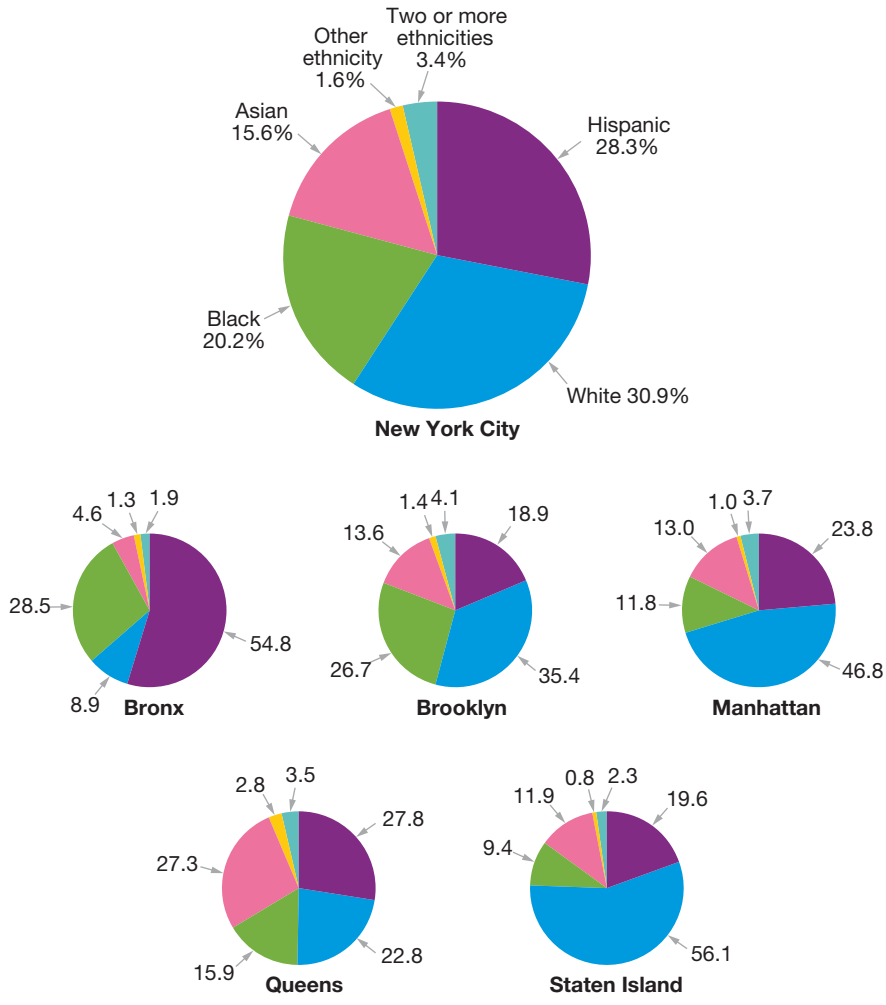
New York City experienced major immigration from Europe in the nineteenth century and another major wave in the early twentieth century. Restrictive immigration laws meant that migration was largely limited to Europeans, with large numbers arriving from Western Europe (especially Ireland, England and Germany). Later waves of migrants from Southern and Central Europe would further enhance the city's cultural diversity.

The passage of the *Immigration and Nationality Act, 1965*, not only increased the rate of immigration, but also diversified the sources of immigrants. Immigrants arrived from Latin America, the Caribbean, Asia, Eastern Europe and Africa. No single country or region of origin now dominates. The 11 nations constituting the largest sources of current immigration to New York City are the Dominican Republic, China, Jamaica, Guyana, Mexico, Ecuador, Brazil, Haiti, Trinidad and Tobago, Colombia, Russia and El Salvador.

The 2020 census demonstrates the diversity of the city's population. Among the four major racial groups, the Asian population grew at the fastest rate (33.6%) over the last decade, and other groups saw below-average growth or declines. The Latino American population grew by 6.6 per cent, while the number of Black New Yorkers declined by 4.5 per cent and the white population fell marginally, by 0.1 per cent. In absolute terms, the Asian American population increased by 345 383, accounting for more than half of the city's population growth. Overall, however, the white population remained the largest ethnic group, comprising 30.9 per cent of the population, followed by the Latino American (28.3%), Black American (20.2%), and Asian American (15.6%) populations (see Figure 9.3.7).

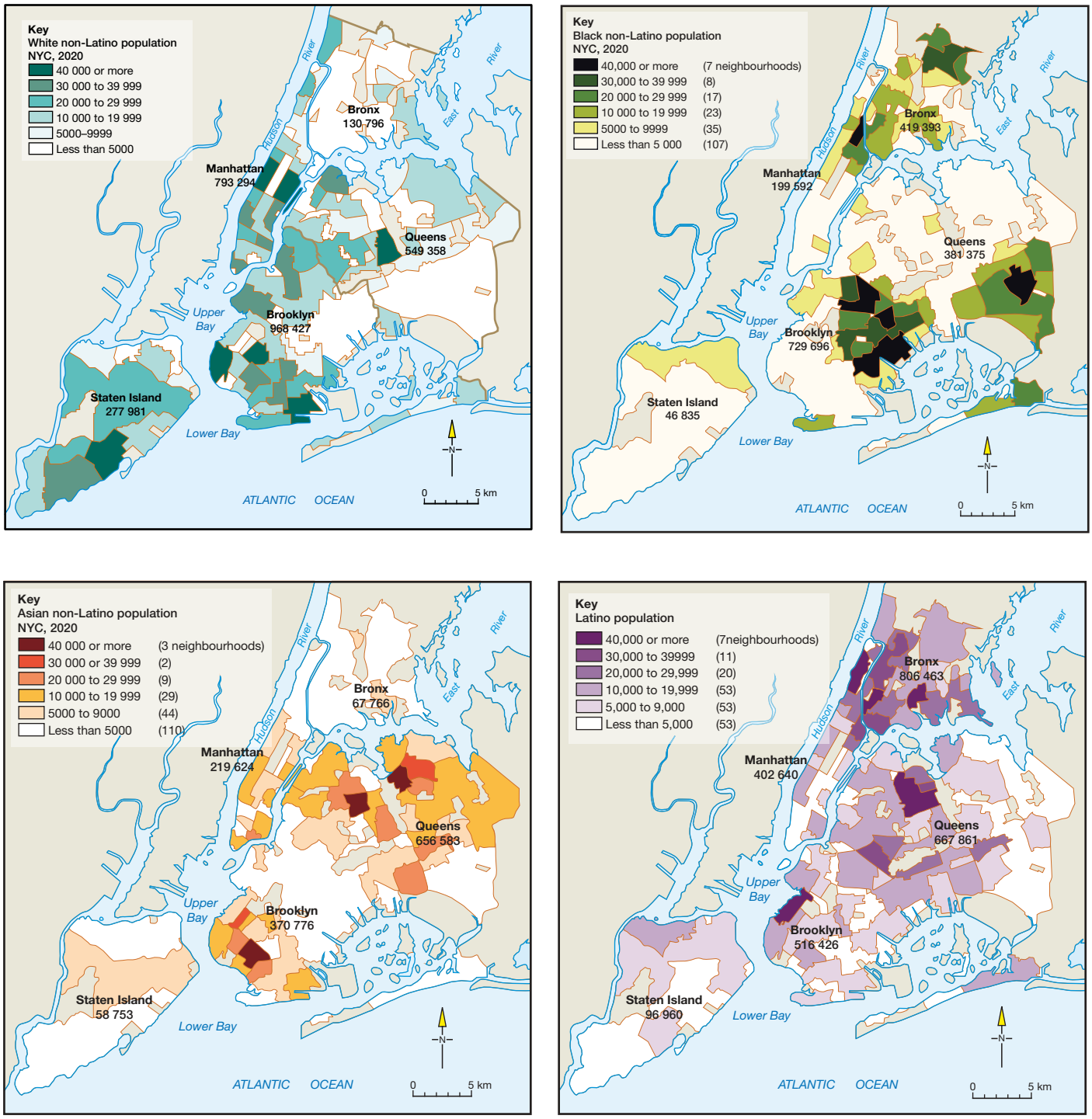
Figures 9.3.7 and 9.3.8 illustrates the ethnic variations in the population of New York City's five boroughs. The Bronx is overwhelmingly Latino (54.8% of its population). Black New Yorkers account for 28.5 per cent and whites just 8.9 per cent. Contrast this to Manhattan where 46.8 per cent of the population is white and Latino Americans account for 23.8 per cent of the population, followed by Asian Americans (13%) and Black New Yorkers (20.2%), most of whom are concentrated in the north of Manhattan, in Harlem. Whites constitute a clear majority (56.2%) of residents living on Staten Island, and also account for the largest racial group living in Brooklyn (35.4%), followed by Black residents (26.7%), Latino (18.9%) and Asian (13.6%). While no one group dominates Queens, the borough does have the highest proportion of Asian residents in the city (27.3%).

The racial residential segregation evident in New York City is reflected in a range of social variables, including poverty rates, income inequalities, property values, race-based disparities in health and education and incarceration rates (see Figure 9.4.9, page 254).



Source: US Census Bureau, 2020 Census

9.3.7 Population by ethnic background for New York City and its boroughs, 2020



9.3.8 Distribution of NYC's white (top left), Black (top right), Asian (bottom left) and Latino (bottom right) populations

SPOTLIGHT

Ten facts about NYC's demography

- Thirty-seven per cent of the city's residents are immigrants.
- Between 55 and 60 per cent of city residents are either immigrants themselves or have at least one immigrant parent.
- The New York City metropolitan area is home to the largest Jewish community outside Israel.
- Nearly 25 per cent of Indian Americans and 15 per cent of Korean Americans live in New York City.
- There are six Chinatowns in New York City and 660 000 people of Chinese origin. People of Chinese ethnicity make up 6 per cent of the city's population.
- New York City is home to the largest Italian population in North America and the third-largest Italian concentration outside Italy. Italians emigrated to the city in large numbers in the early twentieth century. The Irish also have a notable presence, along with Germans.
- In 2021, Dominicans (770 000) were the largest Latino subgroup, having surpassed the Puerto Rican population (587 000).
- In 2021, the Chinese population remained the largest Asian subgroup (572 000), comprising nearly one-half of the Asian population.
- The Bangladeshi population nearly tripled over the decade, to 102 000 in 2021, vaulting them from sixth to third place among Asians.
- New York is home to more than 1.2 million Asians.

Population changes by ethnic group, 2010–20

The maps in Figure 9.3.10 provide some interesting insights into the changing ethnic composition of New York City's boroughs and neighbourhoods. New York City's white population is increasing in Brooklyn and Manhattan, while declining in Queens, the Bronx and Staten Island. Significantly, the white population in the northern neighbourhoods of Brooklyn (those closest to the southern tip of Manhattan) is increasing as this part of the borough undergoes urban renewal and gentrification. The white population is declining, or increasing only marginally, in the outer neighbourhoods of Brooklyn, Queens, the Bronx and Staten Island. The Black American population has declined most significantly in Brooklyn, and to a lesser extent in parts of Queens. It has increased marginally on Staten Island and the Bronx. Overall, the Black American population of New York City declined in the period 2010–20.

New York City's Latino American population has grown in all boroughs except for Manhattan, where there has been a small decline. The greatest growth occurred in the Bronx and Queens. Overall, the growth has been widespread. The Asian population has grown in all boroughs, most notably Queens and Brooklyn. Again, the growth is spread across the city.

SPOTLIGHT

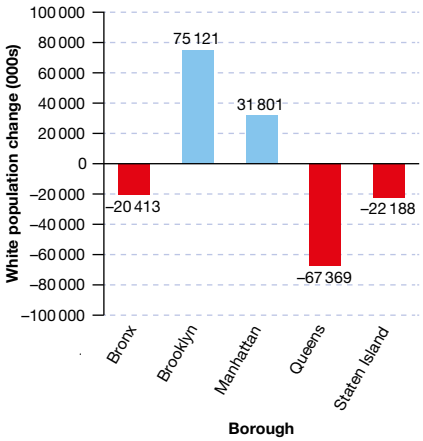
Statue of Liberty

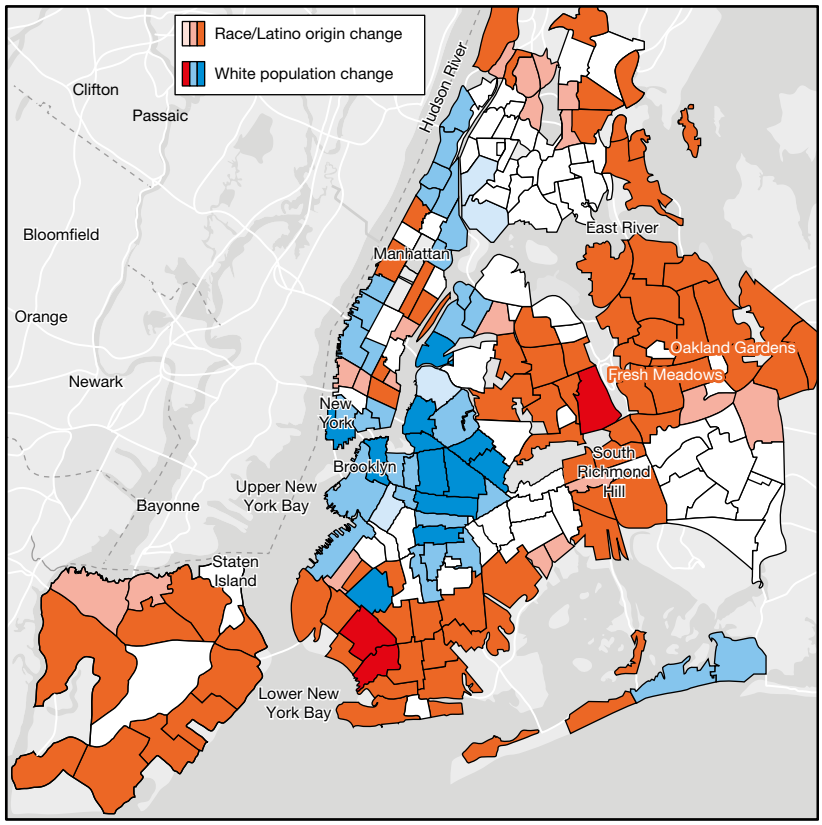
The Statue of Liberty is a 93-metre-high neoclassical sculpture on Liberty Island in New York Harbor. The steel and copper sculpture, a gift from the people of France, was designed by French sculptor Frédéric-Auguste Bartholdi. Its metal framework was built by Gustave Eiffel, the same man who built Paris' most famous landmark, the Eiffel Tower. The statue was formally presented to the people of the United States in October 1886.

The statue is a representation of Libertas, a Roman goddess of freedom, holding a torch aloft. The broken shackle and chain at the statue's feet commemorate the abolition of slavery in 1865.

The statue almost immediately became a symbol of freedom and for many years welcomed immigrants arriving by sea (see Figure 9.3.9). Today, it is one of New York's most popular tourist attractions.

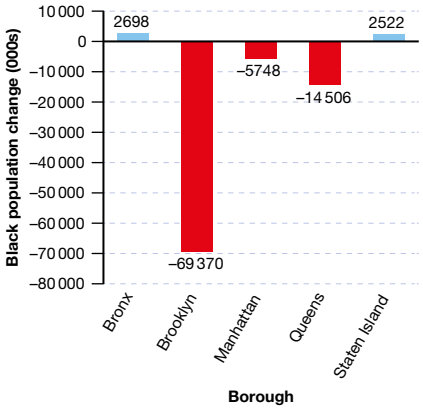
9.3.9 Immigrants arriving in New York Harbour with the Statue of Liberty in the background

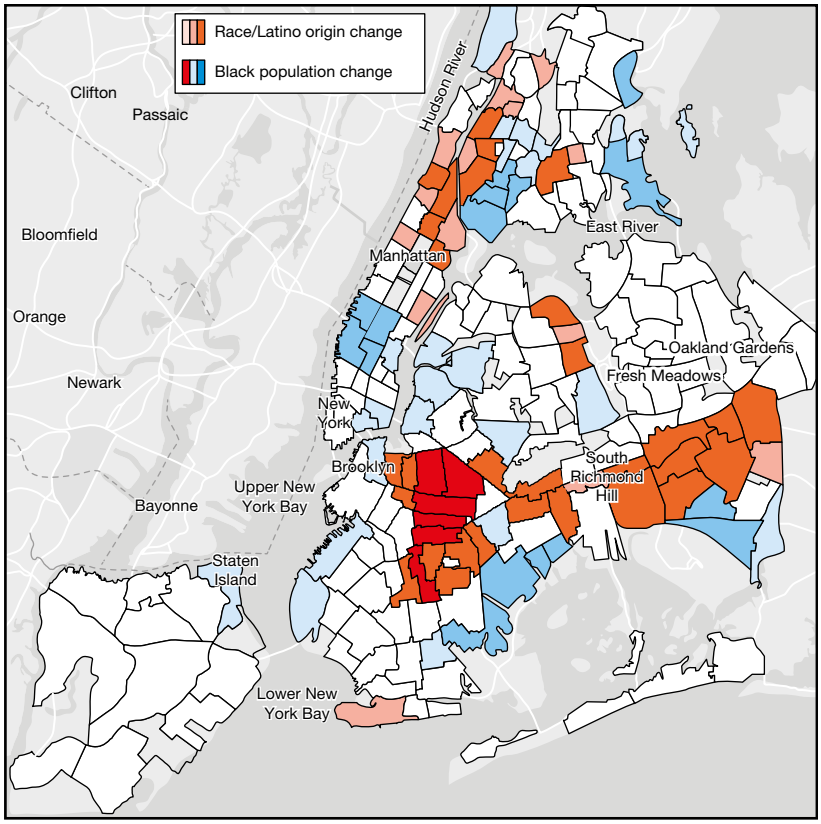




White population change

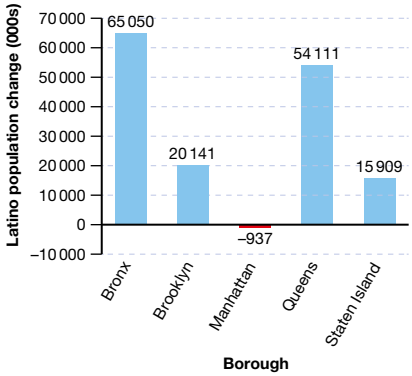
> 5000 — 18 186 | > 500 — 1000 | > −1000 — −500 | −9593 — −5000
> 1000 — 5000 | > −500 — 500 | > −5000 — −1000

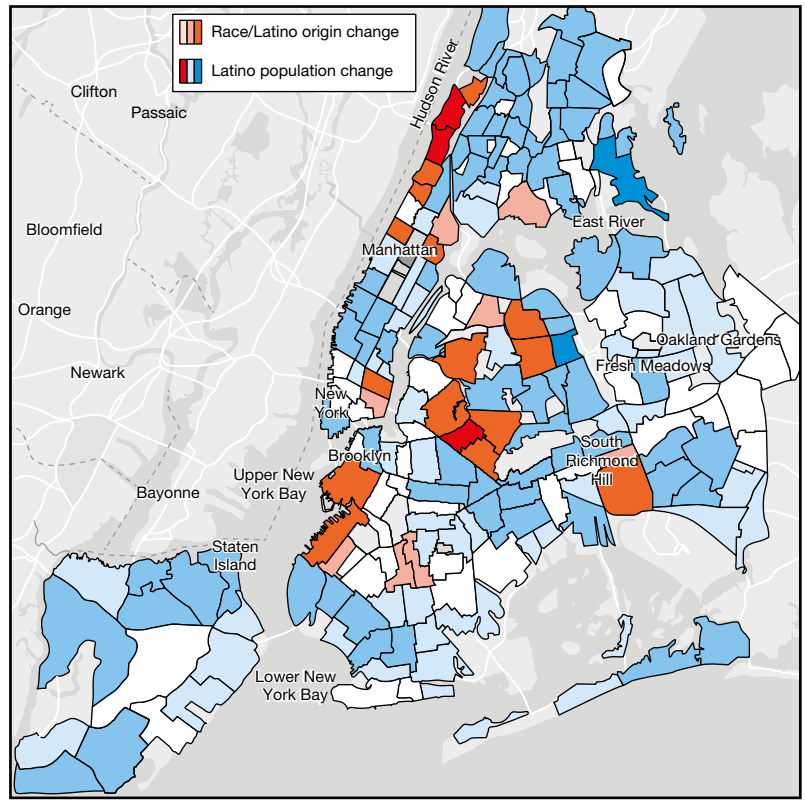




Black population change

> 5000 — 18 186 | > 500 — 1000 | > −1000 — −500 | −11962 — −5000
> 1000 — 5000 | > −500 — 500 | > −5000 — −1000





Latino population change

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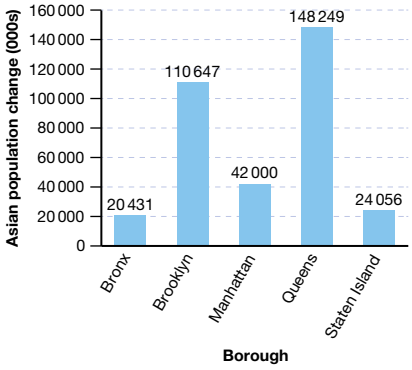
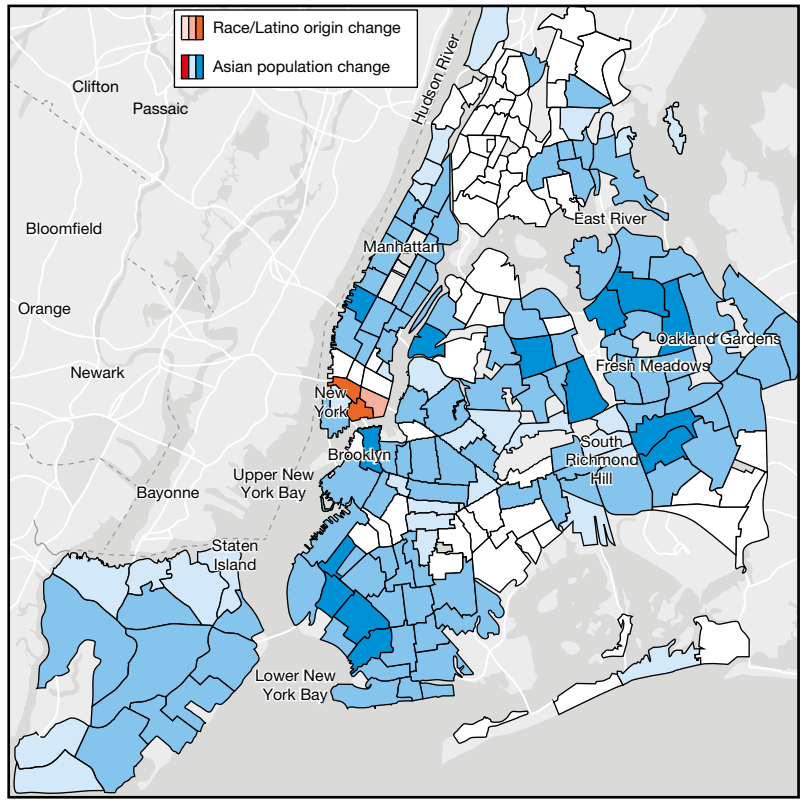
> 1000 — 5000 | > −500 — 500 | > −5000 — −1000





Asian population change

> 5000 — 18 186 | > 500 — 1000 | > −1000 — −500 | −9593 — −5000
> 1000 — 5000 | > −500 — 500 | > −5000 — −1000

9.3.10 Population change by race and New York City borough, 2010–20

Activities

Acquiring and processing geographical information

1 What is the population size and current growth rate of New York City? How does the latter compare to that of the United States as a whole?

2 Explain what fuelled the city's population growth between 1900 and 1930.

3 Name the cause of the stalled population growth in the 1950s.

4 Explain the growth in population beginning in the 1960s and then the decline in the 1970s.

5 Give reasons for the population rebound in the 1980s.

6 Summarise the spatial variations in population growth rates. When a borough's population grew, did all of its neighbourhoods grow? Give at least one example.

7 Give reasons for the shape of the New York City population pyramid.

8 What is the population density of New York City? How does it compare to that of Sydney? What are the advantages and disadvantages of the high population density?

9 List the environmental benefits derived from New York City's high population density. Give reasons as to why this might be the case.

10 Give reasons for New York City's cultural diversity and summarise how it is reflected in the streetscapes and neighbourhoods of the city.

11 Summarise the impact of the *Immigration and Nationality Act of 1965*.

12 Outline the relative growth rates of the four main racial groups.

13 Describe the racial variations across the five boroughs.

14 Summarise the population changes by racial group in the period 2010–20.

Applying and communicating geographical understanding

15 Study Figure 9.3.1. Using data from the graph, describe the pattern of New York City's population growth from 1900 to 2020.

16 Study Figure 9.3.2 and complete the following tasks.
- a Identify the three decades that experienced the fastest rate of growth.
- b Identify three decades that experienced little, if any, growth.

17 Study Figure 9.3.4 and complete the following tasks.
- a State the proportion of the population under the age of 15 years.
- b State the proportion of the population over the age of 65 years.
- c State the proportion of the population in the 25–39 years age group.
- d Speculate on why the 25–29 years age group is so large.

18 Study the box, Spotlight: Hudson Yards. Explain why developments such as this are seen as critical to the liveability of New York City.

19 Study Figure 9.3.7 and complete the following tasks.
- a Using data from the pie charts, describe the racial composition of New York City.
- b Identify the borough with the highest percentage of:
  - i White Americans
  - ii Black Americans
  - iii Latino Americans
  - iv Asian Americans
- c Identify the borough with the smallest percentage of:
  - i White Americans
  - ii Black Americans
  - iii Latino Americans
  - iv Asian Americans

20 Study Figure 9.3.8. Describe the spatial distribution of White, Black, Latino and Asian neighbourhoods.

21 Study the box, Spotlight: Statue of Liberty. Explain the relationship between immigration and the symbolism of the statue.

22 Study Figure 9.3.10. Describe the spatial variation evident in the population growth rates of white, Black, Latino and Asian New Yorkers.

UNIT 9.4

Social and economic patterns

Like all large cities, New York City has developed its own unique social and economic patterns. Those relating to the city's demography are outlined in Unit 9.3. In this unit, we focus on the city's social and economic patterns. The social patterns examined include those of wealth and poverty, socio-economic class and household type.

Key social indicators

A study of the distribution of the demographic and the other social indicators featured in Figure 9.4.1, reveals that of New York City's five boroughs, Manhattan has the highest proportions of non-family and single-occupant households. It also has the highest proportion of the 18–64 age group (69%)—the working-age cohort. The outer boroughs have more families and more children under 18 years of age. Non-family households (e.g. share apartments) represent 57.1 per cent of all Manhattan households, 38.8 per cent of Brooklyn's and 35.4 per cent of those in the Bronx.

In Manhattan, 14.7 per cent of the population is below 18 years of age compared to Brooklyn at 22.7 per cent. Fifty per cent of Manhattan's residents are aged between 20 and 49 years old, while Brooklyn has 44 per cent of residents in this age group. Staten Island's population is smaller and older. It also has a higher median household income compared with New York City as a whole. The borough has approximately 5.8 per cent of the city's total population, with 17 per cent aged 65 years and over.

Overall, these figures highlight the business and work-focused nature of Manhattan, where high incomes and high rents limit the percentage of family households found in the borough. The average rents across the five boroughs reinforce this observation. In mid-2020, the average monthly rent in Manhattan was US$5058 compared to Brooklyn (US$3822), Queens (US$3352), the Bronx (US$1650) and Staten Island (US$1506).

Indicator	Manhattan	Brooklyn	Queens	Bronx	Staten Island	NEW YORK CITY
Population	1 694 251	2 736 074	2 405 464	1 472 654	495 747	8 804 190
Median age	37.7	35.4	39.3	34.5	40.2	36.9
Under 5 years of age	4.4%	6.7%	5.7%	6.7%	5.5%	6.4%
Under 18 years of age	14.7%	22.7%	20.0%	24.5%	21.7%	20.7%
Over 65 years of age	18.3%	15.1%	17.4%	14.0%	17.0%	14.9%
Females (%)	52.4%	52.4%	51.1%	52.6%	51.5%	52.3%
Median household income (in 2020 $US)	$89 812	$63 973	$72 028	$41 895	$85 381	$67 046
Bachelor's degree or higher	62.2%	38.8%	33.5%	20.3%	34.7%	39.1%
Median value of owner-occupied housing (in 2020 $US)	$1 024 500	$734 800	$575 600	$427 900	$546 100	$635 200
Homeownership rate	24.1%	30.3%	45.1%	20.1%	68.8%	32.8%
Persons per household	2.07	2.61	2.81	2.86	2.71	2.57
Persons living in poverty	16.3%	17.8%	10.3%	24.4%	10.6%	17.3%

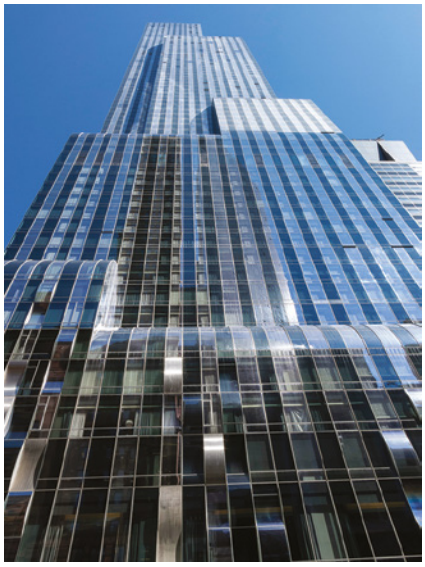
Source: US Census

9.4.1 Key social indicators of New York City's five boroughs, 2020.

As with any city, the generalisations we make tend to obscure anomalies. In Manhattan, for example, there are areas of poverty as well as those of great wealth. The Lower East Side, for example, has traditionally been home to immigrants with generally lower levels of literacy. Such areas also tend to feature poor-quality multi-unit buildings. Many of these buildings were developed in the 1950s as part of the US Government's urban renewal (slum clearance) program (see Figure 9.4.2). Today, this housing (known as 'superblocks') is often associated with lower-income areas of the city such as the Bronx.

9.4.2 Red brick public housing development, built by the New York City Housing Authority in the Lower East Side of Manhattan. There are 12 buildings in this complex, each 17 storeys tall and housing approximately 5739 people in total.

Elsewhere, especially in the Upper East and West Side, and just to the south of Central Park in Midtown, iconic apartment buildings and newly built towers, such as One57 (see Figure 9.4.3), the very rich pay tens of millions of dollars for luxury penthouses. When built, One57 set a record for the city's most and second-most expensive residences, selling respectively for US$100.5 million and US$91.5 million. In 2019, however, a new record was set when a hedge fund billionaire paid US$238 million for a penthouse in Central Park South. Figure 9.4.4 shows some of the ultra-thin 'pencil' towers now transforming Manhattan's skyline.



9.4.3 One57. The 306-metre, 75-storey tower houses 92 condominiums above a Park Hyatt Hotel.

9.4.4 Central Park South, Midtown, viewed from Columbus Circle. There are now seven pencil towers transforming New York City's skyline.

Poverty

While few people in New York City live in **absolute poverty** (where household income is below the level necessary to access basic food and shelter), there is widespread **relative poverty** (where household income is a certain percentage below median incomes) (see Figure 9.4.5). In 2000, around 17.3 per cent of New Yorkers lived in poverty, with a further 45 per cent living in near poverty. While this is partly due to the higher costs of living in New York City compared to other US cities, it also reflects the low wages paid to many service sector workers. In 2023, the minimum wage in New York City was just US$15.00 per hour. In some service sectors, employers can include tips when applying the minimum hourly rate.

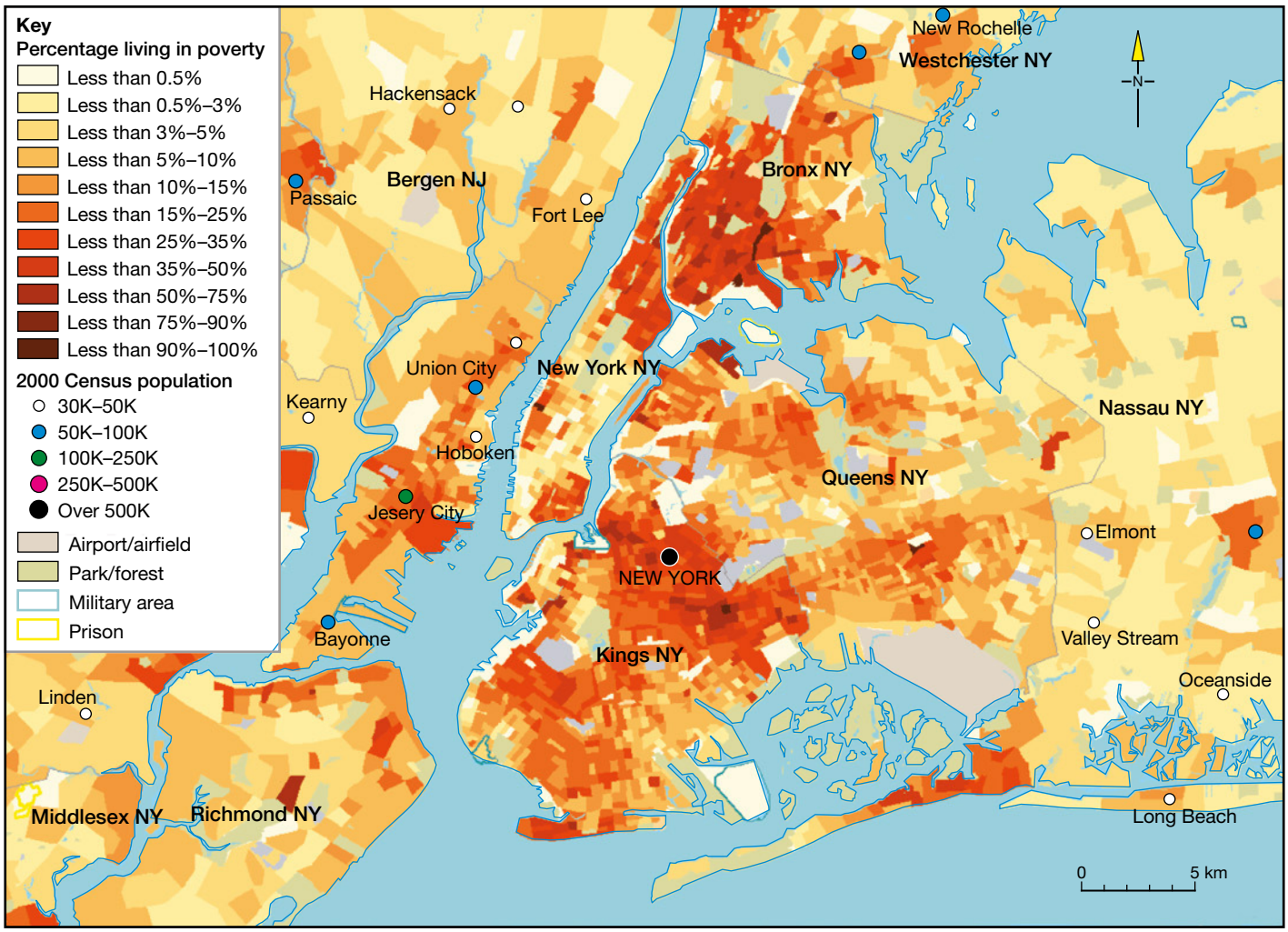
Poverty rates vary spatially, both between and within boroughs. Poverty rates are highest in the Bronx (24.4%) and lowest in Staten Island (10.6%) and Queens (10.3%). Perhaps surprisingly, the poverty rate in Manhattan is 16.3 per cent. This finding illustrates the difficulties in relying on averages. The figure reflects the impacts of the poorer neighbourhoods of Manhattan, such as the Lower East Side and those of Upper Manhattan. Contrast this with the Manhattan neighbourhoods that are among the wealthiest in the United States.

9.4.5 Homelessness is a product of the poverty experienced by some New Yorkers.

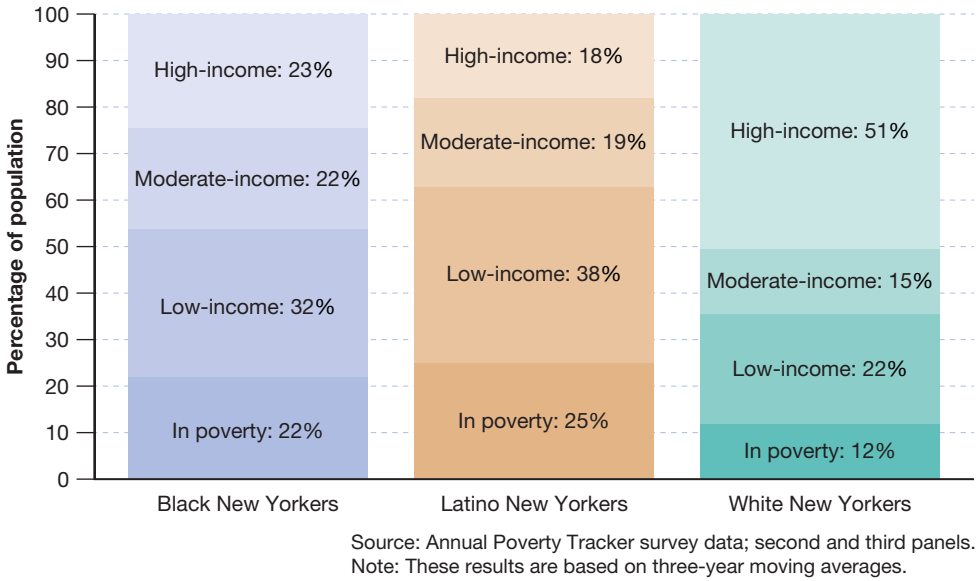
Figure 9.4.6 shows the percentage of the population living in poverty in the census tracts (data collection areas) in different parts of New York City's metropolitan area. This map highlights the spatial variations in poverty rates within boroughs.

Comparing the data mapped in Figure 9.4.6 with the distribution of racial groups in New York City (see Figure 9.3.8, page 245) enables us to draw some general conclusions about variations in the poverty rate among different racial groups. In doing so, we note that white citizens earn more than the other races in all the regions, except between whites and Asians, since Asian Americans have a similar income to white Americans. Regarding the segregation between white and Black citizens, it's evident that Black citizens earn less than white citizens in all the regions. Furthermore, the inequality between white and Black citizens is more significant in areas with a high-density population of both races.

The 2020 *State of Poverty and Disadvantage in New York City* report, compiled by the Columbia Population Research Centre, reports that Black and Latino New Yorkers are twice as likely to live in poverty as white New Yorkers. The report estimates that 22 per cent of Black New Yorkers, 25 per cent of Latinos and 12 per cent of whites lived in poverty. When those in poverty and those classified as low income are combined, 63 per cent of Latino Americans are classified as either living in poverty or low income compared to 54 per cent for Black Americans and 34 per cent for white Americans. It also notes that more than half of whites are higher income, compared to 23 per cent of Black New Yorkers and 18 per cent of Latinos (see Figure 9.4.7).



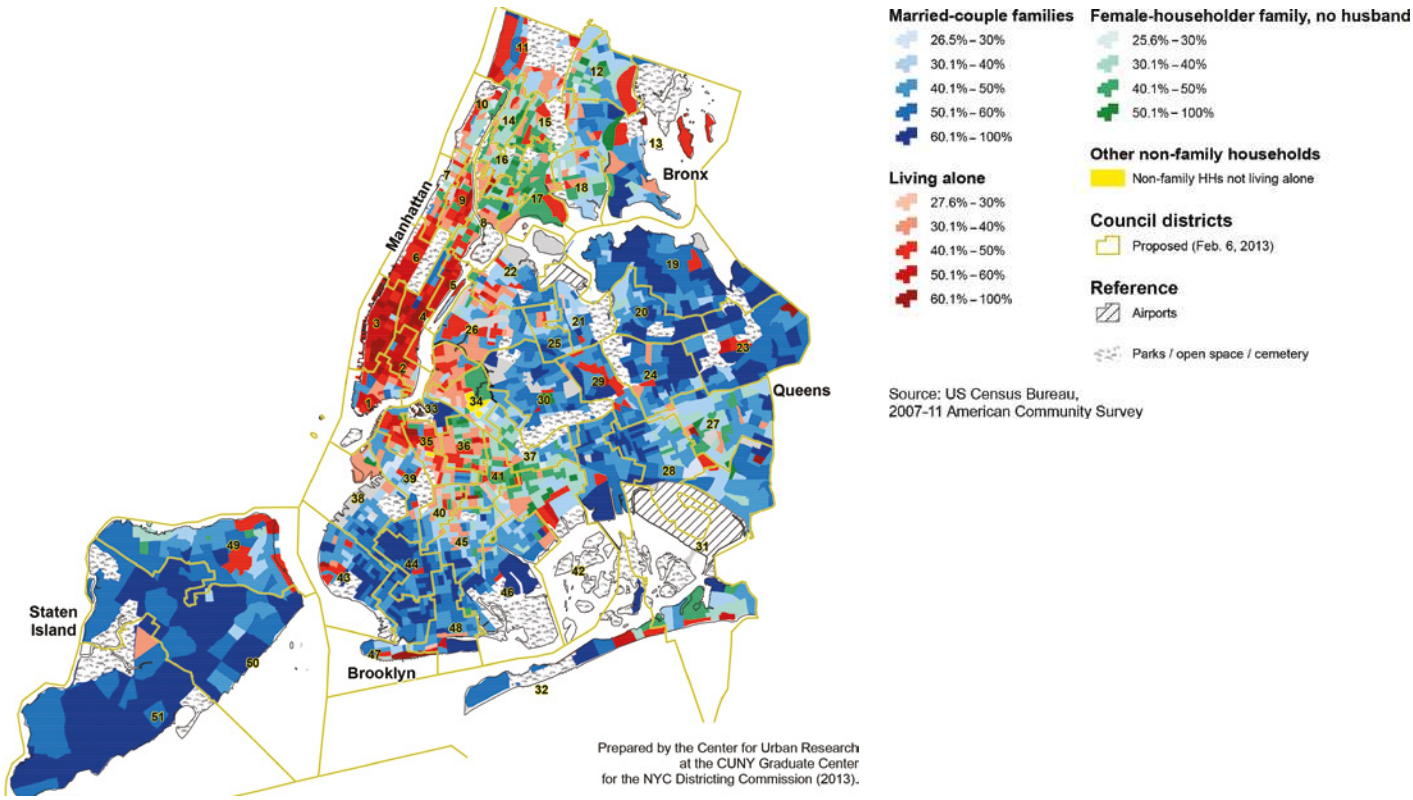
9.4.6 Percentage of New Yorkers living in poverty, by Census tract and by county, 2020



Source: Annual Poverty Tracker survey data; second and third panels.
Note: These results are based on three-year moving averages.

9.4.7 Distribution of income relative to the poverty line in New York City by selected race and ethnicity, 2019 (before the COVID-19 pandemic)

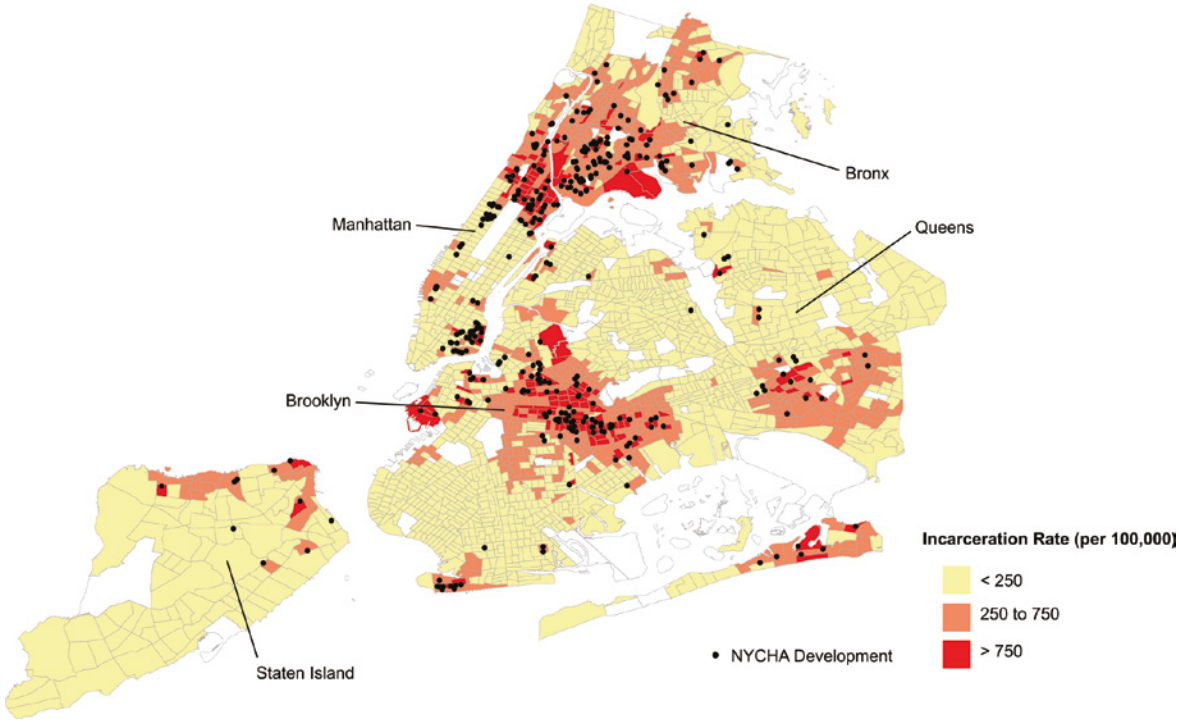
Figure 9.4.8 provides several interesting insights into the social patterns evident in New York City. The maps show that married couple households are typically found in suburban Staten Island, southern Brooklyn and eastern Queens. Those living alone are most often found in Manhattan and those areas of Brooklyn closest to Manhattan. Of particular interest is the relationship between female-household family, no husband and the neighbourhoods with the highest poverty rates, as shown in Figure 9.4.6. This highlights the feminisation of poverty. Women, compared to men, have a higher incidence of poverty. Often this is a consequence of relationship breakdown and women disproportionately bearing the costs of childrearing. We can also conclude that there is a relationship between living alone households and higher incomes earnt by those in the creative and information sectors of economic activity.



9.4.8 Predominant household type by Census tract

Incarceration rates

Figure 9.4.9 illustrates the relationship between poverty and those held in prison (incarcerated). The Lower East Side, northern Manhattan, the Bronx, northern Brooklyn and the poorer parts of Queens have relatively high incarceration rates. Geographers have noted a relationship between incarceration rates and the location of public housing developments. The rate of incarceration in these neighbourhoods is far above those in neighbourhoods without public housing, even though in many instances crime rates may be similar. Geographers attribute the 'public-housing-to-prison-pipeline' to the excessive surveillance and policing of the socio-economically disadvantaged and predominantly Black and Latino American residents of New York City Housing Authority (NYCHA) developments.



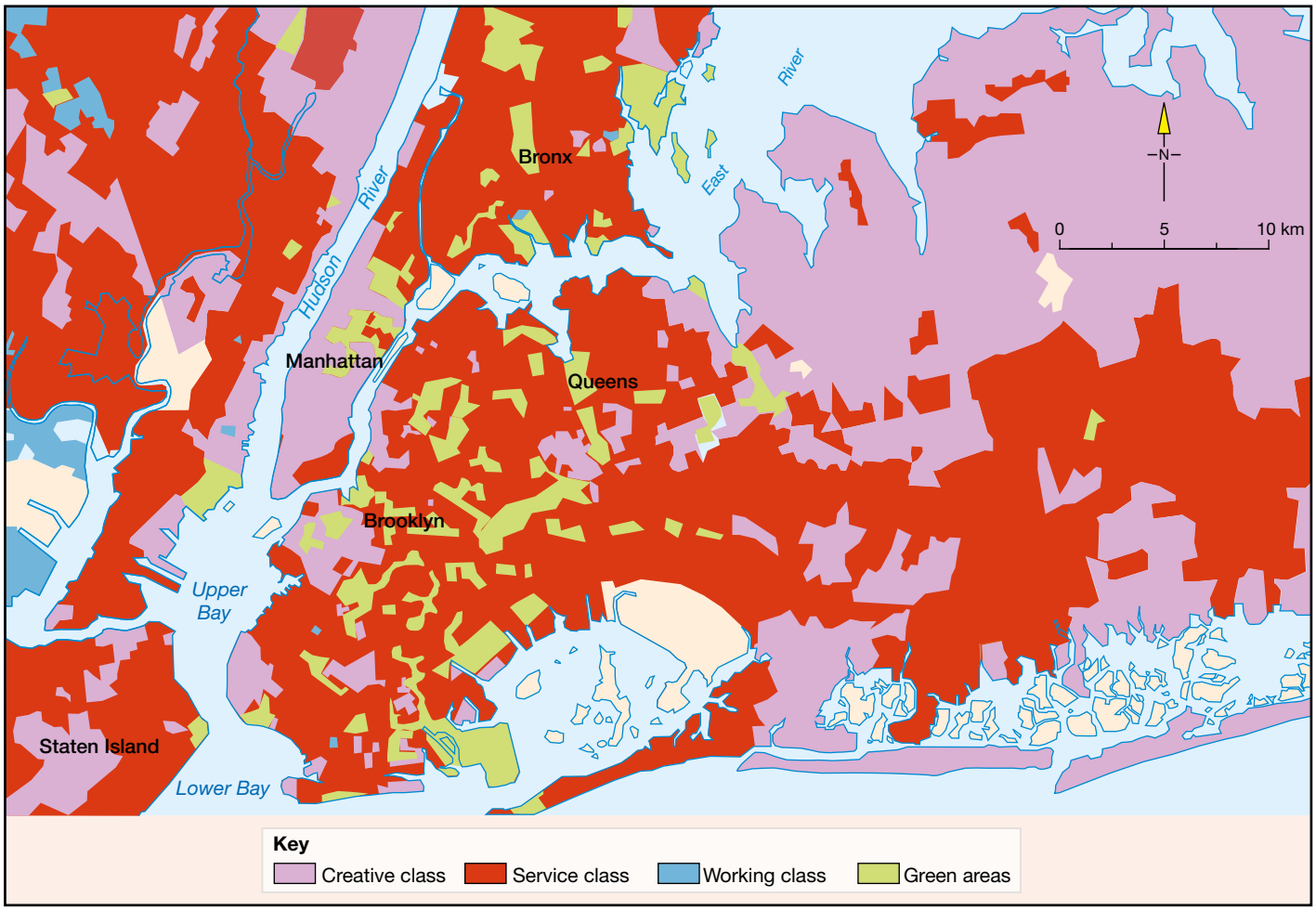
9.4.9 Incarceration rates per census tract, New York City, 2022. The black dots represent public housing (or NYCHA developments).

Social class

Another way of looking at the spatial pattern of inequality is through the lens of class. Social class is an enduring feature of US life and is reflected in almost every element of its culture. US cities, for example, are becoming increasingly divided along class lines. This results in people having quite different lived experiences within the same city.

Across the United States, residential segregation is on the rise. The polarisation between rich and poor neighbourhoods is increasing. The share of middle-income neighbourhoods is declining. In a study conducted by the Pew Research Centre, a Washington DC-based think tank, geographers analysed this trend as it affects New York by plotting and mapping the residential locations of three specific classes: the shrinking middle class of blue-collar workers in manufacturing, transportation and maintenance; the rising numbers of highly paid knowledge, professional and creative workers in the creative class; and the even larger and faster-growing ranks of lower-paid, lower-skill service workers. The changes occurring are a result of economic change, including the emergence of the new (information-based) economy, the growth of the service sector and the impacts of new technologies on the nature of work.

New York City is one of the most economically polarised cities in the United States. Figure 9.4.10 shows the spatial pattern of the type of work that residents do. That is, their socio-economic class. In other words, it shows the geography of class for the whole New York metropolitan area. The creative class lives in the areas that are shaded purple, the red areas are primarily service class, and the blue areas are working class.



9.4.10 Map showing the distribution of socio-economic classes in the New York metropolitan area

The creative class, which includes workers in science and technology, business and management, arts, culture, media and entertainment, law and the healthcare professions, make up 35.8 per cent of the metropolitan area's workforce. For the most part, these are highly-skilled, highly-educated people in high-paying positions. The average income from wages or salaries for this class was US$87 625 at the time of the 2020 census.

In the case of New York City, the creative class is highly concentrated in Manhattan, from the southern tip of the Financial District through TriBeCa, SoHo, Greenwich Village, Chelsea, Midtown, and the Upper East and West sides. Further afield, there are also concentrations of creative class employees in outer metropolitan areas—the commuter zone.

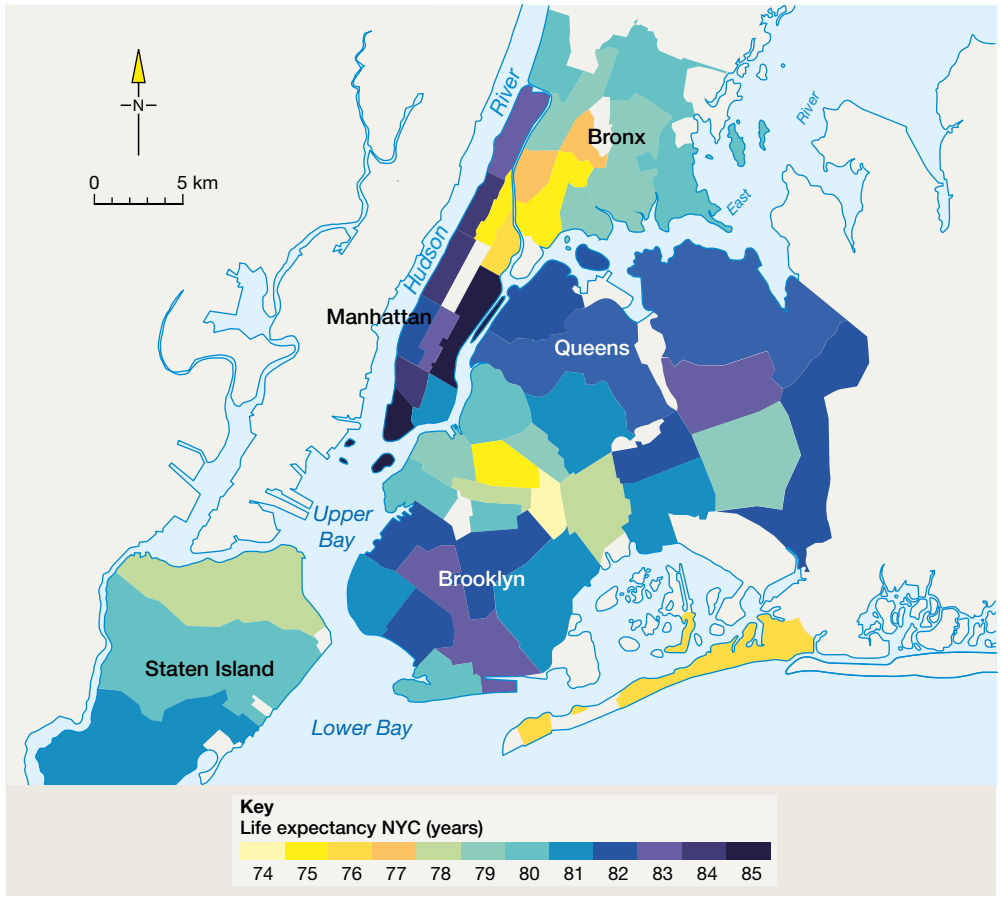
The service class, which includes the low-wage, low-skill workers who hold routine service jobs in food service and preparation, personal services, retail sales, clerical and administrative positions, represent the largest group of workers. They make up 48.1 per cent of the metropolitan area's workforce and include some of the fastest-growing areas of employment. The average wage/salary for this group in 2020 was US$34 241, just 39 per cent of the amount earnt by those in the creative class. The service class has, over time, been pushed further outward, with a small concentration found on the Lower East Side, and then north in Harlem, Morningside Heights, Washington Heights and Inwood. Most, however, live in the Bronx, Brooklyn and Queens, with others living in the counties of the larger metropolitan area.

Both the creative class (purple areas) and service class (red areas) cover a much larger area than the working-class areas (blue areas). The creative class is located closer to the city centre, while lower-paid service-class neighbourhoods are found in Brooklyn, the Bronx and Queens, and the greater metropolitan area of Long Island, as well as coastal and northwest New Jersey.

Significantly, the working class have all but disappeared from the geography of New York City. The working class includes those who work in factory jobs or transportation and construction. These now comprise just 16 per cent of the region's workers. On average they earnt US$43 723 in wages and salaries in 2020, which is higher than the average of service workers.

Life expectancy

Life expectancy in New York City varies across the city's neighbourhoods (see Figure 9.4.11). In TriBeCa, Murray Hill and the Upper East Side, the average resident lives until 85—on par with places in the world with the highest life expectancy, such as Japan. In Brownsville, Brooklyn, life expectancy is 74, closer to that of many developing countries, such as Brazil. Brownsville has the largest concentration of public housing of any neighbourhood in the city. Residents there die from most major diseases at much higher rates than the city average. There is clearly a correlation between socio-economic status and life expectancy. The wealthy live longer than the poor. This was most recently apparent during the COVID-19 pandemic. The poorest neighbourhoods had the highest death rates from the virus.

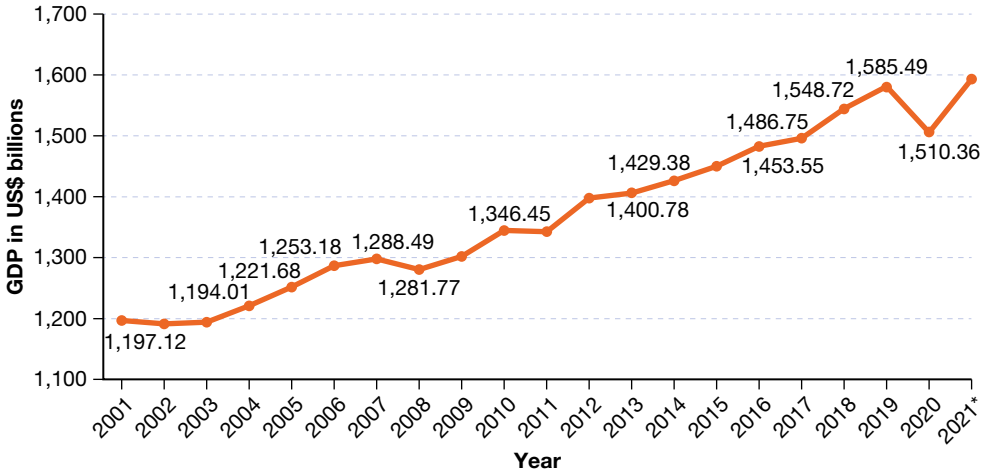


9.4.11 Life expectancy in New York City is closely related to socio-economic status.

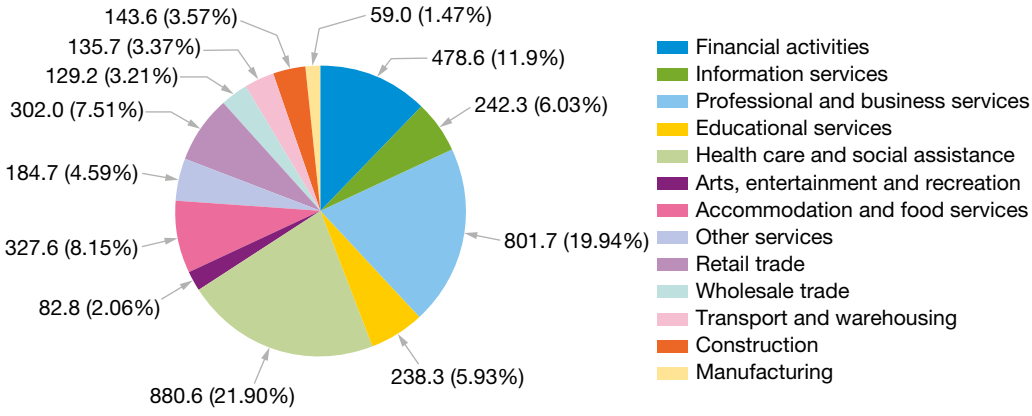
Economic patterns

Today, finance, health care and the life sciences, sophisticated technologies and biotechnology, real estate and insurance form the basis of New York City's economy. The city is also a national and global centre for the mass media, journalism and publishing, and a leading centre for the performing arts and the creative industries, including digital media, advertising, fashion, design and architecture (see Figures 9.4.12 and 9.4.14). Figure 9.4.13 shows the trend in GDP of the New York metropolitan area from 2002 to 2021. After a downturn caused by the COVID-19 pandemic, the city's GDP reached US$1.6 trillion in 2021.

9.4.12 New York City is a global centre of business and commerce, and a national centre for banking and finance, retailing, trade, transportation, tourism, real estate, new media, traditional media, advertising, legal services, accounting, insurance, theatre, fashion and the arts.



9.4.13 GDP of New York metropolitan area 2001–21



Source: New York City

9.4.14 New York City private employment by sector, December 2022

Financial sector

New York City is the world's financial capital. It is home to many of the world's biggest banks, credit rating agencies, insurance companies, hedge funds and many more. The city's securities industry (generically known as Wall Street) accounts for more than 180 000 jobs and is the largest player in the financial sector. Employees in the securities industry earn an average salary (including bonuses) of more than US$400 000. One in 10 New Your City workers are employed in financial sector.

Health care

Research and the provision of medical services are the elements of New York City's healthcare industry. In 2022, the sector employed 861 000 people across 70 hospitals and numerous medical research centres.

Information technology sector

New York City's high-tech information technology industries include those based on the internet and telecommunications. It includes digital media, software development, biotechnology and game design. Initially, the sector was focused on Silicon Alley—a concentration of high-tech companies centred around southern Manhattan's Flatiron district. It has subsequently spread throughout the metropolitan area. The biotechnology sector has grown quickly, based on the city's strength in academic scientific research and backed by funding from private and commercial sources. Biotechnology utilises biological systems and living organisms to develop or create different products and services such as biofuels, genetically modified crops, skincare products and detergent enzymes.

9.4.15 Tourism is one of New York City's biggest industries.

Tourism

Just prior to the COVID-19 pandemic, New York City hosted around 66.6 million tourists annually, 13.5 million of whom were international tourists (see Figure 9.4.15). Post-pandemic, tourist numbers recovered slowly. By 2021, total visitor numbers reached 32.9 million, with only 2.7 million international visitors. In 2022, international visitor numbers reached 56.7 million, 9.4 million of whom were international arrivals.

The pandemic hit the tourism sector hard. Employment in the sector declined by 89 000 jobs (31.4%) to 194 200 in 2020—down from a record 283 200 jobs in 2019. Tourism indirectly supported 376 800 jobs in 2019. Overall, tourism accounts for 7.2 per cent of total private sector employment. The industry supports a higher share of workers who are self-employed (14.4%), and its wages are relatively low at US$32 000 annually. It is also dominated by minorities (66%), and immigrants (44.7%). Hotels employ over 50 000 workers and full-service restaurants employ over 33 000.

In 2019, tourists contributed US$47.9 billion to the city's economy—US$13.5 billion on accommodation, US$10.5 billion on food and beverages, US$9.3 billion retail, US$5.6 billion on arts, culture and entertainment and US$8.5 billion on local transport.

The highest concentration of hotels is found in Midtown, Manhattan. The city's principal tourist attractions are also found in Manhattan.

Did you know?

Tourism is a vital cog in New York City's economy. The industry supports more than 280 000 jobs in hotels, restaurants, museums and theatres.

Did you know?

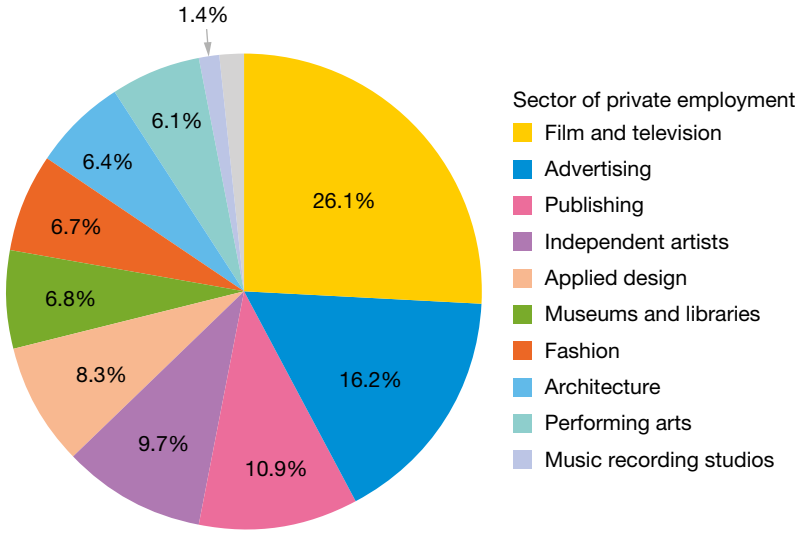
Tourism contributes US$48 billion to the city's economy. International travellers have the biggest impact because on average they spend more than three times as much as the typical domestic tourist does.

Creative sector

The key components of the creative sector and their share of the sector's employment is shown in Figure 9.4.16. The largest is film and television, followed by advertising and publishing. In total, the sector employs more than 300 000 people. An astonishing 12 per cent of all creative industry jobs in the United States are located within the five boroughs of New York City. In total, the sector accounts for 13 per cent of the city's total economic output. That's more than US$110 billion (nearly one in every eight dollars generated). The creative industries are largely located in Manhattan.

Manufacturing

Manufacturers in New York City employ approximately 1.5 per cent of the city's workforce and generate more than US$75 billion in economic activity. Garments, chemicals, metal products, processed foods and furniture are some of the goods still manufactured in New York City. Of these, the food-processing industry is the most stable. This US$5 billion industry employs nearly 20 000 workers, many of them immigrants who speak little English. The nature of economic change and its impact on manufacturing is explored in greater detail in Unit 9.5.



9.4.16 New York City creative sector employment by industry, pre-pandemic

Activities

Acquiring and processing geographical information

1 Compare the demographic and social data for Manhattan with the other New York City boroughs. What does this reveal about the character and economy of Manhattan?

2 Compare Manhattan's social indicators with those of the Bronx. What does this data reveal about inequalities in New York City?

3 Give an example of how social indicators can obscure anomalies with boroughs.

4 Define absolute and relative poverty. What percentage of New Yorkers live in poverty and near poverty? What accounts for this level of poverty?

5 Summarise the spatial variation found in the rate of poverty experienced across New York City's five boroughs.

6 Using data, describe the relationship between race and poverty in New York City.

7 Describe the spatial distribution of the following household types: married-couple households, living alone households and female-family household, no husband. Explain what is meant by the term feminisation of poverty.

8 Explain the concept of social class as defined by the Pew Research Centre. What changes have contributed to the growth of the creative class and the shrinking of the working class? Who makes up the creative class?

9 Describe the spatial distribution of the service, creative and working classes?

10 Describe and account for the relationship between poverty and life expectancy, and poverty and incarceration rates in New York City.

11 Identify the sectors of economic activity that form the basis of New York City's economy.

12 Outline the importance of tourism to New York City's economy.

13 Identify the main manufacturing industries remaining in New York City.

Applying and communicating geographical understanding

14 Study Figure 9.4.1. Briefly describe and account for the demographic characteristics of each of New York City's five boroughs. How does each compare with the city as a whole?

15 Study Figure 9.4.6. With the aid of Figure 9.1.4 (page 224), describe the spatial pattern of poverty shown on the map.

16 Study Figure 9.4.7. Using data from the graph, describe the race-based variations in income relative to the poverty line in New York City.

17 Study Figure 9.4.8. Identify and describe the spatial distribution of:

- **a** married-couple families
- **b** female-household family, no husband (single mothers)
- **c** living alone (single-person households).

18 Study Figures 9.4.6 and 9.4.9. Describe, and suggest reasons for, the relationship between poverty and incarceration.

19 Study Figure 9.4.10. Describe the spatial distribution of the creative class, service class and working class.

20 Study Figures 9.4.6 and 9.4.11. Describe, and suggest reasons for, the relationship between poverty and life expectancy.

22 Study Figure 9.4.13. Using data from the pie chart, describe the trend in New York City's GDP between 2001 and 2021.

23 Study Figure 9.4.14. Using data from the pie chart, describe the employment structure of New York City. What does this data tell us about the city's economy?

24 Study Figure 9.4.16. Identify the three biggest components of creative employment which together account for more than 50 per cent of employment in the sector.

UNIT 9.5

Economic restructuring and its impact on New York City

Economic restructuring—a significant and enduring change in the nature and structure of an economy—has had a lasting impact on the morphology of Western cities. New York City is no exception. The process of economic restructuring, which had its origins in the 1970s, is most apparent in the change that has occurred to the employment structure of urban areas. Typically, this has involved a shift away from manufacturing to service-based economic activities. Over time it has had a profound implications for the productive capacities and competitiveness of cities and regions, the demographics of cities, income distributions and social hierarchies. The process of economic restructuring continues to this day, driven to a large extent by advances in communications and information technologies.

Economic shocks

Major economic nodes such as New York City are subject to economic shocks, both those that occur suddenly and those that take place gradually over time. The 2008 Global Financial Crisis (GFC), for example, caused rapid and significant unemployment in the financial and service sectors within New York City. The COVID-19 pandemic also had an economy-wide impact. Unemployment increased from 4.1 per cent in 2019 to 12.5 per cent in 2020. Hardest hit were those without college degrees (16.5%). The rate for those with degrees was just half that rate (8.4%). Unemployment in the 16–24 age group reached 20.4 per cent compared to 12.9 per cent in the 25–54 years age group.

At the start of the pandemic, from February to April 2020, employment in New York City fell by 21 per cent (971 800 jobs). As New York City was the nation's initial epicentre of the COVID-19 pandemic, it experienced more significant employment disruption compared to other places in the United States. Three hundred thousand jobs were lost in the leisure and hospitality sector, as hotels, restaurants and bars were forced to close and tourist arrivals collapsed. Retail trade lost 115 000 positions as shops closed.

The post-COVID recovery saw employment rebound by 199 200 (to 4 million) in the year to December 2022. The areas of increased employment provide an insight into the nature of the city's economy. Gains occurred in educational and health services (+63 300), leisure and hospitality (+47 900), professional and business services (+42 800), other services (+13 100), financial activities (+10 800), information (+9300), trade, transportation and utilities (+5300), natural resources, mining and construction (+4200), and manufacturing (+2500).

Long-term economic restructuring

Economic restructuring, however, has a longer-term impact on employment and the morphology of cities. From 2000 to 2020, New York City's metropolitan area lost 310 000 manufacturing jobs. The hardest hit industries were garment manufacturing, textile mills, chemical manufacturing, paper manufacturing, transport equipment manufacturing, machinery manufacturing, computer and electronic product manufacturing, and printing and related support services. Despite the impacts of economic restructuring, New York City remains a major manufacturing centre. There are still more than 155 550 manufacturing jobs and more than 2888 manufacturing-based plants in the city. Most of these are small businesses, on average employing just 21 people. While Manhattan remains the leading manufacturing borough, Brooklyn ranks second, with 1356 manufacturers employing 33 630 workers.

Changes in the spatial pattern of land use

The decline in labour-intensive manufacturing and the rise of knowledge and service-based industries (the defining feature of economic restructuring), resulted

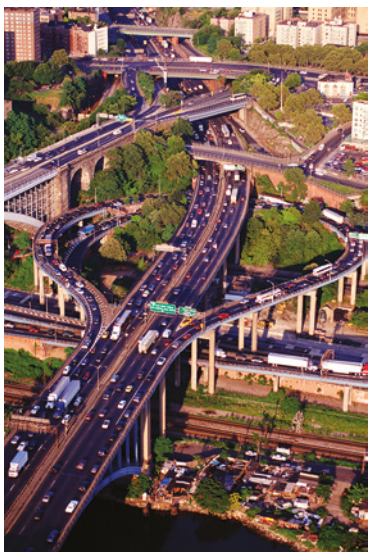
in the wholesale abandonment of industrial land and related infrastructure. Some 3000 commercial and industrial complexes now stand vacant, and thousands of sites need decontamination. To date, the US Environmental Protection Agency has spent almost US$2 billion decontaminating former industrial sites. The costs involved in site remediation highlight the high economic costs incurred by the process of economic restructuring. It does, however, provide an opportunity to address some of the city's greatest challenges, including the provision of new housing and the need to accommodate emerging industries. Many of the brownfield sites resulting from the closure of industrial plants are used for mixed-use urban renewal projects. These typically include new housing projects, commercial space and new community facilities (see Figure 9.5.1).

9.5.1 The abandoned and partially demolished Domino Sugar factory in 2014 (left). A computer -generated visualisation of the urban renewal project planned for the site (right). The historic core of the factory is retained in the 10-year project that will yield 2300 apartments, over 46 000 square metres of commercial space and a new school.

Globalisation has not been the only driver of economic restructuring. The emergence of new types of capital-intensive industrial activity have generated a demand for greenfield industrial sites away from the congested sites of the five New York City boroughs. New industrial estates were built away from the city centre, often at accessible points on the metropolitan area's freeway network. Greenfield sites in the outer metropolitan area proved popular with emerging industries. In addition to accessibility, sites were larger and the land cheaper.

Changes in the spatial pattern of socio-economic class

As also observed in Australia's large cities, the decline of the older, inner-city industrial areas was accompanied by urban decay—abandoned and/or neglected infrastructure, decaying housing stock and a loss of **amenity**. Reinforcing the tendency of industry to relocate, was the development of New York City's freeway system. In many instances, this involved large-scale demolition of existing urban structures, including homes. This had the effect of fragmenting communities, promoting the process of **suburbanisation** and the development of urban sprawl (see Figure 9.5.2).



9.5.2 The Cross Bronx Expressway, from where it feeds into West River Drive and the George Washington Bridge

The process of suburbanisation would, in turn, play an important role in the relocation of activity to the periphery of the metropolitan area. Suburbanisation was driven by both push and pull factors. Rising levels of crime, and the general decay and loss of amenity of established neighbourhoods acted as push factors. The perceived attractions of low-density suburban living, combined with the availability of federal government-backed mortgages, proved to be effective pull factors, especially for white middle-class families. In a process often referred to as 'white flight', the middle classes abandoned their crowded inner-city homes and moved to the spacious family-orientated suburbs. Immigrants, taking advantage of the now underutilised (and cheap) housing in industrial neighbourhoods, took their place. Many found it difficult to find work as factories closed. As a result, such neighbourhoods became home to significant numbers of unemployed, unskilled or semi-skilled migrants.

9.5.3 New Jersey container terminal

Unlike Australia, where state governments fund essential services such as schools, primary health care and emergency services, in the United States these are typically funded by local government authorities. As the profile of those living in the old industrial areas changed, so too the revenue base declined. As it did, the quality of the services declined, as did the quality of the neighbourhood's infrastructure. A cycle of economic and social decline was the inevitable result.

The impact of changes in shipping

Like all the world's great port cities, the introduction of containerisation, and the technological advances in shipping and cargo handling, led to the large-scale obsolescence of the city's existing port facilities and associated transport infrastructure. Containerisation required a large area of harbourside land, something in short supply in New York City. A vast new container terminal complex was built in New Jersey, taking much of New York City's imports and exports (Figure 9.5.3).

The impacts of economic restructuring

Economic restructuring has had a range of economic, social and environmental impacts on New York City.

Economic impacts

The economic impacts of economic restructuring were profound. Hundreds of thousands of jobs were lost and whole neighbourhoods fell on hard times. The city's debt climbed as its revenues fell. The services provided to communities were cut and there was declining investment in new housing and urban infrastructure. Urban blight and the loss of amenity, especially in the former industrial areas of Brooklyn and the Bronx, was widespread.

Social impacts

Adverse social impacts accompanied the economic decline being experienced, especially in the older industrial neighbourhoods. Vandalism further eroded the amenity of such areas, and crime and social unrest increased. Abandoned industrial sites are still a feature of many such neighbourhoods.

The transition away from manufacturing to tertiary sector activities (finance, businesses services and the creative industries) and the expansion of the service sector that supports them (leisure and hospitality, retail trade, social assistance and construction) have been accompanied by a polarisation of incomes, as high-income professionals are often paid far more than service workers. The middle class has shrunk, as the jobs they once relied on have disappeared. The shift from a city of production to one of consumption has fuelled an increase in the number of low-paying service jobs, which continue to attract immigrants, both legal and illegal, as well as investment.

9.5.4 Gentrification has transformed many inner New York City neighbourhoods.

The economic transition has also resulted in the increased attractiveness of inner-city living, reversing the suburbanisation trend of earlier decades. Spurred on by the shortage of rental accommodation, young, well-paid professionals, keen to live close to work in the Financial District or Midtown, have driven the process of gentrification evident in many established Manhattan neighbourhoods (see Figure 9.5.4). They have moved in and spruced up neighbourhoods such as Chelsea, SoHo and the Upper West Side. Increasingly,

this process has extended to accessible areas of Brooklyn and Queens. Where factories, warehouses and abandoned apartment buildings once stood, fashionable boutiques, restaurants, and media, entertainment and tourism functions have now replaced them. The redevelopment and gentrification of such neighbourhoods have increased real estate prices and changed the socio-economic character and amenity of many neighbourhoods, often at the expense of low-income residents, who are displaced.

Environmental impacts

Economic restructuring also has environmental impacts. These include contaminated industrial sites, polluting both soil and water. Contaminants include heavy metals, organic solvents and other pollutants left over from previous industrial land uses. Public exposure to environmental toxins can have a range of health impacts. They can also impact on natural ecosystems and wildlife. Remediating contaminated soil is expensive and often involves removing or incinerating soil at very high temperatures before the site can be reused.

SPOTLIGHT

Newtown Creek's industrial contamination

Newtown Creek, which divides Queens and Brooklyn, is one of the most polluted waterways in the United States (see Figure 9.5.5). Scientists working for ExxonMobil began sampling gases leaking from the soil around its old oil refinery in Greenpoint, Brooklyn, in the early 2000s. It was found that Exxon had let more than 64 million litres of petroleum products leak into the surrounding soil and Newtown Creek. They also found evidence of highly toxic and volatile organic compounds from three unrelated industries—dry cleaners, metalwork foundries and a lacquer factory.

An initial clean-up of the creek is expected to be completed by 2028. Full remediation of the creek is not expected to begin until 2032 at the earliest—22 years after it was first declared unsafe because of the detected high levels of copper, lead, dioxins, pesticides, carcinogenic chemicals, petroleum by-products and other contaminants.

9.5.5 Newtown Creek, Brooklyn

Activities

Acquiring and processing geographical information

1 Define economic restructuring. When did it commence and what was its defining feature? What were its implications? Who was most affected?

2 Summarise the economic impacts of the COVID-19 pandemic.

3 Summarise the impacts of economic restructuring on New York City.

4 Summarise the impacts of the emergence of new types of capital-intensive industrial activity on the morphology of New York City.

5 Describe the consequences of suburbanisation on the morphology of New York City.

6 Explain why the process of urban decay was more pronounced in New York City compared to what occurred in Australia.

7 Summarise the impact of containerisation on the morphology of New York City.

8 Describe the social, economic and environmental impacts of economic restructuring.

Applying and communicating geographical understanding

9 Draw a diagram or create a flow chart that links the causes and impacts of the economic restructuring challenges in New York City.

10 Write an explanation outlining two planning strategies used to address the economic restructuring challenges in New York City.

11 Conduct a class discussion on the topic, 'To what extent do the impacts of economic restructuring in New York City mirror those in Australia's large cities?'

12 Using the internet, investigate a New York City-based brownfield site and its redevelopment potential. Outline the extent of the remediation required and the nature of any planned development.

UNIT 9.6

New York City's political, economic and cultural roles

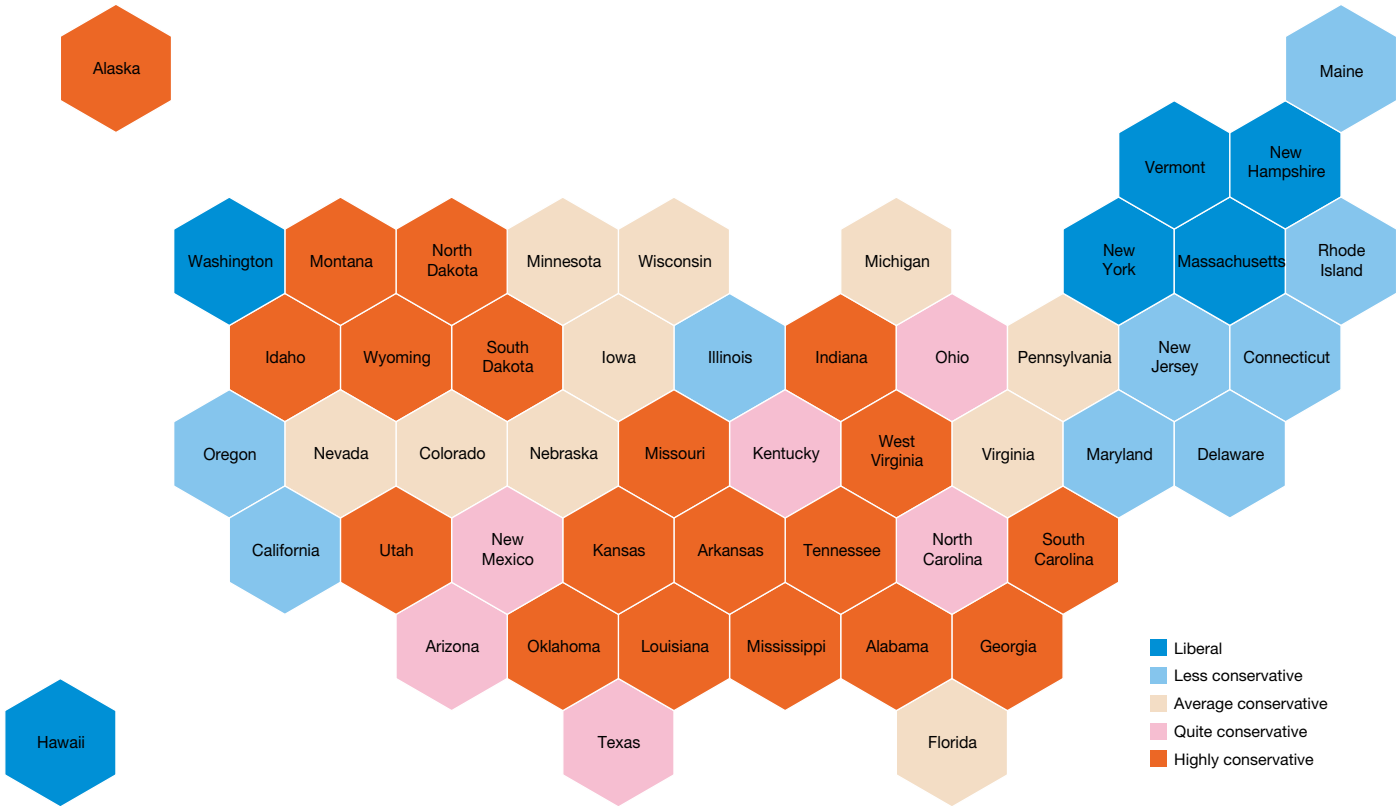
Throughout much of the twentieth century, and the opening decades of the twenty-first century, New York City has exercised remarkable influence over the economy, politics and culture of the United States, and indeed the world.

Political role

The political role of New York City can be examined at both the national and global scales. At the national scale, New York City's liberal tradition has influenced social norms across the country. Changing social attitudes and trends originating in New York City, together with liberal states of the West Coast and northeast (see Figures 9.6.1 and 9.6.2), have an impact on attitudes across the country and ultimately the world. The New York City-based media and entertainment corporations (together with those of California) amplify these changes until they are accepted as the new norm. Invariably, some of these trends, including those relating to abortion, same-sex marriage, the death penalty and cannabis use, spark a political and social backlash from conservatives, the spatial outcome of which is an increasingly polarised US society—often referred to as red (conservative/Republican) states versus blue (liberal/Democrat) states.

Conservatives rail against progressive (**woke**) agendas and issues, especially those that are important to marginalised communities—social injustice, racial discrimination, gender and sexual orientation, affirmative action and misogyny. Today, elements of the conservative right in some Western countries employ the word woke to describe any progressive movement or ideology they disagree with. Likewise, radio shock jocks and right-wing media personalities (such as those on Fox News in the United States and Sky News 'after dark' in Australia) use the term to disparage those pursuing any issue they object to. The dominance of Democrats in New York City politics, at all levels, is an outcome of the generally progressive worldview of the city's population.

9.6.1 Thousands attending the World Pride March for LGBTQ+ rights, New York City, 2019



9.6.2 The political-social positioning of US states, 2023

On an international scale, New York City's influence grew rapidly in the decades following World War II, when US power was at its peak. The elites and institutions based in New York City exercised enormous political, economic and cultural influence. Wall Street lawyers, bankers and intellectuals played key roles in shaping the policies of containment, collective security and liberal internationalism that the United States pursued in the international arena.

New York City-based institutions continue to play an important role in world affairs. In all, there are 2161 international and foreign affairs organisations based in the Greater New York City metropolitan area. They include organisations and institutes dealing with development and relief, humanitarian issues, world peace and international security, human rights, international refugees and migration, foreign affairs, research and public policy. The most significant of these is the United Nations. The UN General Assembly and Security Council meet in the UN Headquarters on the banks of the East River in Midtown Manhattan. The UN General Assembly is the main policy-making organ of the organisation. Comprising all member states, it provides a unique forum for multilateral discussion of the full spectrum of international issues covered by the UN Charter. The General Assembly meets in regular sessions from September to December, and resumes in January until all issues on the agenda are addressed. The UN Security Council is made up of 15 members, of which five sovereign states are permanent: China, France, Russia, the UK and the United States. These were the victorious powers of World War II. Permanent members can veto (block) any substantive Security Council resolution, including the admission of new member states to the UN. The UN enjoys a special legal status in New York City. It is, for example, exempt from the jurisdiction of a range of local laws, mostly as the result of diplomatic negotiations.

Economic role

New York's power base of corporations, banks, insurance firms and its New York Stock Exchange (NYSE) have been key players in shaping how the global capitalist economy operates. Movements on the NYSE invariably influence stock exchanges around the world,

including those in Australia. Decisions made by executives of New York City-based TNCs can impact the economies and politics of countries worldwide. Often, the governments of countries hosting TNCs are only informed of decisions after they are made.

New York City's dominant position in finance appears relatively secure and is perhaps reinforced by the rise of new communications technologies and the internationalisation of capital markets. The city continues to shape the nature of the world's financial institutions and the thinking that underpins the capitalist system. New York City remains the centre of US foreign trade.

The economic influence of New York City is not, however, always positive. The share market crash of 1929, for example, led to the Great Depression. The GFC of 2007–08 had its origins in excessive risk-taking by home lenders who targeted low-income borrowers, the majority of whom were members of minority groups. It led to the collapse of the New York City-based Lehman Brothers, which, in turn, initiated a worldwide economic crisis.

SPOTLIGHT

The Great Depression (1929–1939)

The optimism of the Roaring Twenties (the name given to the period of general economic prosperity, social liberation and optimism of the 1920s, following the deprivations of World War I) was most apparent on the New York Stock Exchange. Share prices rose to unprecedented heights. The Dow Jones Industrial Average (the Dow) increased six-fold from August 1921 to September 1929. However, the boom was to end in a devastating bust. On Black Monday, 28 October 1929, the Dow declined nearly 13 per cent. On the following day, Black Tuesday, the market dropped 12 per cent. By mid-November, the Dow had lost almost half of its value. The slide continued through to the summer of 1932, when the Dow closed at its lowest value of the twentieth century, 89 per cent below its peak. The Dow did not return to its pre-crash heights until November 1954.

As a result of the collapse, the US economy shrank by one-third in the four years from the beginning of the Great Depression. The country's GDP fell 29 per cent from 1929 to 1933 and the unemployment rate reached a peak of 25 per cent in 1933 (see Figure 9.6.3). Industrial production fell 46 per cent, consumer prices fell 25 per cent and some 7000 banks, nearly one-third of the country's entire banking system, failed.

The economic shockwaves of the collapse spread throughout the world. In Australia, for example, the economy collapsed, and unemployment peaked at 32 per cent in 1932. National income declined by one-third. The immediate effect was on individuals and families: children with not enough to eat; men, the traditional breadwinners, unemployed, humiliated and powerless; women struggling to hold families together. Suicide rates increased sharply. In the absence of unemployment benefits, which had not yet been introduced, charity groups became the only source of relief, but were unable to feed the overwhelming numbers of hungry people.

9.6.3 The unemployed queue for food outside a soup kitchen during the Great Depression

Cultural role

New York City has been the United Sates' premier cultural centre since the 1890s. But unlike other global cultural centres—London, Paris and Tokyo—it is not also a political capital. Consequently, economic and cultural elites in New York do not have the same opportunities for daily interaction with the national political class as their counterparts do in those other world cities. Nonetheless, its influence has been profound.

For more than a century, those who were determined to succeed in the popular arts—songwriting, theatre or journalism—considered New York City their ultimate destination. While would-be film stars or directors went to California, the site of most motion picture production, ambitious journalists, playwrights and songwriters looked to New York City. As a result, New York City's pre-eminence as a cultural capital is reflected in the literary and social critiques of New York City intellectuals, as well as in the fine arts, performing arts and popular culture.

Endowed with some of the world's greatest art collections, housed in the city's many galleries, it's not surprising that New York City emerged as the centre of the global art market after World War II.

New York City also boasts some of the world's greatest performing arts companies and venues. These include the New York Philharmonic, the New York City Ballet, the Metropolitan Opera and the Juilliard School. All are housed in the Lincoln Center for Performing Arts in the Upper West Side neighbourhood (see Figure 9.6.4).

9.6.4 The Metropolitan Opera House, part of New York City's Lincoln Center

The cultural influence of the media cannot be underestimated. *The New York Times* and *The Wall Street Journal* emerged as international newspapers from the 1940s and, together with the other New York City-based media organisations, including Fox News and NBC, they have helped to shape public discourse and debate at a national and international scale.

In terms of popular culture, the city retains its global significance. The city is frequently the setting for novels, movies and television programs, and New York Fashion Week is one of the world's pre-eminent fashion events. Successful Broadway musicals and plays are replicated on stages worldwide.

The city is also the birthplace of numerous cultural movements and music genres. These include the Harlem Renaissance in literature and the visual arts, abstract expressionism in painting, and hip hop and rap from the Bronx. Disco and punk rock also originated in NYC. Jazz developed in New Orleans, but was popularised in Harlem.

New York remains at the peak of the United States' urban system, and its status as a world city is secure. Yet it is also clear that in some areas, New York City is not as dominant as it was in the mid-twentieth century. This is most evident is its declining status as a manufacturing centre.

Activities

Acquiring and processing geographical information

1. Summarise the ways in which New York City has influenced politics at the national scale. How has the city's media and entertainment industry amplified this influence and to what effect? What has been the response of conservatives?
2. Define the term woke. How has it been weaponised by the conservative right?
3. Explain why New York City is widely associated with progressive worldviews.
4. Outline New York City's global political role.
5. Describe New York City's global economic role. Explain why it is not always associated with positive outcomes.
6. Outline the nature and extent of New York City's cultural influence.

Applying and communicating geographical understanding

7. Study the box, Spotlight: The Great Depression (1929–1939). What role did New York City play in the onset of the Great Depression? Summarise the extent and consequences of the Wall Street collapse of 1929.
8. Using the internet, investigate New York City's role in the Global Economic Crisis (2007–08). Write a brief report outlining your findings.
9. Using the internet, access the website of one the New York City cultural institutions mentioned in the text. Prepare a brief oral report outlining what is special about the institution, the cultural role it plays and whether its influence extends beyond the city.
10. Investigate an element of popular culture that originated in New York City. Share your findings with the rest of the class.

UNIT 9.7

New York City's regional and global links

Given New York City's status as a world city, at the very pinnacle of the global hierarchy of such cities, it's not surprising that it is among the most connected places on Earth. Many of its linkages are explored in Unit 6. In this unit, we focus on New York City's regional links and its international links in aviation and world trade.

Regional links

New York City's regional links extend well beyond the state of New York to include the Northeast megalopolis, which extends from Boston in the north to Washington DC in the south. The region is linked by the Northeast Corridor railway line, the busiest passenger rail line in the country, and a vast freeway system that plays an important role in the movement of people and goods within the region.

Beyond the five New York City boroughs, lies the much larger metropolitan area of New York. Much of this is regarded as the city's commuter zone. Manhattan is the main employment centre in the city, with 56 per cent of all jobs. Of these, 30 per cent of workers commute from within Manhattan, while a further 43 per cent commute from the other four boroughs. That leaves 27 per cent who commute from counties beyond the city's boundaries. The region's vast public transportation system carries 67 per cent of all workers to their place of employment.

Politically, the city is linked to the state in which it is located, the capital of which is Albany. Decisions made in the capital inevitably impact the city and its people. New York state stretches from Lake Ontario to the Atlantic Ocean at Long Island. The state's population is 19.84 million (2021). Given that New York City's 8.5 million people make up 43 per cent of the state's population, it's not surprising that their elected representatives exert a significant influence in the deliberations of the state legislature.

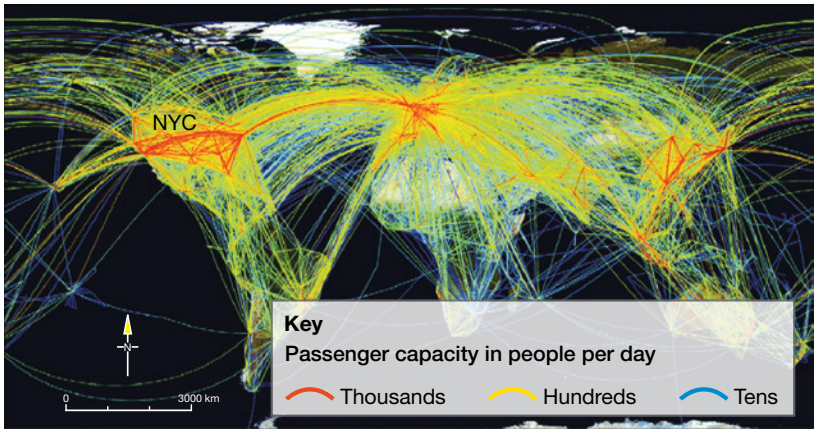
There are, of course, many social and educational links across the region. Take tertiary education, for example. Unlike most Australian school leavers, US high school graduates often elect to move away from home to attend their university of choice. Students often see this as a 'rite of passage', part of the transition to adulthood. The best-known tertiary institutions within the Northeast megalopolis are Harvard, Yale, Brown, Columbia, Cornell, Dartmouth, Princeton and the University of Pennsylvania. These are among the world's most prestigious places of learning. New Yorkers also have personal links with friends and relatives throughout the region.

International links

Airline links

Owned and operated by the Port Authority of New York and New Jersey, New York City's four major airports handle more than 120 million passenger movements each year. The network of airports operated by the Port Authority is the largest airport system in the United States, the second in the world in terms of passenger traffic, and the first in the world in terms of total flight operations (see Figure 9.7.1).

JFK Airport (named after the 35th president of the United States, John Fitzgerald Kennedy) is the city's main international airport. The airport is the city's busiest, the 13th-busiest airport in the United States, and the busiest international gateway in North America. More than 90



9.7.1 The global aviation network lines show direct links between airports, and the colour indicates passenger capacity in people per day (thousands [red], hundreds [yellow], tens [blue]).

airlines, from more than 50 countries, operate flights to and from the airport, with nonstop or direct flights to destinations in all inhabited continents, except Australia. Even this will change in 2025, when Qantas commences its ultra-long haul, non-stop flights from Sydney and Melbourne to NYC.

The other airports serving the city are Newark Liberty International, New York Stewart International and LaGuardia. The latter two primarily accommodate airlines serving domestic (and limited international) destinations. All airports accommodate domestic flights. FedEx, the world's busiest cargo airline, uses Newark Airport as its regional hub.

Trade links

Having long been the busiest on US east coast, the port of New York–New Jersey handled a record 8.2 million TEUs (20-foot equivalent units—a standard-sized shipping container, the measurement used in the container industry) in the 10 months to October 2022 (see Figure 9.7.2). This made the port, and its vast container terminals, the largest such complex in the country, surpassing California's for the first time. The key to this development has been the Panama Canal expansion project, which doubled the capacity of the canal by adding a new lane of traffic. By adding the lane and increasing the width and depth of the lanes and locks, larger ships can carry twice as much cargo, and twice as many vessels can travel through it. The greatly expanded capacity of the canal has significantly enhanced New York City's trading links with the Asia-Pacific region. Today, the port of New York-New Jersey is the world's 18th-busiest port.

9.7.2 New York–New Jersey container terminals and Newark Liberty International Airport

SPOTLIGHT

Transatlantic crossings

New York City was home to the transatlantic ocean liner during its golden age (see Figure 9.7.3). Popular from the end of the nineteenth century to the late 1960s, ocean liners carried passengers, including immigrants, across the Atlantic Ocean between Europe and North America. The advent of affordable air travel would ultimately make the ocean liner obsolete. Today, only one, Cunard's *Queen Mary 2*, undertakes the transatlantic crossing on a semi-regular basis. New York City does, however, continue to welcome cruise ships. Today, it is the sixth-busiest port in the United States and the 16th-busiest in the world for passenger travel.

9.7.3 Transatlantic liners berthed in New York City, 1961

Activities

Acquiring and processing geographical information

1 Summarise New York City's regional and international links, as outlined in this unit.

Applying and communicating geographical understanding

2 Access the Flightradar24 or FlightAware website. Observe the flights approaching or departing from New York City's airports. Where are they arriving from or heading to?

3 Identify and access a suitable marine tracking website, such as ShipMap or MarineTraffic. Describe the global pattern of maritime movements, including those going to and from New York City.

4 Study the box, Spotlight: Transatlantic crossings. Investigate the golden age of transatlantic travel and the nature of the global cruise ship industry today. Write a short report in response to the question, 'How has the nature of travel on ocean-going passenger vessels changed since the late 1960s?'

UNIT 9.8

Living in New York City: Challenges and responses

Did you know?

New York City's housing stock includes nearly one million rent-regulated housing units, 175 000 public housing apartments, and many market-rate units that house millions of low- and middle-income New Yorkers.

Like all large cities, New York City has its challenges for those who live there. These include access to affordable housing, congestion, ageing infrastructure and a shortage of open space (see Figure 9.8.1). Addressing these challenges is critical if people's quality of life is to be improved, spatial inequality reduced and sustainability enhanced.

9.8.1 Tenants protest about the shortage of affordable housing

Access to affordable housing

The shortage of affordable housing, rapidly increasing rents and high rates of homelessness are the key, interrelated, housing-related challenges facing New York City. Compounding the housing crisis are real estate speculation and funding cuts to federal housing programs that assist the most vulnerable households.

The NYCHA defines affordable housing as, 'housing that costs roughly one-third or less of a household's income and is regulated in such a way that the rent cannot increase drastically over time'. Such housing is especially important in New York City where 67.2 per cent of residents are renters, compared to 31 per cent in Australia. Fifty-three per cent of New Yorkers are described as being 'rent burdened'. Meaning that more than 30 per cent of their income is required to pay their rent.

Did you know?

The issue of affordable housing came to the fore in the period immediately after the lifting of COVID-19 pandemic emergency housing measures. These included restrictions on evictions and emergency rental assistance programs. Once they ended, thousands of landlords filed eviction notices due to tenants not paying back-rent.

Spatial pattern of renters

It is also evident that there are some important spatial variations in the percentage of people living in rented accommodation across the five boroughs and there is a relationship between a borough's percentage of renters and its median income. The Bronx has the highest proportion of renters (81.1%) and the lowest median income (US$41 895). Manhattan's percentage of renters is 76.7 per cent and it has the highest median income at US$85 066. Then comes Brooklyn (70.2%; US$66 937), Queens (55.9%; US$69 320) and Staten Island (34.3%; USUS82 166).

Median rents highlight the extent of the affordability challenge faced by New Yorkers. In late 2022, the shortage of housing helped send the typical median rent on new apartment leases in Manhattan to over US$4100 a month (a 26% increase year-on-year). Median rents ranged from US$2650 for entry-level apartments to US$14 535 at the top end of the market.

Median income and housing affordability

Not surprisingly, many New Yorkers depend on affordable housing initiatives. Eligibility for city-financed affordable housing is based on a measure known as the average median income (AMI), which is determined annually by the US Department of Housing and Urban Development. The AMI for the New York City region in 2022 was set at US$93 400 for an individual and US$120 100 for a three-person family. The AMI enables people to identify the income band they fall under each year, which determines the type and level of housing assistance they are eligible to receive. The five income bands and the corresponding percentage of the federally determined AMI are:

- extremely low income: 0–30 per cent
- very low income: 31–50 per cent
- low income: 51–80 per cent
- moderate income: 81–120 per cent
- middle income: 121–165 per cent

The Bronx has the highest need for government housing support (with its median income of US$41 895, well below the AMI of US$93 400). Access to affordable housing ultimately depends on whether there is enough housing stock available in a particular AMI band. Apartment buildings typically have a mix of band-specific accommodation units, but generally there is a shortfall of units catering to people in the low-income brackets, where the need is greatest.

NYCHA programs

The NYCHA provides public housing in the city. The authority aims to provide decent, affordable housing for low- and moderate-income New Yorkers. It also administers a citywide Section 8 Leased Housing Program. The authority provides a range of housing types, including large-scale apartment buildings, which are commonly referred to as projects (see Figure 9.8.2). The distribution of the authority's developments often results in large income disparities between the residents of projects and the surrounding neighbourhood.

9.8.2 Huge housing project apartment towers in upper Harlem

In 2022, more than half a million New Yorkers lived in NYCHA's 335 public housing developments across the city's five boroughs. Another 235 000 received subsidised rental assistance in private homes through the NYCHA-administered Section 8 Leased Housing Program.

Constructing new affordable housing

Significantly, the construction of affordable housing lags behind population growth. As the city continues to grow, competition for housing only intensifies making it increasingly unaffordable, particularly for the most vulnerable residents—the elderly, those on low to moderate incomes, some immigrants and the 17.3 per cent of the population who live in poverty.

Affordable housing is also provided by the private sector. However, the barriers to the provision of such housing are many. Most centre on the complicated process that developers must go through to gain building approvals.

In 2022, the Governor of New York State and the Mayor of New York City initiated an investigation into the issues hindering the development of new housing. The outcome was a series of changes to the real estate development process. These involved changes to the city's zoning rules and building, environmental and tax regulations. The objective is to provide 800 000 additional housing units by 2032. However, this, will prove difficult. In 2022 only 40 projects were approved by the city authorities—some 12 000 units, of which only 7000 were affordable. The scale of the undertaking is clear when considering that the target of 800 000 is 150 000 more housing units than was built over the last two decades in total.

Other housing initiatives include:

- a mandatory inclusionary housing policy which requires that developers whose properties are rezoned ensure a portion of the new housing is made permanently affordable
- the selective relaxation of zoning regulations, including those related to parking requirements and height limits, in exchange for affordable housing units
- the elimination of tax breaks for luxury apartment buildings
- increased efforts to protect tenants from harassment, unsafe living conditions and eviction
- providing legal aid to all New York City tenants engaged in renter disputes
- trialling modular construction techniques to determine whether they can significantly reduce construction time and cost
- promoting shared housing initiatives on private sites throughout the city. Shared housing, defined as any unit with two or more independently occupied rooms that share a kitchen or bathroom, can meet housing needs, promote income diversity and take advantage of construction cost savings
- unlocking the potential of vacant lots by encouraging the building of tiny homes and other infill housing on sites previously considered too small or irregular for development
- initiatives that transform basement apartments into safe, legal, affordable homes
- continuing to clean up brownfield sites suitable for housing developments.

Taken together, the city hopes to achieve a sustainable goal of 25 000 affordable housing units preserved or constructed each year—a rate it has never achieved before.

Rethinking the rental model

Some people question the very basis on which housing is provided for New Yorkers. They argue that landlords and housing corporations continue to place profits before people and that it's time to develop alternatives to this private, corporate ownership model. Housing owned by communities of tenants, rather than corporations, is one option. This is where state and city authorities acquire or develop properties that can be owned and managed through community land trusts, and occupied by tenants across the income spectrum.

Why does it matter? Access to decent, secure and affordable housing has a range of benefits. It leads to higher productivity and better health outcomes for people. Also, affordable housing frees up funds within family budgets to ensure they have food security and access to health care and educational opportunities, which are some of the keys to wellbeing. It is also an important contributor to the notion of the liveability of cities.

Homelessness

In 2022, 102 656 homeless New Yorkers slept in the New York City Department of Homeless Services shelter system. This included 29 653 homeless children. While most families entering shelters come from the city's poorest neighbourhoods, homeless families and single adults come from every New York City neighbourhood.

The primary cause of homelessness, particularly among families, is the lack of affordable housing. Surveys of homeless families have identified the following major immediate, triggering causes of homelessness: eviction, severely overcrowded housing, domestic violence, job loss and hazardous housing conditions. Compared to homeless families, homeless single adults have higher rates of serious mental illness, addiction disorders and other severe health problems.

Each night, thousands of unsheltered homeless people sleep on New York City streets, in the subway system and in other public spaces. While there is no accurate measurement of New York City's unsheltered homeless population, studies show that the large majority of unsheltered homeless are people living with mental illness or other severe health problems.

Black and Latino New Yorkers are disproportionately impacted by homelessness. Approximately 56 per cent of heads of household in shelters are Black, 32 per cent are Latino, 7 per cent are white, less than 1 per cent are Asian-American or Native American, and 4 per cent are of unknown race/ethnicity.

Helping the homeless

The Coalition for the Homeless, a New York City non-profit organisation, is the United States' oldest advocacy and direct service organisation helping homeless individuals and families. Each day, the coalition provides food, clothing, eviction prevention, crisis services, permanent housing, job training and special programs for youth to more than 3500 homeless people, including children.

New York City Council's report *Our Homelessness Crisis* (2020) proposes a range of initiatives to address the challenge. These include:

- increasing the city rental assistance voucher amount to a fair market rate
- increasing access to affordable housing
- increasing the portfolio of supportive housing
- expanding housing options for homeless youth
- expanding mental health services
- rapid re-housing—an intervention designed to quickly connect people to housing and support services.

Activities

Acquiring and processing geographical information

1 Explain what is meant by affordable housing. What determines whether accommodation is considered affordable?

2 Outline the factors impacting on housing affordability in New York City.

3 Explain why affordable rental accommodation is so important in New York City.

4 What is the percentage of New Yorkers described as being rent burdened?

5 Explain why the issue of affordable housing came to the fore in the period following the COVID-19 pandemic.

6 Summarise the spatial variations in the proportion of people living in rental accommodation across the five New York City boroughs. What role does median income play in these variations?

7 Describe how access to affordable housing is determined.

8 Summarise the role of the NYCHA. How many New Yorkers depend on NYCHA housing?

9 Explain how the lag in housing construction makes housing increasingly unaffordable, especially for the disadvantaged.

10 Summarise the barriers to the provision of housing by the private sector. What has been the response of state and city authorities? Describe the scale of the housing challenge.

11 Summarise the initiatives designed to increase affordable housing in New York City. What alternative strategies have been proposed?

12 Summarise the benefits that flow from access to decent, secure and affordable housing.

13 What is the extent of homelessness in New York City? What are the primary causes of homelessness? What medical conditions are common among New York City's homeless population? List the groups disproportionately impacted by homelessness.

14 Summarise the initiatives used to address the homelessness issue.

Applying and communicating geographical understanding

15 To further investigate the issue of affordable housing, access the OneNYC2050 Thriving Neighbourhoods strategic plan. Name the key element of this strategy. Summarise how it will address the issue of safe, secure and affordable housing.

16 Investigate the current state of the affordable housing challenge in New York City. Are the city's targets being achieved?

17 Investigate a major new development project in New York City. Outline the nature of the development. Does it include an affordable housing component?

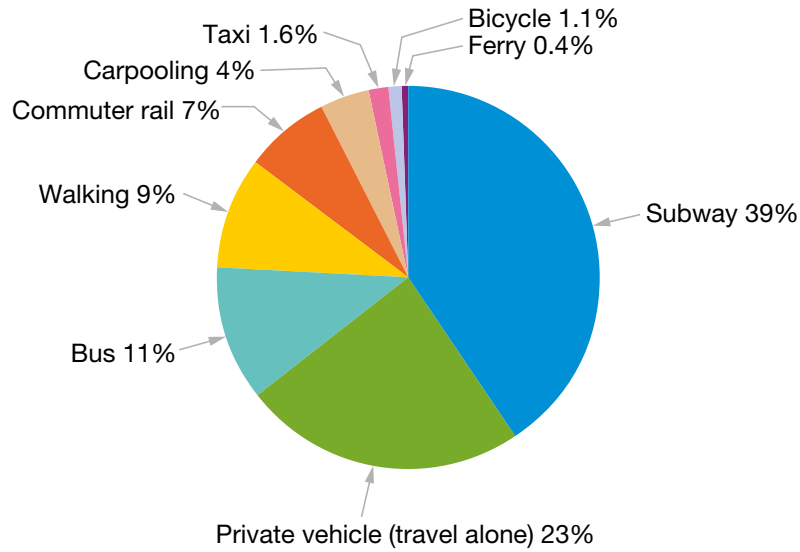
18 Access New York City Council's *Our Homelessness Crisis* (2020) report. Investigate the state of homelessness in New York City, its drivers, and strategies for preventing homelessness. Present your findings as an extended written response.

19 Investigate a not-for-profit organisation assisting the homeless in New York City. Write a report outlining the strategies it is pursuing.

Transport infrastructure

Access to reliable, affordable and safe public transport is seen as central to the liveability and sustainability of New York City. The city's famous yellow cabs, extensive subway system and iconic bridges and tunnels have long been seen as the keys to mobility in a city where rates of car ownership are low by US standards. Car ownership rates are lowest in Manhattan, where only 22% of households own a car, and only increase to significant rates in the outer neighbourhoods of Queens, Brooklyn and Staten Island. Overall, 55 per cent of New York City households rely on public transport because they don't own a vehicle.

The commute to work is the most significant of all the movements within the city. An estimated 1.6 million people commute to work each day. Figure 9.8.3 shows how this commute was undertaken in 2019, before the distortions caused by the COVID-19 pandemic. The average commuting time for New Yorkers is 41 minutes.



9.8.3 New York City commute by means of transport, 2019

The percentage of the population using public transport in New York City is well beyond that of other US cities, where the use of private cars is far more extensive. Most other US cities are defined by low-density urban sprawl with high rates of car ownership. Los Angeles is probably the best known such city. As a result, the environmental footprint of New Yorkers is lower than the average American. Due primarily to the relatively low rate of car ownership, New York City's greenhouse gas emissions are just 7.1 metric tonnes per person. New Yorkers are collectively responsible for 1 per cent of the nation's total greenhouse gas emissions, while comprising 2.7 per cent of the nation's population. The sustainability of the city is therefore enhanced by the capacity of its public transport infrastructure.

Responsibility for the functioning of the city's extensive public transport infrastructure rests with the New York Department of Transportation (DOT), the Metropolitan Transportation Authority (MTA) and New York City Transit (NYC Transit). The DOT is responsible for maintaining the city's streets and highways, footpaths, bridges and tunnels, street signs, traffic lights, lane markings and streetlights, and it operates the Staten Island Ferry service. NYC Transit operates the Staten Island Railway and New York City subway and bus systems, while the MTA is responsible for all public transportation in the New York City metropolitan area in the State of New York. The Port Authority of New York and New Jersey is responsible for much of the interstate transport infrastructure linking New York City with New Jersey and beyond, including bridges, tunnels, airports and seaports.

Transport-related challenges

The challenges associated with New York City's vast transport system include its ageing infrastructure and traffic congestion. This is because the city's subways, roads and bridges are among the oldest in the country and the most intensively used.

The New York City subway

The city's subway, in operation since 1904, is one of the world's oldest public transport systems. Most of the subway's infrastructure dates from before the 1930s, when the city's population was just 6.9 million. It was not built to cater for a population of 8.8 million, let alone a projected population of 9.8 million in 2050.

With 28 routes or services, 472 stations and 399 kilometres of track, the subway's maintenance demands are enormous (see Figure 9.8.4). Many stations are dilapidated and in urgent need of upgrading. Some are subject to flooding in heavy rains and the whole system is infested with rats. Parts of the subway's signalling system are more than 70 years old. As a result, services are often disrupted or delayed. Routine maintenance and cleaning are difficult because the system operates 24 hours a day, all year round.

In 2017, a state of emergency was declared after a series of derailments, track fires and overcrowding incidents. In response, the city announced a two-phase US$9 billion action plan aimed at stabilising the subway system and preventing its continued decline. The first phase, costing US$836 million, consisted of improvements in signal and track maintenance, carriage reliability, system safety and cleanliness, and customer communication. The second phase, costing US$8 billion, will fix more widespread problems.

9.8.4 New York City's subway map

Traffic congestion

Traffic congestion is common throughout much of New York City. It is especially bad in Manhattan, where gridlock is common (see Figure 9.8.5). The sheer volume of traffic and the borough's narrow streets result in traffic jams, which are not only a source of inconvenience, but also add to the costs of doing business. It also impacts on the amenity of neighbourhoods. Delivery vehicles are a major cause of congestion—an issue made worse by the growth in online shopping and their tendency to disrupt the flow of traffic while making deliveries. Other sources of congestion are the vehicles that transport construction materials and the many tourist buses travelling around the city's many attractions. The cost of traffic congestion has been estimated at US$15 billion annually and an extra 1135 million litres of fuel.

Did you know?

In 2021, the subway delivered 1.31 billion passenger rides (or about 6.76 million rides a day), compared to the 150 000 in the year it opened (1904). The daily record for rides is 6.2 million, on 29 October 2015.

Did you know?

Only 40% of the subway's track is above ground.

Did you know?

In the most congested parts of Manhattan, traffic moves 23% slower than it did a decade ago. For the bridges and tunnels moving traffic to and from Manhattan, traffic has slowed even more markedly. The average speed of a car in Midtown is now just 7.5 km/hr.

9.8.5 Traffic jam, Times Square

While traffic congestion makes driving challenging, it also makes the streets more dangerous for pedestrians and cyclists. In 2021, there were over 228 000 motor vehicle accidents in New York City (around 625 accidents per day). Queens had 29.5 per cent of all accidents, followed by Brooklyn (28.8%), Manhattan (20%) and the Bronx (16.1%). Staten Island recorded 5.7 per cent of all accidents.

To reduce traffic congestion in Manhattan, city authorities have proposed introducing a congestion charge of up to US$23 a day, which is estimated to reduce the number of cars entering Manhattan by 15–20 per cent. The charge would apply to all traffic entering an area between 60th Street in Midtown and Battery Park at the southern tip of the borough. If approved by the Federal Highway Administration, New York City would become the first large US city to follow London, which introduced a similar charge in 2003. Congestion pricing is described as good for the environment, good for public transport and good for New York and the region. An environmental assessment found the charge would not only reduce traffic congestion, but would also improve air quality. It would make buses more reliable and increase public transport use by 1–2 per cent. The toll would generate revenue of US$1 billion to 1.5 billion a year and support US$15 billion in debt-based financing for mass transit improvements.

9.8.6 Share car, New York City

Traffic congestion has also been addressed via the promotion of car sharing initiatives (see Figure 9.8.6). Car sharing reduces the incentive for car ownership. If a car is needed, one simply rents a vehicle, often by the hour. GoGet is an Australian example of a car sharing initiative. Zipcar is one of the most popular carshare providers in New York City. Members pay a monthly fee to have access to an assortment of rental cars, and car use is billable by the minute, hour or day. Zipcar is a subsidiary of the Avis Budget hire car group. Other popular car share providers are Silvercar, Car2Go and Real Car. All offer the convenience of car ownership without the ongoing costs involved or the challenge of securing a parking space. New York City's DOT has encouraged the growth of car sharing by providing designated parking spaces for use by recognised car sharing organisations in municipal parking stations and on designated streets.

To address the accident rate, the city initiated the Vision Zero Action Plan focused on road safety. The plan aims to reduce collisions, serious injuries and fatalities associated with pedestrians and cyclists. Since its inception in 2014, the program has resulted in fewer road deaths each year by focusing on education, enforcement and engineering. The latter includes expanding bike lanes and implementing pedestrian priority areas.

Vision Zero Action Plan initially targeted intersections and road corridors based on pedestrians killed or seriously injured. By the end of the initial five-year plan, the DOT had addressed 90 per cent of priority intersections and 86 per cent of priority corridors with design and engineering interventions that contributed to a 36 per cent drop in pedestrian deaths at those locations.

In 2022, the city initiated a US$900 million plan to further enhance pedestrian safety via the Speeding Ruins Lives, Slow Down campaign. The campaign targeted multi-lingual media, so that the message reached a wide range of communities across the five boroughs, including minority communities that are disproportionately affected by traffic accidents. A multi-platform and multi-lingual advertising campaign was launched to target speeding and dangerous driving behaviours. Additionally, funding was provided to redesign 1000 intersections across the five boroughs. This included the installation of speed and red-light cameras, which have proved effective in reducing dangerous driving. Pedestrian intersection crossing times have also been modified to cater for older pedestrians. While those aged 65 years and older make up less than 15 per cent of the city's population, they represent 47 per cent of all annual pedestrian fatalities.

Roads, bridges and tunnels

New York City has about 30 500 kilometres of roads and highways. In Manhattan, 43 per cent are deemed substandard, in Staten Island it is 40 per cent, the Bronx 34 per cent, Queens 31 per cent and Brooklyn 28 per cent. Substandard roads impact travel times, costing businesses time and money. They can also damage vehicles.

Maintaining the city's underground utilities impacts road surfaces and is a major source of traffic congestion. Each day, more than 300 streets are dug up to conduct utility infrastructure inspections, maintenance and repair. While this work is essential to keep the city in functioning order, it forces New Yorkers to navigate streets undergoing a seemingly endless series of excavations.

9.8.7 Brooklyn Bridge, a famous New York City landmark, was opened in 1883.

Of the 162 bridges in New York City, 11 per cent are more than 100 years old (see Figure 9.8.7). Forty-seven bridges are rated 'structurally deficient' and 'fracture critical'. The latter category identifies bridges that engineers identify as having 'little structural redundancy'. In other words, they are prone to failure and/or collapse.

The Holland Tunnel, the oldest of the vehicular tunnels, was opened in 1927. The city's other major tunnels are the Lincoln Tunnel (1937), the Queens–Midtown Tunnel (1940) and the Brooklyn–Battery Tunnel (1950). All require expensive, ongoing maintenance. Tolls are used to offset at least part of the cost.

Addressing transport challenges

New York City's transportation challenges are addressed under the goal of efficient mobility in OneNYC 2050—the city's long-term strategic plan. The aim of efficient mobility is to 'enable reliable, safe and sustainable transportation options'. Specific initiatives include the modernisation of the city's mass transit networks, reducing congestion and emissions, and making sure that the city's streets are safe and accessible.

The modernisation of mass transit will involve massive, system-wide repairs and upgrades, to improve reliability. Other initiatives include optimising streets for the efficient operation of buses, providing discounted MetroCards for low-income New Yorkers through the Fair Fares Program, increasing the accessibility of subway stations (75% remain inaccessible to people with limited mobility) and exploring options for the expansion of the subway.

Tackling congestion and emissions involves building a citywide network of electric vehicle charging stations, incentivising the adoption of low and zero-emissions vehicles, the use of new technologies to enforce road rules, the use of congestion pricing, expanding the use of bus and bike lanes and promoting car sharing.

Making sure that the city's streets are safe and accessible involves implementing the Vision Zero Action Plan, transforming dangerous arterial roads into Vision Zero Great Streets (i.e. turning roads that currently divide neighbourhoods and hinder accessibility into safe and thriving community connectors), reducing fatalities and serious injuries involving fleets managed or regulated by city agencies, expanding and increasing the connectivity of the bike network and enhancing walkability and accessibility.

Activities

Acquiring and processing geographical information

1 Explain why access to reliable, affordable and safe public transport is considered important in terms of the liveability of New York City.

2 Summarise the environmental benefits derived from New York City's reliance on public transport.

3 List the authorities responsible for New York City's transport infrastructure.

4 Describe the transport-related challenges faced by New York City. How does New York's subway highlight these challenges? What is being done to address these challenges?

5 Summarise the causes, impacts and costs of traffic congestion in New York City.

6 Summarise the strategies being used and proposed to address the issue of traffic congestion. What are their benefits, especially those related to pedestrian and cyclist safety, the environment, and the economy?

7 Describe the state of the city's road, bridge and tunnel infrastructure.

8 List the key elements of the OneNYC250 efficient mobility strategy.

Applying and communicating geographical understanding

9 Study Figure 9.8.3. Write a paragraph describing the principal modes of commuting in New York City. Suggest reasons for the dominance of the subway.

10 Study Figure 9.8.4. Which New York city boroughs are best serviced by the subway? How does the subway reinforce the economic dominance of Manhattan?

11 Conduct a class discussion on the topic, 'Subways or metro systems work best in high-density cities such as New York City, London and Paris, where stations are within easy walking distance of where most people live', or, 'Is the Metro the best public transport system and the best solution for a low-density city such as Sydney?'

12 Access the city's OneNYC250 efficient mobility strategy. Write a short report on the progress being made to improve the city's transport infrastructure.

Recreational spaces and facilities

In high-density cities such as New York City, access to recreational spaces is an important, lifestyle-related, consideration. People need space to exercise, relax, interact with others, or just be alone in the open air.

The New York City Department of Parks and Recreation is responsible for the city's parks and public recreational facilities. These consist of more than 12 141 hectares of land (14% of New York City). This includes more than 5000 individual spaces ranging from Coney Island Beach and Central Park to community gardens and Greenstreets. It operates more than 800 athletic fields and nearly 1000 playgrounds, 1800 basketball courts, 550 tennis courts, 65 public pools, 51 recreational facilities, 15 nature centres, 14 golf courses and 22.5 kilometres of beaches. It is New York City's principal provider of recreational and athletic facilities and programs.

The Greenstreets program converts paved, vacant traffic islands and median strips into green spaces filled with trees, shrubs and groundcover to capture stormwater. GrowNYC—the largest and most established environmental organisation in NYC—has built more than 150 community gardens in public housing developments, day care centres and senior centres. Communities use the gardens to grow fresh vegetables.

Under the OneNYC 2050 Thriving Neighbourhoods strategy, city authorities aim to enhance liveability and sustainability by providing all New Yorkers with access to neighbourhood open spaces. Under the Community Parks Initiative and Parks Without Borders, city authorities are working with communities to invest in dense and growing neighbourhoods. The Community Parks Initiative involves engaging with the communities who use the parks and then incorporating their ideas into their redesign. Parks Without Borders involves making parks more open (e.g. by removing fencing), welcoming and beautiful, by improving entrances, edges and park-adjacent spaces. The aim is to make park entrances easier to find, the edges of the parks greener, add furnishing, programming and amenities, and improve sightlines to make parks safer. In addition to improving parks within the boroughs, the city is planning to complete the Manhattan Greenway, a 53-kilometre loop that will run around the edge of the island of Manhattan. In neighbourhoods with limited open space, authorities are promoting the development of pedestrian plazas and streets—places where people can meet and interact.

By investing in parks and recreation spaces in areas of highest need, city authorities are seeking to enhance liveability by increasing New Yorkers' access to open spaces, cultural events and activities. The aim is to bring communities together, contribute to better health, and foster cohesion and community development.

SPOTLIGHT

Little Island

Set on 132 huge tulip-shaped concrete pillars on the banks of the Hudson River, Little Island is New York City's newest park and tourist attraction (see Figure 9.8.8). Costing US$260 million, the park straddles the site of Pier 54—the site where the survivors of the *Titanic* arrived in New York City and from where the ill-fated *Lusitania* departed before it was sunk by a German U-boat, 18 kilometres off the southern coast of Ireland on 7 May 2015, killing 1198 passengers and crew. There were 761 survivors.

Little Island is connected to Manhattan by walkways that take visitors to and from the fashionable Meatpacking District. Little Island is part of the rejuvenation of the West Side. Once dominated by a bustling port, the area deteriorated into industrial eyesores and homeless camps before a revitalisation program this century converted much of it into the Hudson River Park. The park, a component of the Manhattan Waterfront Greenway, stretches for 7.2 kilometres and covers 220 hectares, making it the second-largest park in Manhattan after Central Park.

9.8.8 New York City's newest park, Little Island

● SPOTLIGHT

New York City's High Line

The High Line is a 2.33-kilometre elevated linear park, created on a former New York Central Railroad spur line on the west side of Manhattan (see Figure 9.8.9).

The High Line (see Figure 9.8.10) was built in 1934 as part of a massive infrastructure project called the West Side Improvement. It lifted freight train traffic 9–10 metres above the ground, removing dangerous trains from the streets of Manhattan's largest industrial district. The trains carried meat, produce and factory goods.

After the last train ran along the tracks in 1980, the High Line became just another piece of decaying urban infrastructure. The rails rusted and the ballast turned into a growing medium for weeds.

In the 1990s, the city's mayor was keen to tear down the High Line. It was seen as a blight on the rapidly gentrifying Chelsea neighbourhood with its trendy galleries, restaurants and loft living.

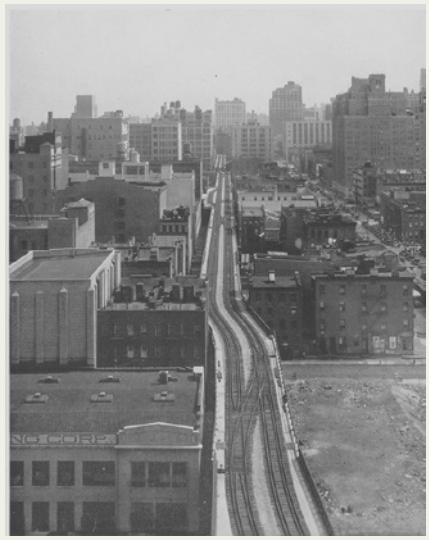
Almost 20 years after the last train travelled along its tracks, two residents of the High Line neighbourhood, Robert Hammond and Joshua David, both civic activists, recognised the line's potential. They started campaigning for the area's preservation and re-use. Eventually, their activism paid off. By 1999, they had founded Friends of the High Line, the non-profit body that now maintains and operates the High Line and its programs. Funds come from both public and private sources.

Ten years after the founding of Friends of the High Line, the first section, from Gansevoort Street to West 20th Street, opened to the public in 2009. By 2011, the second section opened, covering the city from West 20th to West 30th Street, and finally in 2014, the Rail Yards, from West 30th to West 34th opened.

The High Line quickly became one of the city's most popular recreational facilities. It attracts over 8 million New Yorkers and tourists each year.

The development of the High Line illustrates how the provision of additional green space can accelerate the pace of gentrification and urban renewal. The opening of the High Line not only improved the amenity of adjacent neighbourhoods, but it also increased property prices and rents—in some instances driving out long-term residents. The High Line has also attracted the interest of developers. Land adjacent to the High Line now boasts one of the highest concentrations of architecturally designed buildings in the country.

The High Line's landscaping reduces storm-water run-off by up to 80 per cent and lessens the urban **heat island effect**. The trees provide shade and a habitat for many native insects and birds. The High Line forms part of a migratory corridor along the Hudson River for more than 300 bird species. The plants used are drought-tolerant and low-maintenance species. This reduces the need for pesticides and chemical fertilisers.



9.8.9 Historical photograph of the High Line

9.8.10 The High Line following its abandonment in 1980 (left). The High Line is now a popular recreational space and tourist attraction (right).

Activities

Acquiring and processing geographical information

1 List the range of recreational spaces and facilities available to New Yorkers. Why are they considered an important lifestyle consideration? Name the authority responsible for maintaining them.

2 Outline the contributions made by the Greenstreets program and GrowNYC.

3 Outline the key elements of the OneNYC2050 Thriving Neighbourhoods strategy.

Applying and communicating geographical understanding

4 Study the box, Spotlight: Little Island. Explain what the development suggests about the importance of open space in New York City.

5 Study the box, Spotlight: New York City's High Line. Summarise the origins of the High Line, its impact on adjacent neighbourhoods and its environmental benefits.

Digital infrastructure

Internet access is fundamental to economic inclusion and mobility, yet the unreasonably high cost of services and uneven access across the city excludes millions of New Yorkers. To address this, the city has committed to having universal broadband available across the five boroughs as soon as 2025. This involves incentivising new providers to bring broadband to parts of the city that are currently underserved. At present, only Lower Manhattan has robust fibre optic infrastructure—the basic building block of internet connectivity. In the rest of the city, options are limited. This makes it harder for new internet service providers or other businesses to expand in those areas.

Ecological footprint: Pollution and waste challenges

New York City's 8.8 million people generate an incredible amount of waste—almost 10 000 metric tonnes per day. Managing this waste is primarily the responsibility of the New York City Department of Sanitation. The department maintains the waste collection infrastructure and hires public and private contractors who remove the city's waste. Until the 1930s, the city dumped its solid waste into the ocean. Then, until 1990, it was burnt in the city's 11 incinerators and the resulting ash was dumped into landfills scattered across the five boroughs. Since the closure of the last municipal incinerator in 1990 and the last municipal landfill in 2001, all the city's solid waste has been transferred to incinerators well outside the city. The waste is placed in containers at one of the three marine transfer stations, the containers are then taken by barge to the Staten Island waste transfer station, where the containers are transferred to trains for shipment to landfills and incinerators outside the city.

New York City began mandatory kerbside recycling in the late 1980s. The primary recycling facility is the Sunset Park Material Recovery Facility in Brooklyn.

New York City's sewerage system transports more than 1000 metric tonnes of solids, including faecal matter, per day to the city's 17 wastewater treatment plants. The waste is treated, and the solids are removed. The treated water is then released into the city's waterways. The remaining sludge is shipped to a water pollution control plant on Randalls Island, where the remaining water is extracted. The remaining solids are then sealed in containers and shipped to landfill sites well beyond the city.

Did you know?

Tourists place additional pressure on New York City's infrastructure. In 2019, before the COVID-19 pandemic slashed visitor numbers, New York City hosted 66.6 million visitors, making it the most visited city in the Western Hemisphere.

Climate change

While climate change is a global challenge, New York State and New York City, perhaps unsurprisingly given their progressive politics, are at the forefront of the United States' efforts to reduce its environmental footprint. Clean Path NY is one example. This US$11 billion clean infrastructure project is made up of more than 20 wind and

solar generation projects (all located in New York State) and a new 280-kilometre, underground transmission line. When complete, it will provide more than 7.5 million megawatt-hours of emissions-free energy into New York City every year, reducing the emissions from New York's electric grid by an estimated 22 per cent. It will also remove 49 million metric tons of carbon dioxide from the atmosphere between now and 2040 and provide a 20–22 per cent reduction annually in air-born pollutants, such as nitrogen oxides, sulphur oxides and particulate matter generated by the fossil-fuel powerplants it replaces. Cleaner air will yield billions of dollars in social benefits, including a reduction in pollution-linked diseases and associated treatment costs.

More generally, New York State aims to achieve 70 per cent renewable energy by 2030, 100 per cent zero-emission electricity by 2040, a 40-per cent reduction from 1990 levels in state-wide greenhouse gas emissions by 2030, an 85-per cent reduction from 1990 levels by 2050, and net-zero emissions state-wide by 2050. To achieve this, the city has:

- committed billions of dollars to energy-efficiency measures in municipal buildings
- initiated a vehicle replacement strategy—the city also operates the largest electric municipal fleet in the nation, with more than 1750 electric vehicles (EVs), with more to come
- helped more than 5000 privately owned buildings complete energy retrofits under the Retrofit Accelerator and Community Retrofit NYC programs
- introduced property tax incentives to install solar energy.

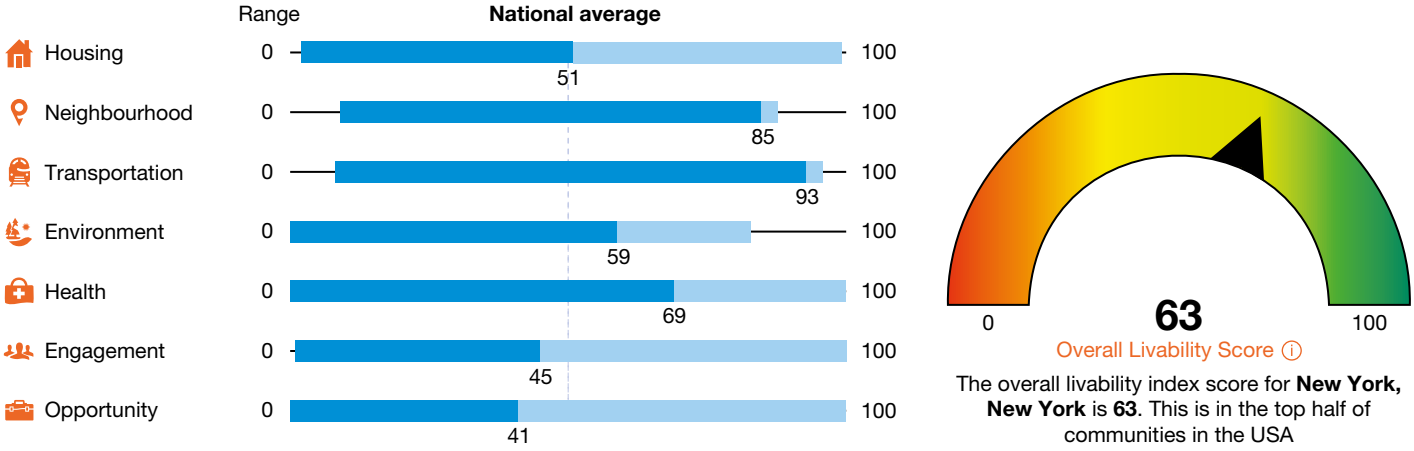
The private sector is also playing its part, investing billions in installing energy-efficiency measures in buildings across the city.

Liveability

The challenges and responses outlined above all impact on the liveability of New York City. Each year the AARP (American Association of Retired Persons) publishes a liveability index of American cities. The AARP is the nation's largest non-profit, nonpartisan organisation focusing on improving the liveability of communities.

The AARP gives New York City a liveability score of 63 out of 100, with the average for US cities being 50. The categories used to generate the score are housing, neighbourhood, transportation, environment, health, engagement and opportunity.

Figure 9.8.11 shows the range of scores received by New York City on each of the AARP's seven criteria and a comparison with the US median. For example, the city scores highest on access to transportation, neighbourhood amenity and health care. It scores below the US average in engagement and opportunity. The latter is impacted by the city's income inequality and its relatively low high school graduation rate. The engagement score is impacted by the low voter turnout at elections—perhaps inevitable in the absence of compulsory voting and the political dominance of the Democratic Party in the city.



9.8.11 New York City's scores compared with the median of all US neighbourhoods

Activities

Acquiring and processing geographical information

1. Describe the importance of digital infrastructure. How is New York City seeking to enhance internet access?
2. Summarise the amount of waste generated by New York City's 8.8 million people and how it is disposed of.
3. Summarise how the Clean Path NY development will assist the city to reduce its environmental footprint. In what other ways is the city seeking to achieve its renewable energy targets?
4. Describe how the liveability of New York City compares with that of other US cities.

Applying and communicating geographical understanding

5. Investigate additional developments that the state of New York or New York City is undertaking or planning to further reduce its greenhouse gas emissions. Share your findings with the class.
6. Study Figure 9.8.11. Using data from the graph, write a report comparing the liveability of New York City with the US median for the seven criteria used by the AARP. Access the AARP website to find the sub-criteria used within each of the seven criteria to add additional detail to your report.

CHAPTER

10 A city outside Australia: Mumbai

Mumbai (formerly known as Bombay) is an important urban centre in India and one of the largest and most densely populated megacities in the world. It is India's commercial and financial capital and has booming stock exchanges. Mumbai epitomises India's hope of becoming an economic rival to China. It is a fast and busy city, best known globally for Bollywood—the Indian film industry—and it is where some of the richest Bollywood celebrities, entrepreneurs and businesspeople in the world live. However, in stark contrast, Mumbai, known as the City of Dreamers, has some of the largest informal settlements in Asia, where both poverty and deprivation are the harsh reality for residents.

In this chapter, the focus is on the character and spatial dimensions of Mumbai; the changing demography of the city; its social and economic patterns; its political, economic and cultural roles; its regional and global links; and the challenges and responses of living in Mumbai.

> **Mumbai is like Manhattan. There is a certain pace, a social life and the thrill of professional life.**
>
> **Madhuri Dixit, Indian actor**

10.0.1 Mumbai, the state capital of Maharashtra, India

Chapter glossary

archipelago a chain or a group of islands

BCE Before the Common Era, Before Current Era or Before Christian Era; any time before the year 1 CE in the current system of counting

cable landing station a place where international underwater cables meet the land

caste system a Hindu social stratification system that divides Hindus into four rigid, hierarchical groups

chawls buildings to house factory workers; usually four- to five-storeys, with up to 16 dwellings on each floor

deindustrialisation a reduction in industrial activity because of a major economic or social change

Fourth Industrial Revolution new and emerging technologies that are expected to transform and disrupt economies, and the way people work, communicate and live, including cloud technology, artificial intelligence and augmented reality

informal sector part of any economy that is neither taxed nor monitored by any form of government

information technology (IT) the use of computers to create, process, store, exchange and retrieve information and data

information technology-enabled services (ITES) outsourcing of services where the provider utilises telecommunication technologies and the internet

infrastructure the basic systems transport, communication, electricity, water and sewerage

land reclamation the process of creating new land from the sea or wetlands by placing landfill in them to raise their elevation above sea level

liberalisation the easing of government controls and restrictions (such as trade barriers) to improve business opportunities and economic growth

natural increase the difference between the birth rate and the death rate

security of tenure the legal right to continue living in or using a dwelling

shanties informal small, poorly constructed dwellings

slum an informal settlement that lacks one or more of the following conditions: access to clean water, access to sanitation, adequate living space and durable construction

special economic zone (SEZ) a geographical region that has economic laws that are more liberal than the rest of a nation's domestic economic laws

squatter settlements an informal settlement where residents do not have a legal right to occupy the land and do not have security of tenure

urbanisation an increase in the proportion of people living in urban areas

UNIT 10.1

The character and spatial dimensions of Mumbai

10.1.1 Mumbai is in Maharashtra in the south-west of India. Its geographical location facing West Asia, Africa and the Suez Canal, provides access to Europe and has established Mumbai's' trading supremacy in the region.

Mumbai is a place of extremes. It is a city of exploding size with immense wealth and inherent poverty, where the luxury skyscrapers of the rich sit alongside the informal settlements of the poor. Like other megacities in the developing world, Mumbai has attracted a flood of rural migrants looking for a better life. The sheer scale of rapid **urbanisation** over the last 60 years has outstripped the ability of city planners to accommodate these migrants. This rapid expansion has been characterised by the growth of informal settlements, also known as **slums**, and poverty. Overcrowding, a lack of basic amenities and unsound dwellings characterise such neighbourhoods, whose residents endure squalor and lack **security of tenure**. The twin phenomena of urbanisation and the proliferation of informal settlements together pose the greatest challenges for Mumbai, especially as having established its commercial and financial supremacy in India, it strives to be recognised as an influential world city.

A favourable location

Mumbai (latitude 19°34' N, longitude 72°52' E) is the capital city of the state of Maharashtra in the south-west of India (see Figure 10.1.1). It is located on the coast of the Arabian Sea and has a deep natural harbour, which has faciliated its growth and development.

Mumbai was originally an **archipelago** of seven small islands that were home to the fishing communities of the Koli people. The islands fell under the control of several empires, initially the Portuguese, then the British, who leased the islands to the British East India Company in 1668 for commercial purposes. To make more profit on the islands, the British set about reclaiming them from the sea. In 1782, William Hornby, Governor of Bombay, commenced the first reclamation project, which involved building a causeway between two of the islands. Subsequent **land reclamation** projects continued and by 1845 all the islands were joined to form a single landmass known as Bombay Island.

Bombay was connected to Salsette Island in the north by road and rail, providing access to the rest of India. This supported Bombay's role as a major trading centre. East of the island was a deep, natural harbour of 400 square kilometres sheltered from the open sea. The British colonial administrators developed it to become the most important port on the Arabian Sea. As the number of businesses and support services around the port increased, Bombay grew under British rule. During the American Civil War, Bombay became the leading cotton-trading market in the world and its mill industry was so large that it employed nearly three-quarters of the city's labour force.

The East India Company quickly recognised the superiority of Indian cotton and established textile mills in Bombay in the 1850s, which marked the beginning of industry in Bombay. As with any major port, Bombay became industrialised, processing goods for export and handling imports, with most trade taking place with Britain. This marked the establishment of neighbourhoods in less desirable areas close to the factories, where the factory and wharf workers lived in sub-standard dwellings. These are the same informal settlements that exist in Mumbai today.

Did you know?

Mumbai has a tropical monsoon climate with two seasons: wet and dry. In summer, the weather is uncomfortably hot and humid, often reaching 40°C. The summer monsoons deluge the city and over 760 mm of rain has fallen in a single day. The winters are dry and temperatures range between 23°C and 30°C. The climate of Maharashtra suits cotton growing and the state has the largest area under cotton cultivation in India.

SPOTLIGHT

The Gateway of India

The British dubbed Bombay's port and its surrounds as the Gateway to India. Its west coast location made it the closest port of entry for those travelling by sea to the subcontinent from Europe. When the Suez Canal opened in 1858, ships no longer had to sail around the Cape of Good Hope in Africa, cutting travel time from 3 months to 4 weeks. This transformed sea travel and trade with Bombay and the city thrived, as an expanding network of railway lines connected the growing city with the rest of the country.

In 1913, an arch-shaped monument was built to commemorate the first British monarch to visit India, King George V (see Figure 10.1.2). It was known as the Gateway of India and served as a symbolic ceremonial entrance for high-ranking British colonial personnel, until India's independence in 1947.

10.1.2 The Gateway of India, constructed by the British, has become an important landmark in Mumbai.

Did you know?

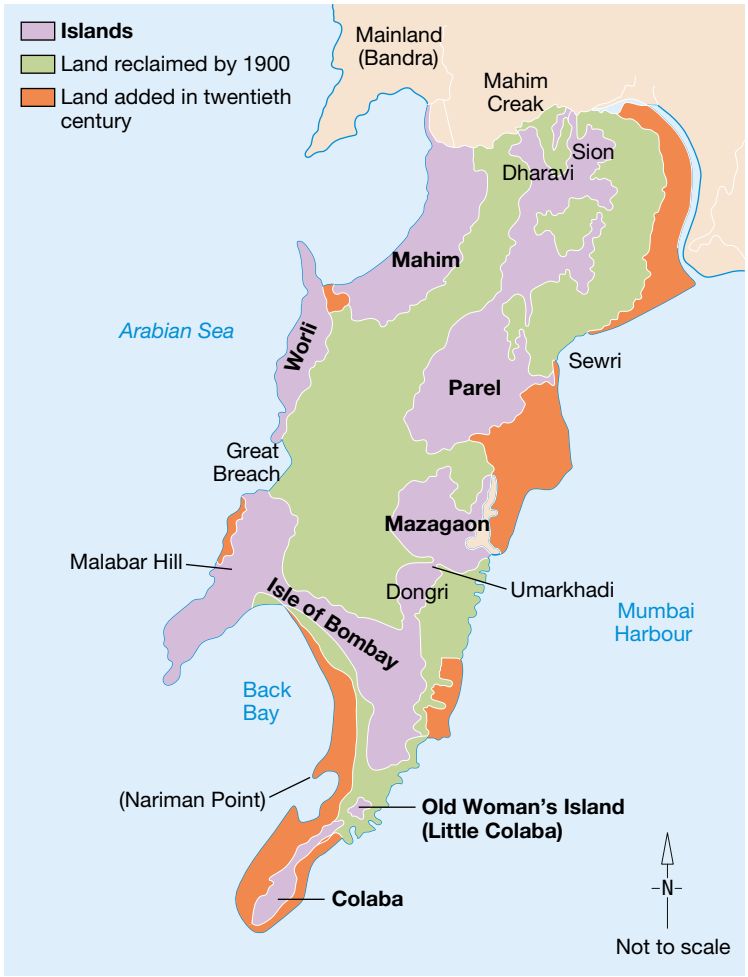
Mumbai is thought to have taken its name from the local Hindu goddess Mumba of the Koli community, whose temple once stood on one of the islands. However, it became known as Bombay under British colonial rule, perhaps because of how the British pronounced Mumbai. Or it may have come from the Portuguese 'bom baia' meaning 'good bay'. Bombay was the official name of the city until 1995, when the original name Mumbai was restored. Bombay is still commonly used.

Site

The present-day city of Mumbai is built on an archipelago (see Figure 10.1.3). It is made up of the original seven islands plus reclaimed land. Land reclamation was undertaken during both the colonial and the post-independence periods. In Mumbai, more land reclamation has taken place in the last 40 years than during the previous 300 years.

A major land reclamation project was completed by the Bombay Port Trust in 1918 when it constructed a dry dock. Embankments were built to control water flow, and one by one the hills on Bombay Island were levelled, broken up and dumped in the sea, which built up land for residential, industrial and commercial use.

With city administrators desperate to find more space for the migrants pouring into Mumbai, many projects were undertaken as the city continued to grow in an unplanned and unrestrained manner. Land was reclaimed from the sea, its inlets and the mangroves lining its shores, by both legal and illegal means (see Figure 10.1.4).

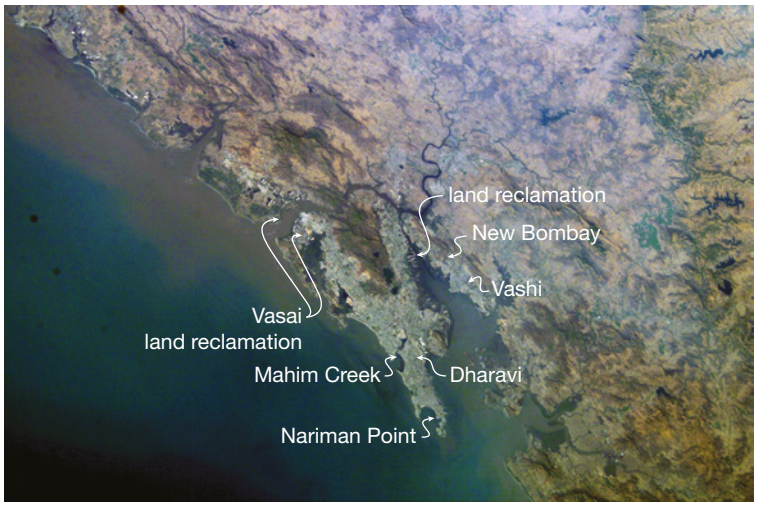


10.1.3 The original seven islands and the subsequent physical growth of Mumbai

10.1.4 Substantial areas of mangroves lining the shoreline of the harbour and waterways remain at risk of land reclamation. Mumbai has already lost 40 per cent of its mangroves.

Mumbai's ability to physically grow is constrained by the Arabian Sea to the west, the harbour to the east and creek systems to the north. As seen in Figures 10.1.4 and 10.1.5, land reclamation has occurred in the waterways of Vasai and in the mangroves lining the west of Mumbai Harbour.

As the city has expanded west of Mumbai Harbour, Navi Mumbai was established as a satellite city to accommodate growth. Again, natural hills were flattened and broken up and the debris was used to fill in wetlands and waterways. In both the construction of the Navi Mumbai International Airport and Jawaharlal Nehru Port, mangroves have been lost to make way for terminals, roads and container **infrastructure**.



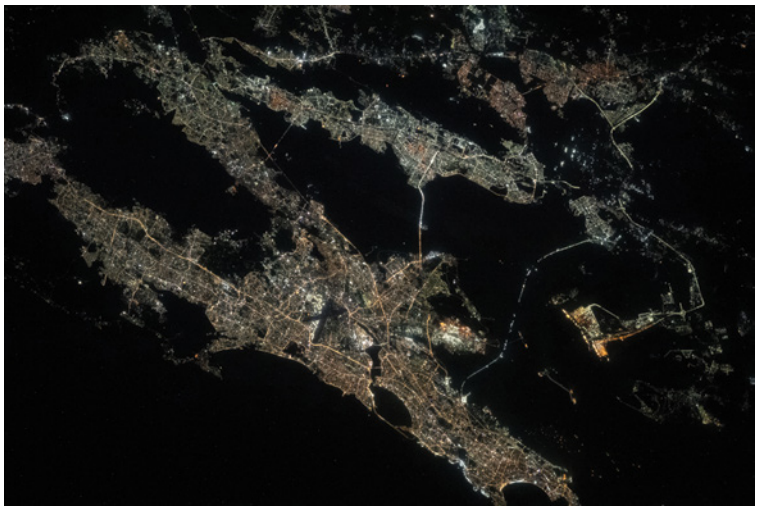
10.1.5 Mumbai from space. The site of the city and the constrictions on its expansion are evident with the sea to both the east and the west and the waterways to the north. Both Vasai in the north and the wetlands lining the western side of Mumbai Harbour are sites of land reclamation.

Mumbai's urban morphology

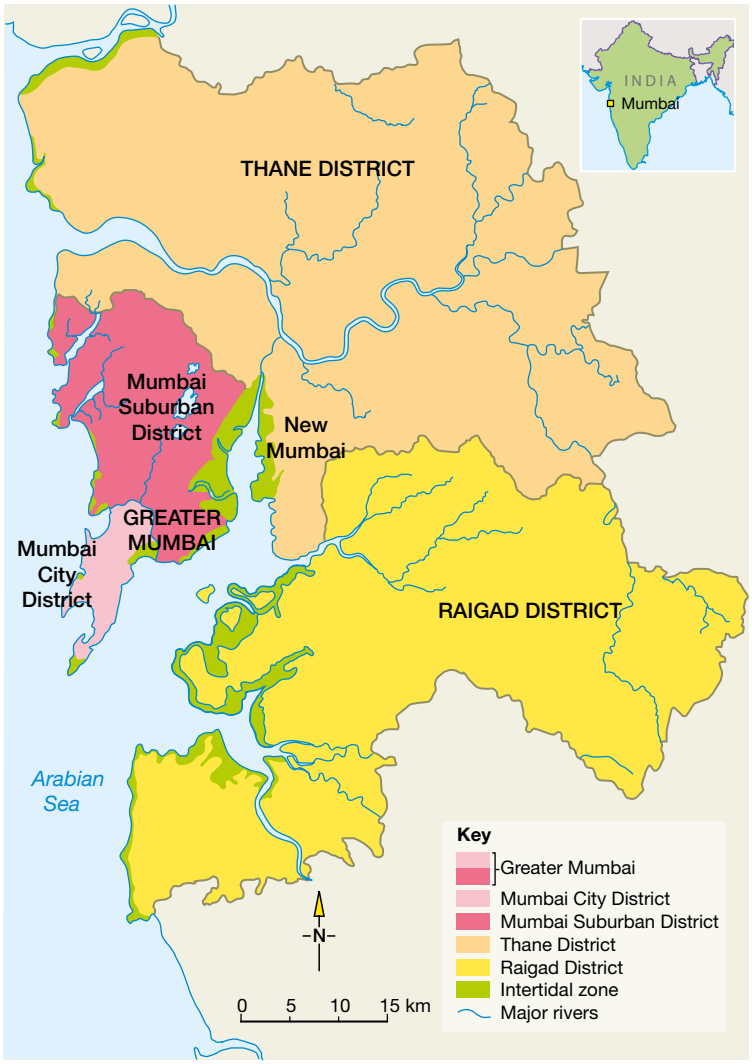
The Mumbai Metropolitan Region (MMR) has grown to 6328 square kilometres as it has spread to the north and across to the mainland on the eastern side of Mumbai Harbour. This can be observed in Figures 10.1.6 and 10.1.7. It consists of distinct districts, the Mumbai City district, the Mumbai Suburban district, the district of Thane, to the east and north, and the district of Raigad, to the south.

Did you know?

Most of Mumbai sits at or near sea level, with the average elevation between 10 and 15 metres above sea level (ASL). A quarter of Bombay Island lies below sea level and the airport sits at only 7.5 metres ASL. This creates many challenges, making Mumbai vulnerable to flooding in the monsoon season and inundation from rising sea levels due to climate change.



10.1.6 Mumbai seen from space at night



10.1.7 The Mumbai Metropolitan Region. The area shown as Greater Mumbai consists of the city and suburban districts. The most recent growth in Thane and Raigad has brought them into the metropolitan region.

Mumbai City district

The Mumbai City district occupies the southern tip of Bombay Island. It is the oldest part of the city, the historic core where the British built the docks, established textile factories and merchants set up businesses. As the area became more commercialised, the wealthy British and Indian elite moved southwards along the coast to establish exclusive residential districts, such as Malabar Hill overlooking the Arabian Sea. The centre of commerce increased in influence and became the CBD of Mumbai. Both India's national stock exchanges are in the CBD, the National Stock Exchange and the Bombay Stock Exchange. There are several distinctive areas in the CBD, the most prominent being Nariman Point and the Bandra Kurla Complex (BKC). These premium business hubs also have upscale residential condominiums and command some of the most expensive real estate in the world. They include the corporate towers of major institutions, banks and corporations such as Citibank, Bank of India, Microsoft, Dow Chemicals, Amazon and Spotify.

To its north, the CBD merges into a commercial-residential area. This is where most of the older factories and docklands are located and where textile workers previously lived. It is now characterised by overcrowded and poorly maintained squatter and informal settlement settlements, including Mumbai's largest, Dharavi.

SPOTLIGHT

Antilia: The world's second-most expensive property

Antilia is the home of India's richest man, Mukesh Ambani. He is chairman of Reliance Industries, India's most valuable private company, with a net worth of $96.4 billion, according to the Bloomberg Billionaires Index. Antilia is the second-most expensive property in the world, after Buckingham Palace, UK. It is designed for luxury with a ballroom, a 50-seat theatre, a temple and terraced gardens. It has a six-level car park for 168 luxury cars, with its own servicing station. Antilia is a 27-storey structure, but it stands as tall as a 60-storey building because of its high ceilings (see Figure 10.1.8). It is accessed by nine high-speed lifts and has three helipads on the roof. Antilia sits next to the Golibar informal settlement in central Mumbai, where both the rich and the poor are squeezed together.

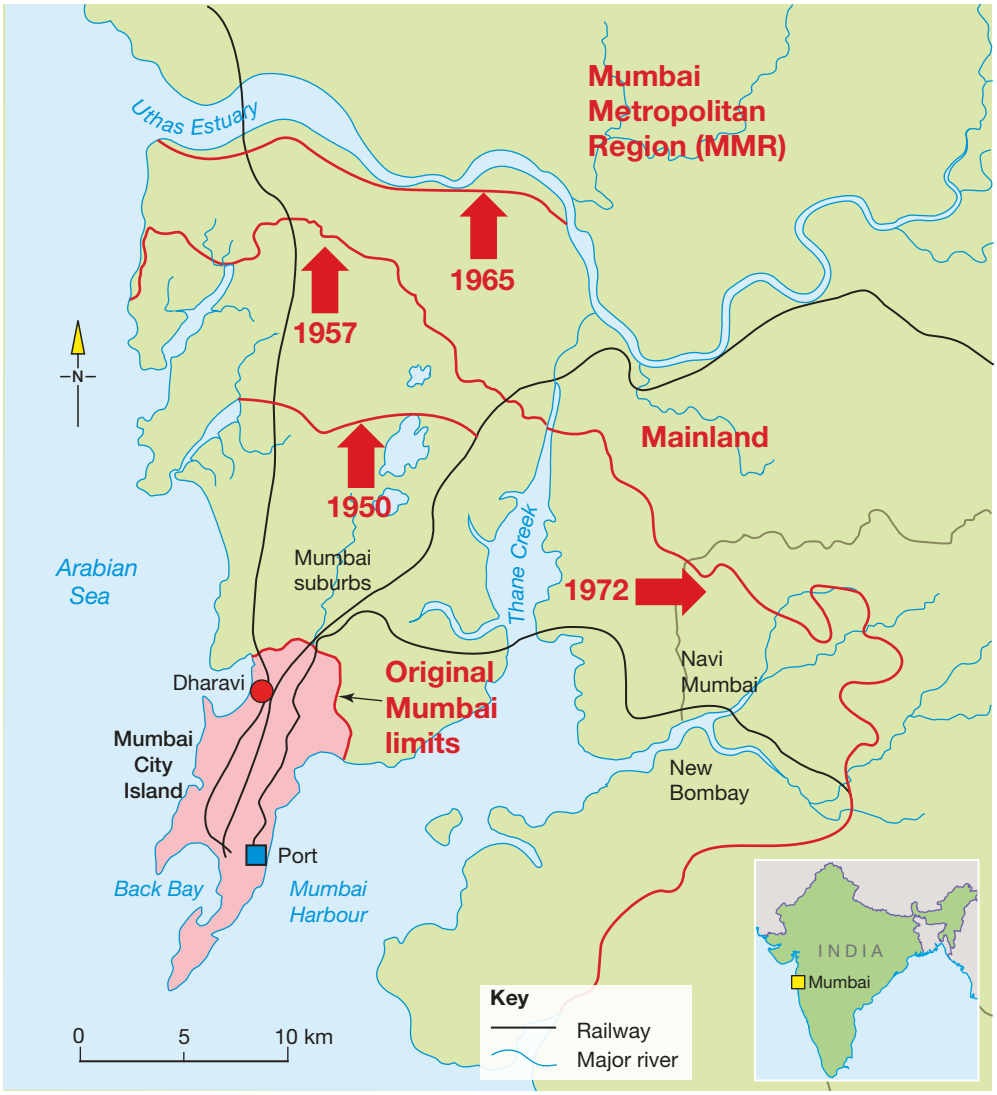
10.1.8 Antilia towers over the other buildings in the area and can be seen from all directions.

Mumbai Suburban district

With the growth of Mumbai's manufacturing and its surge in population, Mumbai City district quickly became crowded and congested. After independence, industry and housing of the working class moved northwards and the Mumbai Suburban district began to grow at a faster rate than the city. This district occupies the central region of Salsette Island. New industrial areas were developed along the railway line as production diversified into metals, chemicals and electronics. It became a jumble of cotton mills, factories, railway lines, congested roads and overcrowded informal settlements. Workers were forced to settle in informal housing in less desirable areas, such as marshes and along railway tracks.

Mumbai has had a long history of suburbanisation, initially to the north along roads and railways and then across to the mainland on the east where vast sprawling suburbs are characteristic (see Figure 10.1.9). In the 1970s, this growth was accompanied by the development of new industrial areas in extended suburbs. It was during this decade that the population of the suburbs overtook the city district. Surrounding towns and villages have been absorbed into the MMR as the built-up area has spread.

In 1971, the City Industrial Development Corporation (CIDCO) was set up, with the aims of decongesting Mumbai and dispersing its population. CIDCO planned and constructed a second city centre. Navi Mumbai, the new twin city, was established on the mainland (see Figure 10.1.10). It is the largest planned city in the world and is an active business hub with many regional offices of transnational corporations, such as Barclays, Bank of America and Stream Global Services.



10.1.9 The Mumbai Metropolitan Region initially spread north and then across to the mainland.

Thane and Raigad

During the last 20 years, Thane has absorbed much of Mumbai's expansion and now has the largest population of any district in India. It also has one of Asia's largest industrial belts, which provides employment for 60 000 people. With investments in infrastructure, logistics hubs have developed, as well as business parks. Thane has also emerged as a preferred place to live in the MMR with the growth of residential towers, for those who can afford them. As elsewhere in Mumbai, informal settlements proliferate. Raigad is also rapidly emerging as an industrial city and a major producer of steel and power.

10.1.10 Navi Mumbai

Activities

Acquiring and processing geographical information

1 Summarise why Mumbai is important to India.

2 Describe the stark contrast that exists in Mumbai.

3 Explain why Mumbai has been a magnet for rural migrants and how the scale of urbanisation has affected the city.

4 Summarise the greatest challenges faced by Mumbai.

5 Describe the location of Mumbai and how this has favoured its development.

6 Explain why land reclamation was undertaken in Mumbai and what it involved.

7 Describe the role played by the East India Company in the early history of Mumbai.

8 Explain the physical constraints on the growth of Mumbai and why this has resulted in continued land reclamation.

9 Describe the elevation of Mumbai and how this is problematic both now and will be even more so in the future.

10 Describe the location and spatial extent of Mumbai.

11 Explain the importance of the Mumbai City district.

12 Describe the pattern of suburbanisation that occurred as Mumbai grew.

13 Name the district that has absorbed much of the city's growth in recent decades. Describe how it has transformed the area.

Applying and communicating geographical understanding

14 Study Figure 10.1.1 and the box, Spotlight: The Gateway of India. Justify why this monument is so named.

15 Study the text and Figure 10.1.3. Describe the various phases of land reclamation in creating Mumbai Island.

16 Study the text and Figures 10.1.4 and 10.1.5. Explain the location of land reclamation areas.

17 Study the text and Figures 10.1.4 to 10.1.6. Why are there no lights visible in some areas of Figure 10.1.6?

18 Study the text and Figure 10.1.9. Write a paragraph summarising the spatial expansion of Mumbai because of suburbanisation.

UNIT 10.2

The changing demography of Mumbai

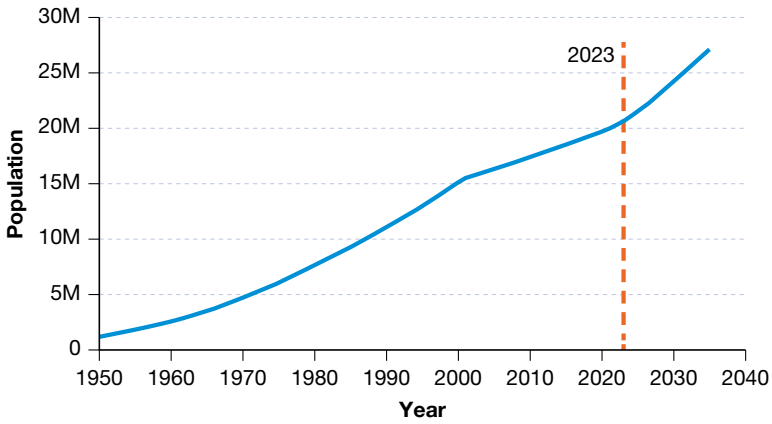
From its earliest days, the changing demography of Mumbai has reflected the forces shaping it. In 1872, Bombay was one of the world's most populous cities, and today, Mumbai is the world's fourth most populous city. Its 2023 population was estimated to be 21 296 517, making it the second-largest city in India, after the capital Delhi. The MMR is also one of the world's densest urban agglomerations, with a population density of 28 000 per square kilometre. It is the physical restrictions on the expansion of Mumbai that have led to its astonishing increase in population density. Residents have little choice but to live in cheap, cramped, substandard housing, often far from work. They must endure long commutes on the city's crowded mass transport systems.

Did you know?

In Mumbai, the living space per person is only 4.5 square metres, compared to 87 square metres for Australians.

The growth of Mumbai

In 1900, Mumbai's population was 850 000; by 1950 it had doubled. The biggest population growth was after independence in 1947. While the annual rate of growth rate then slowed, the population continued to rise, reaching 16 million in 2000. The annual growth rate is increasing again, and the UN predicts that Mumbai will have a population of over 27 million by 2035 (see Figure 10.2.1). Its population growth first peaked in the Mumbai City district, then in the suburbs. Population growth is fastest in the north, with the fastest growth in the informal settlements of the poorest areas. Most of the recent growth in population in the MMR has been is in outlying suburbs of Thane and Raigad.



10.2.1 The growth of Mumbai's population

Natural increase

Births and deaths cause population change, and it is the difference between the birth rate and the death rate that determines **natural increase** in population. This has been a major cause of population growth in Mumbai, accounting for over 60 per cent of the rise in population. Many of the city's residents tend to be young and of childbearing age. Mumbai's birth rate is much lower than the rest of India as a whole, because of the implementation of successful family-planning programs. Improvements in health care and sanitation have lowered Mumbai's death rate.

Migration

Migration has also been a significant part of Mumbai's population growth. In other Indian cities, migration largely comes from within the state. However, in Mumbai, 67 per cent of its migrants come from other states. Migrants are attracted to Mumbai for its employment opportunities, as a centre of trade, commerce and industry in India. Many migrants to Mumbai are unskilled labourers from rural areas, and their main reason for moving is employment. Migrants from across India believe their quality of life will improve in Mumbai and that their families will have access to medical and educational facilities.

Structure of the population

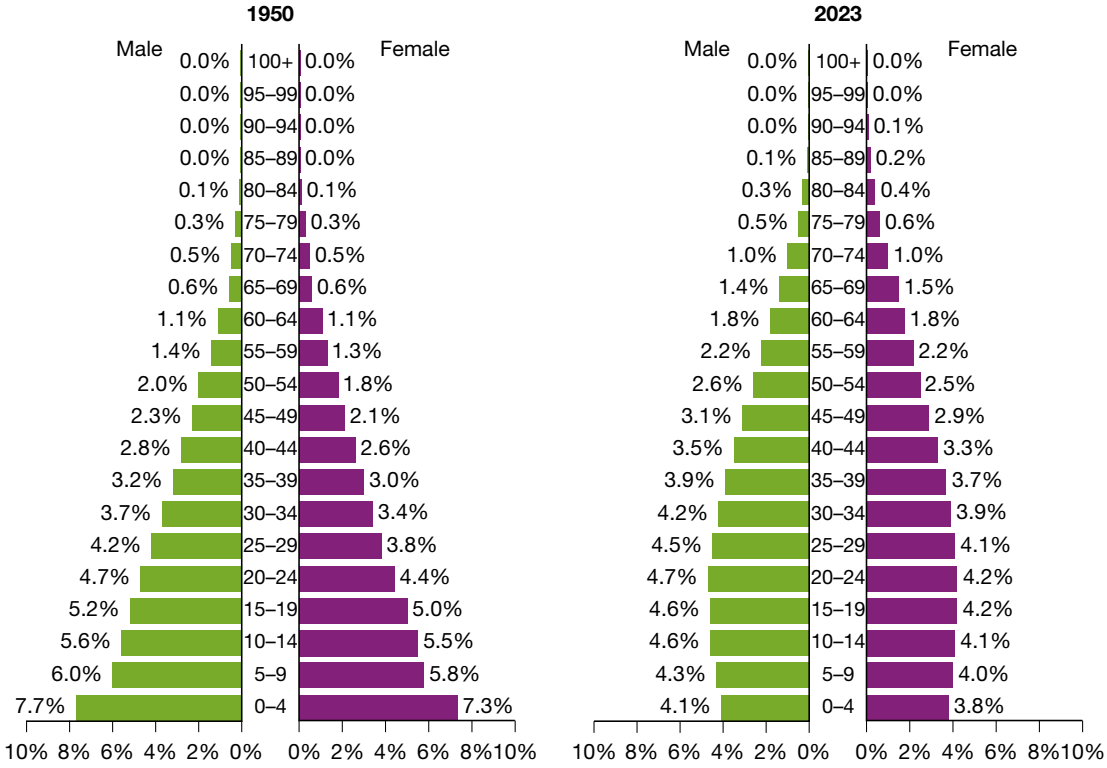
The structure of India's population is reflected in Mumbai. Figure 10.2.2 shows that India's population structure was typical of a developing country for 40 years after independence: it displays the broad base of a young population, narrowing towards the older cohorts, indicative of a low life expectancy. By 2023, the population pyramid had started to tuck in at the bottom. It tends to do so as a country develops, the fertility rate drops and life expectancy improves because of better health care lowering the death rate.

The population pyramid also shows the gender difference between males and females. In Mumbai in 2023 there were 853 females per 1000 males. This reflects the preference for male children, the low status of women and a higher mortality rate among women in relation to childbearing. However, Mumbai's sex ratio is lower than the national average

Did you know?

The average literacy rate in Mumbai is 89.73, with male literacy at 92.56 and female literacy at 86.39. This rate is higher than the state of Maharashtra as a whole, which stands at 82.34.

of 914 females per 1000 males. This is related to the larger number of lone male migrants seeking work in Mumbai.



10.2.2 The structure of India's population 1950 to 2023

● **SPOTLIGHT**

India's demographic transition

India has gone through a demographic transition. It experienced a baby boom from 1980 to 1994, which subsequently boosted its working-age population (20–60 years of age). This has grown from 44 per cent in 1980, to 55 per cent in 2022. It is expected to peak at 58 per cent in 2032. Globally, between 2021 and 2052, India will have the highest share of working-age population in the world.

This will lift India's productivity, but it will also mean that India's old-age dependency ratio will rise in the future. It is currently 19 per cent and is expected to increase to 35 per cent by 2050. Therefore, the benefits of the demographic transition could fade away when India's baby boom generation starts retiring and needs to be supported.

Activities

Acquiring and processing geographical information

1 Describe the population size and population density of Mumbai. How does it compare to the rest of the world?

2 Describe the pattern of population growth over time in Mumbai and its spatial spread.

3 Describe the contribution of natural increase to Mumbai's population.

4 Explain why migration into Mumbai differs to other Indian cities. What does this demonstrate?

5 Describe and account for the gender difference in Mumbai's population.

6 Explain how India's demographic transition may initially benefit India, but may be a burden in the future.

7 Describe the average literacy rate in Mumbai and compare it to the rest of the state of Maharashtra. Why do you think Mumbai is different?

Applying and communicating geographical understanding

8 Study Figure 10.2.1. Describe the growth of Mumbai's population from 1950 to 2035.

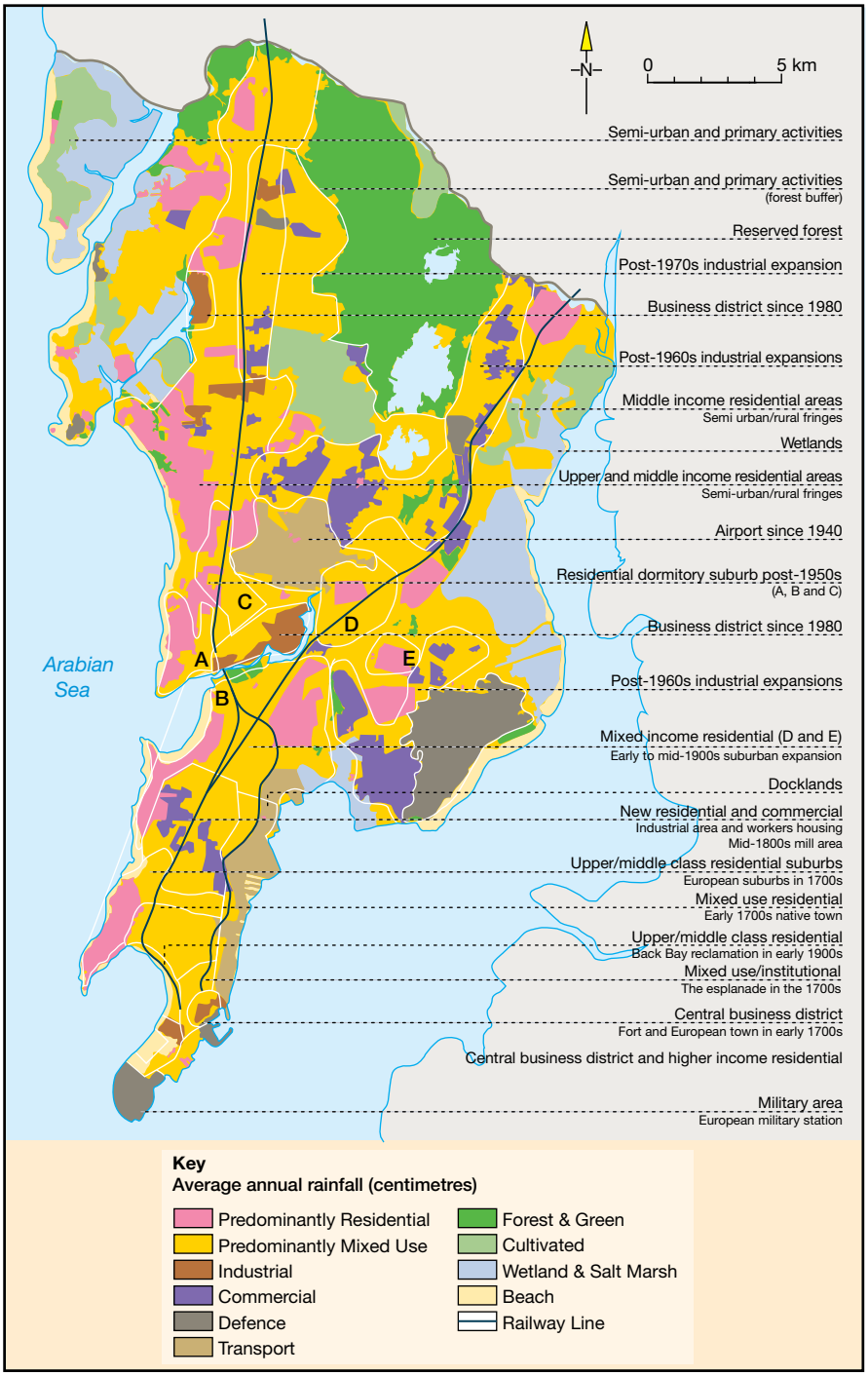
9 Study Figure 10.2.2 and complete the following tasks.

- **a** Calculate the difference in the percentage of children under 10 between 1950 and 2023.
- **b** Explain the reasons for this difference.
- **c** Calculate the percentage of the population of working age (20–60 years of age) in both 1950 and 2023.

UNIT 10.3

Social and economic patterns

Mumbai is a symbol of India's ambition to be wealthy and powerful again. The city has attracted people from some of the most remote parts of the country with the promise of a new beginning and a better life. Mumbai has grown its economy to become India's wealthiest city, yet it is a city of stark contrasts where the ultra-rich share neighbourhoods with impoverished slum-dwellers.



10.3.1 The land use in Mumbai in 2012, showing the various phases of urbanisation

Economic patterns

Mumbai has a diverse and dynamic character. Its long history played out on a site limiting its spatial expansion, which has resulted in overcrowding, fragmentation and a merging of several types of land use. This is evident in Figure 10.3.1, which shows the distinct phases of urbanisation and the economic pattern of Mumbai. The immediate impression when examining the map is that it is a mosaic of different land uses, some planned, most not. In time, pressures forced the city to spill to the north and onto the mainland east of the harbour.

In the colonial era, Mumbai functioned as a port city, a gateway into India. It soon became the centre of trade and commerce. Towards the end of the nineteenth century, industry became established in the city and textiles dominated its economy. After independence in 1947, the government adopted a model of economic development that combined features of both capitalism and socialism. The government invested heavily in large state-owned industrial enterprises producing steel, chemicals and machinery, with the goal of reducing the country's reliance on imports of basic and heavy industrial goods. In 1991, the government embraced a free-market model of economic development, investing heavily in infrastructure to support economic growth. The guiding principles of policy became **liberalisation**, privatisation and globalisation. The economy responded with a surge in growth, averaging 6.3 per cent annually in the 1990s and early 2000s, double the rate of previous decades. Manufacturing in Mumbai diversified into a wide range of engineering products, automobiles, chemicals and petrochemicals in an extensive suburban manufacturing zone north of the Mumbai City district.

The dominance of Mumbai's textile manufacturing waned in the 1990s, as **deindustrialisation** occurred due to

Industries	Number of companies
Other financial services	184
Trading	172
Investment services	96
Computer software	78
Drugs and pharmaceuticals	65
Other asset financing services	43
Gems and jewellery	32
Textile processing	32
Commercial complexes	24
Metal products	21
Organic chemicals	21
Other chemicals	20
Steel	20

10.3.2 A summary of Mumbai's businesses by sector shows the dominance of financial and IT services in the city's economy.

globalisation and liberalisation. With the opening of the economy to the global market, the textile mills were an early casualty. There were once 58 textile mills in Mumbai, and as they closed the mill compounds were gentrified. In the Kamala Mills area in the CBD, mill structures and warehouses were converted into art galleries, media outlets and fashion houses, as the creative industries moved in. This reflects the shift in the economic pattern of Mumbai to the service sector. The city became dominated by financial and **information technology (IT)** businesses (see Figure 10.3.2). The emergence of Mumbai as the financial capital of India resulted in an unprecedented change in its business landscape and urban form.

● **SPOTLIGHT**

Reliance Industries mirrors the changing economic pattern in Mumbai

Reliance Industries has grown from a textiles and polyester producer to become the largest private-sector corporation in India. It has been at the forefront of changes in the Indian economy. Reliance Industries developed into a mega manufacturing company, diversifying into chemicals, hydrocarbons and petrochemicals. It also entered the retail market and is now the largest retailer by revenue in India. Its outlets sell everything from groceries and clothing to electronic goods and farm tools. In 2020, it launched its online shopping platform, JioMart in over 200 cities in India.

Reliance Communications was established in 2004, moving into cloud phone systems. Then in 2007, it established Reliance Jio Infocomm Limited, India's largest telecommunications company, servicing both individuals and businesses across the country. Reliance is credited with bringing the digital revolution to India. Its headquarters are Reliance Corporate Park, Ghansoli, Navi Mumbai (see Figure 10.3.3).

Reliance Industries is a Fortune Global 500 company. In 2023 it was ranked 88th largest in the world, up from 104th in 2022. The motto of the corporation is 'Growth is life' (see Figure 10.3.4) and they are focused on building platforms that support the **Fourth Industrial Revolution** (see Unit 10.4, page 301).

10.3.3 The headquarters of Reliance Jio Infocomm Limited in Navi Mumbai

10.3.4 The logo and motto of Reliance Industries

The Navi Mumbai special economic zone

A **special economic zone (SEZ)** is a geographical region with economic laws that are more liberal than the rest of a nation's domestic economic laws. In India, they are set up by the federal government. SEZs have attracted the investment of many transnational corporations (TNCs), as they offer superior infrastructure, tax incentives and duty-free exports. Approvals for developments favour IT, **information technology-enabled services (ITES)**, biotechnology, pharmaceuticals and engineering.

Navi Mumbai enjoys the status of an SEZ with the benefits of tax incentives and fewer regulations than elsewhere. An early development was Millennium Park, which has become the largest state-of-the-art software park in India. More recently, the old industrial cluster of chemical factories between the satellite cities of Thane and Navi Mumbai have been replaced by a high-tech, multi-storeyed business complex. This road corridor occupies 27 square kilometres. It holds the offices of Reliance Jio Infocomm Ltd and software services providers and consultants, including Accenture.

The informal sector

The new urban landscape with its corporate towers, shopping malls, high-end restaurants and luxurious apartments is in sharp contrast to the informal settlements of the working poor that sit alongside them. This is the stark reality of a significant section of the economic pattern of Mumbai, the **informal sector**. While the informal settlements are inadequate as residential environments, through necessity their residents have created their own work. This work might be street vending, rickshaw-pulling or grinding up discarded plastic ready to be fashioned into fake Barbie dolls.

Informal employment as a proportion of total urban employment in Mumbai has increased from one-third in the 1960s to more than two-thirds today. In the past, a migrant may have found a job in a factory. However, with deindustrialisation, the availability of these low-skill jobs has declined. Informal settlement residents generally do not have the level of education or skills that would make them employable in the new finance and IT industries of Mumbai today, so creating their own work is fundamental to their survival. Still, the promise of work draws people like a magnet and with the focus on developing the economy of Navi Mumbai, people have followed, hopeful of being part of it. This is visible in the informal settlements that surround the new Navi Mumbai International Airport on all sides.

Did you know?

Those working in the informal sector have created opportunities for themselves. They operate outside the regulated formal economy, so they do not pay taxes. However, there are no work contracts, and they may work in dangerous conditions.

● SPOTLIGHT

Dharavi

Until the late nineteenth century, the site of Dharavi was a mangrove swamp where the Koli fishers lived. Over time, the swamp was reclaimed and space became available for others. A potter's colony was established by the Kumbha people who came from Gujarat, and Tamils arrived and opened tanneries. Thousands travelled from Uttar Pradesh seeking jobs in the textile mills. As more migrants arrived, they brought with them special skill sets and when unable to find formal employment, set up their own businesses.

Today, Dharavi is a teeming informal settlement of 1 million people crammed into 2.3 square kilometres (see Figure 10.3.5). For the residents of Dharavi, their home is also a space for income-generating activities. Ground floor access offers the most flexibility for blended living and working. Seventy per cent of Dharavi's structures are used for commercial/manufacturing purposes, with 5000 businesses and 15 000 single-room factories. Many of these businesses involve sorting and recycling Mumbai's waste, to give every piece of discarded plastic, oil drum or rag another life. Dharavi is renowned for producing some of Mumbai's best leatherworks, pottery and recycled products, and its entrepreneurial community churns out US$1 billion annually (see Figure 10.3.6).

Despite Dharavi being an inadequate residential environment, its residents enjoy a strong sense of community. They band together with spirit and resilience in the face of adversity.

10.3.5 Dharavi is one of the world's largest informal settlements. It is located across the Mithi River from the Bandra Kurla Complex in Mumbai's CBD.

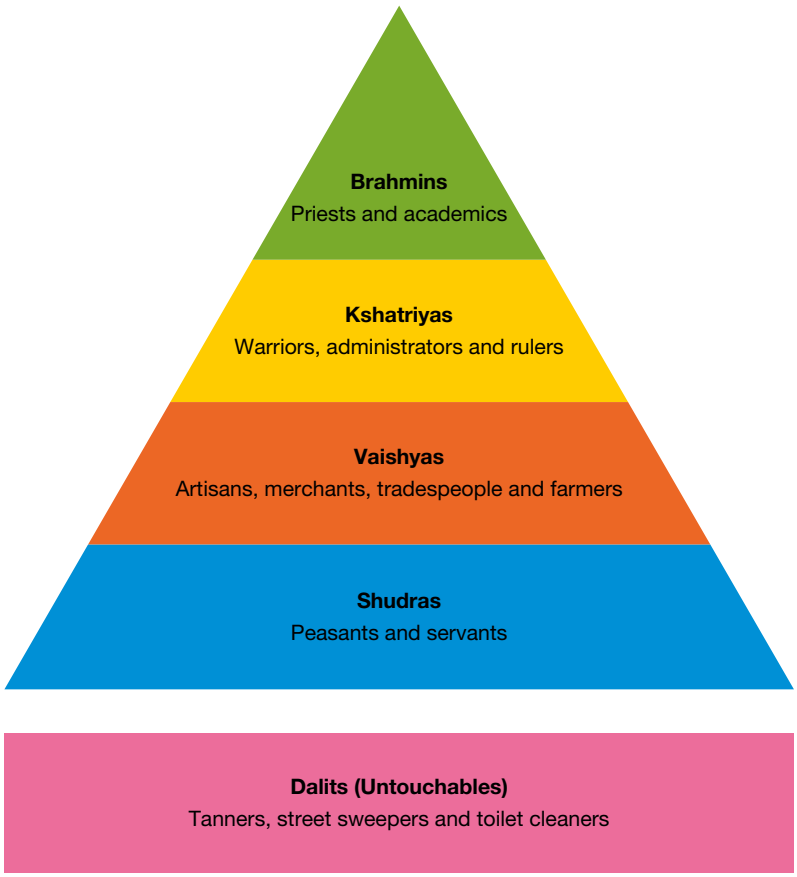
10.3.6 A potter makes clay pots on a pottery wheel in the Dharavi informal settlement

Social patterns

Socio-culturally, Mumbai is a truly diverse city. Historically, it has been home to most major races, languages and religions. Hundreds of small ethnic groups have lived side-by-side as Mumbai has morphed into the cosmopolitan city of today. Many of these close-knit communities still practise the traditions and lifestyles they brought from their homelands. This diversity has provided the backdrop for the evolution of Mumbai's social patterns.

The cultural richness of Mumbai's population can be traced back in history. The earliest known settlers were the Kolis, who established fishing communities on the islands. In the third century **BCE**, the Maurya Empire took control of the islands and established Hindu-Buddhist religion and culture, which remained dominant across successive dynasties until it became a British colony in the 1600s. The British were focused on economic exploitation and did not interfere with the region's religion. Today, 80 per cent of Mumbai's population is Hindu.

Mumbai has the largest Muslim population of any city in India, numbering 2.6 million people. The oldest Muslim communities in Mumbai are the Konkani Muslims and the Ismaili Khojas. In 1640, Parsi refugees arrived from Persia to escape persecution from the Muslims. Hindu India was kind to them, and they were allowed to prosper and grow. When the British arrived, the Parsis were quick to seize the opportunities available as shipbuilders, carpenters, weavers and brokers. Merchants from the neighbouring state of Gujarat were also invited to work with the British and helped establish business in the colony. The British offered them a safe life and religious freedom, as was also enjoyed by the Parsis. To this day, most Gujarati business people live in Mumbai to capitalise on the opportunities available and they are among the wealthiest people in India. Parsis, while being one of Mumbai's smallest minorities, also make up one of the richest communities.



10.3.7 The Hindu caste system. It is believed to have originated from Brahma, the God of Creation: priests, teachers and the intellectuals are at the top, created from Brahma's head; next the warriors and rulers from his arms; the traders from his thighs; and those who did menial jobs came from his feet. At the very bottom are the Untouchables, as the Dalit people are known, who specialised in leather-making and Brahminism declared this was untouchable.

As Mumbai industrialised, it became a major job destination for people across India. These migrants worked in the cotton mills, in construction or service. By 1986, 46% of Mumbai households were migrants.

Today, Mumbai is a city divided, more so than other major cities in India. This can be linked to religion and has, in recent times, been compounded by socio-economic trends at work in Mumbai's quest to become a world city. Urban socio-economic fragmentation and increasing inequalities have significantly shaped the social patterns of Mumbai, widening the gap between rich and poor. This divide now runs deep along both religious and socio-economic status lines. The stark social and spatial disparities in Mumbai's urban landscape continue to grow.

Religion

While most of Mumbai's population is Hindu, there is also a significant Muslim population, as well as Sikhs, Buddhists, Jains and Christians.

Historically, Hinduism's **caste system** has been a defining influence on the social pattern of Mumbai. It is one of the world's oldest systems of social organisation. It divides Hindus into four rigid, hierarchical groups, as seen in Figure 10.3.7. For centuries, the caste system dictated almost every aspect of a Hindu's life, from economic status and

job availability to marriage, depending on the caste one was born into. It can even control what a person can eat or touch. While privileges have been bestowed on the upper castes, the lower castes have been repressed and faced discrimination.

When India gained independence, its constitution banned discrimination based on caste. Many people migrated to Mumbai hopeful that these class lines would be blurred and there would be opportunities for advancement. However, caste continues to play a significant role in employment. Many Dalits continue to work in the dirtiest and most dangerous jobs in Mumbai, including sanitation, cleaning drains and collecting night soil (human faeces). Most of the Dalits in Mumbai live in informal settlements.

Mumbai is divided by religion and Muslim areas are segregated. They live in marginalised communities, mainly in the informal settlements. Opportunities to lift themselves out of poverty are hampered by Muslims having the lowest literacy rate of any religious groups in Mumbai.

Conflict

The established urban rhythms associated with space, work and life in Mumbai are being disrupted. The cause is the placement of different classes of people together in the same urban space without one being displaced or substituted. As Mumbai pushes to become an influential world city, there is added pressure on the crowded city. Those who have the skills and the education to find employment in the rising IT and finance sectors seek luxury accommodation. In the Mumbai City district, on the site of the old textile mills, the dilapidated tenement houses in informal settlements are entrapped by expensive apartment buildings (see Figure 10.3.8). This creates a sense of discontent as the slum-dwellers cling to their old neighbourhoods and aspirational apartment dwellers would want to get rid of the adjacent informal settlements, which they consider unsightly.

While Mumbai, and indeed India, is recognised for the harmonious co-existence of diverse groups, when conflict arises it is often violent. Mumbai's social fabric is changing as the city develops and minority groups are forced into informal settlements. More than half the population live in cramped conditions in informal settlements. Most of the residents are lower caste Hindus or Muslims, who are unable to find housing elsewhere, or formal employment, or more likely, both. They struggle to access basic amenities, or find a job or better living conditions. In one of these large informal settlement areas, Malwani, overcrowding is escalating religious conflict between Hindu and Muslim residents. The informal settlement has become extremely dangerous, with violence between the groups and many illegal activities, such as drug trafficking and gambling.

10.3.8 Informal housing directly abuts some of the wealthiest neighbourhoods in the Mumbai City district.

Activities

Acquiring and processing geographical information

1 Explain how the limitations of Mumbai's site have affected its economic pattern.

2 Summarise the history of manufacturing in Mumbai.

3 Explain how government policies changed from the 1950s, immediately after independence, to the 1990s. Why was this was considered necessary?

4 Name the industry that suffered the most because of globalisation and explain the drop in production.

5 Describe how the buildings used in the industry named in activity 4 were then re-purposed.

6 Define special economic zones (SEZ). Explain why they attract investment and development.

7 Demonstrate how Navi Mumbai has benefited from being an SEZ.

8 Explain why employment in Mumbai has become dominated by the informal sector.

9 Study the box, Spotlight: Dharavi and summarise the economic contribution of the informal settlement.

10 Give reasons for the diverse socio-economic mix of Mumbai.

11 Explain how the Hindu caste system has been a defining influence on the social pattern of the city.

12 Describe and account for the deepening divide and conflict that is occurring in Mumbai.

Applying and communicating geographical understanding

13 Study Figure 10.3.1. Describe the pattern of land use in Mumbai, noting the phases of urbanisation.

14 Study Figure 10.3.2. Calculate the percentage of the finance and IT sectors within the total industry in Mumbai.

15 Study Figure 10.3.3. Using the internet, identify the two largest SEZs in Mumbai. Describe their locations, indicate the type of SEZ and the area that they occupy.

16 Study the text under the heading, Social patterns and Figure 10.3.7. Write a paragraph on the Hindu caste system and how it influences human wellbeing.

UNIT 10.4

Mumbai's political, economic and cultural roles

The port function of Mumbai has historically been influential in India. As the country has embraced globalisation, its size has increased significantly. Mumbai's economic clout is obvious, and it has also been accompanied by a growing influence on culture and the political sphere. Today, India's fortunes are inherently linked to Mumbai.

Mumbai's political role

Mumbai is the state capital of Maharashtra, the most prosperous state in India. The central Indian government controls the transport and communication infrastructure within Maharashtra, including the port, airports and railways. The Maharashtra state government controls law and order, police, water and electricity, health and education.

Mumbai is administered by the Municipal Corporation of Greater Mumbai (MCGM). The municipal corporation and the mayor are elected every five years.

The MCGM's specific duties in delivering public services include the:

- road network within the city
- public supply of clean drinking water and electricity
- implementation of regulations for city planning, building construction and drainage projects
- maintenance of sanitation and health, which includes garbage collection and the sewerage system
- provision and upkeep of hospitals, health centres and public toilets
- upkeep of statistical records, such as the registration of births and deaths.

In effect, the MCGM oversees the key inputs important to the successful operation of the economy of both the city and the state. With globalisation, TNCs and international investment flows are drawn to efficient and cost-effective locations. For Mumbai to remain competitive globally, reliable delivery of these services is critical. Recent high-tech corporate developments in Navi Mumbai point to success in attracting such investments.

However, there are many who see deficiencies in Mumbai's city governance and that the public goods and services delivery system does not serve all who rely on it. Democratic political institutions are intended to ensure the delivery of services and foster development for all. The people expect that elected representatives will act in the public interest. There is a perception that because the wealthy are in formal employment and pay taxes, their neighbourhoods should receive more public funding. Whereas residents in poor, marginalised areas are in the informal sector and don't contribute tax revenue. As a result, their neighbourhoods receive little public funding. What is clear is that the stream of people into Mumbai has overwhelmed city administrators, who have been unable to accommodate them or provide even the most basic of services (see Unit 10.6).

Mumbai's economic role

Mumbai is India's economic hub. It is the country's financial, commercial and entertainment capital. Mumbai's economic role in both India and internationally is increasing. In 2022, Mumbai generated $US310 billion in GDP, 9 per cent of the national total, up from 6 per cent in 2021. Mumbai is one of the fastest-growing cities in India and the world. Mumbai's GDP is projected to reach US$355 billion by 2025 and US$606 billion by 2032. Mumbai has become one of the most desirable destinations for investment, where entrepreneurship and start-up businesses are exploring new markets. Maharashtra had 16 014 start-ups in 2023, the highest number for any state in India.

10.4.1 An innovation laboratory where research in biotechnology is being conducted

10.4.2 Employees assist customers inside the Zaveri Kapoorchand Lalchand jewellery store in the Zaveri Bazaar

Leading industries

Mumbai has many of India's leading industries including IT, ITES, biotechnology, pharmaceuticals, engineering, electronics, automobiles, cement, and diamond cutting and polishing. Increasingly, industry in Mumbai is becoming high-tech, as robotics are used on assembly lines and computer-aided design is being used in production. There is constant development of new products in pharmaceuticals, biotechnology and engineering (see Figure 10.4.1).

The three largest privately owned businesses in India—the Tata Group, the Group of Aditya Birla and Reliance Industries (see Unit 10.3)—are located in Mumbai. The Tata Group was established in 1868 with the purchase of a cotton mill and has grown to become India's largest multinational conglomerate. While Reliance Industries is privately owned, the Tata Group is a public company. Tata Motors was the first company from India's engineering sector to be listed on the New York Stock Exchange.

Like most large corporations, Tata's portfolio of businesses reflects the shifts that have occurred in Mumbai's economy. It has interests in chemicals, cement, steel, automotive, defence, electronics, home appliances, jewellery and fast-moving consumer goods (such as packaged food and toiletries). The Tata Group has acquired several other companies such as Jaguar, Land Rover and Air India. With the emergence of high-tech businesses, Tata Consultancy Services (TCS) has emerged as an industry leader, being the first to enter the bioinformatics market, developing software tools to study biological data. In 2020 TCS was ranked as the world's most valuable IT company with a market capitalisation of US$145 billion.

Gems and jewellery

Mumbai is at the centre of India's jewellery industry, and it receives most of the nation's rough diamond and gold imports. Mumbai is also its largest exporter of gems and jewellery, accounting for almost 70 per cent of India's total exports of these products, which amount to US$42 billion. The industry employs 5 million skilled workers, many of them craftspeople working in small-scale businesses with their polishing and manufacturing units in the Zaveri Bazaar in Mumbai City district (see Figure 10.4.2). The Maharashtra government plans to develop an ultra-modern and high-tech jewellery park in Navi Mumbai. However, it has been criticised for not being inclusive of the many small-scale producers, who could not afford to relocate from Zaveri Bazaar.

Did you know?

India is the birthplace of both Hinduism and Buddhism.

Mumbai's cultural role

Mumbai has a rich culture steeped in tradition. It embraces the multicultural diversity that characterises India with a mix of languages and religions. Varied lifestyles bring to Mumbai a boisterous blend of celebrations, festivals, fine arts, music, entertainment and cuisines. It is known as India's city that never sleeps.

10.4.3 Diwali decorative lights create a colourful celebration during Mumbai's Diwali festival

Religion plays a significant role in Mumbai's culture, and it is a city of many faiths. This is evident in that it is a city that has temples, mosques, churches, synagogues and fire temples. These sacred spaces are focal points for the religious life of Mumbai's residents and visitors to the city. This is Mumbai's traditional side and for many of its people, spirituality is an important part of their lives.

The people of Mumbai hold festivals to honour special religious occasions. These festivals are used to promote tolerance and peace by bringing many different people together. Diwali is one of India's biggest festivals and it is important in Hinduism, Jainism and Sikhism. It is a celebration of the victory of light over darkness, good over evil (see Figure 10.4.3).

● SPOTLIGHT

Ganesha Chaturthi

Ganesha Chaturthi is a Hindu festival marking the birth of the elephant-headed god Ganesha, who is widely worshipped as the god of wisdom, good fortune and prosperity. The festival lasts for 10 days. Initially, small idols of Ganesha are worshipped in homes or in elaborately decorated tents. They are anointed and given offerings of food. At the end of the festival, a statue of Ganesha is carried in a procession to the sound of drumbeats, singing and dancing, through the streets to a local river (see Figure 10.4.4). The statue is immersed in the river, a ritual symbolising Ganesha's journey home, taking with him the misfortunes of his devoted followers.

10.4.4 Mumbai's communities come out to celebrate during the Ganesha Chaturthi festival.

Bollywood

Cinema is one of India's most important cultural exports and Mumbai is the film capital of the nation. It is 110 years since the first black-and-white silent film was made in India. Today this booming industry is dominated by the Hindi-speaking Bollywood, with the 'B' coming from Bombay. Mumbai is where the Bollywood stories are written and around 1000 films are produced each year, twice the number of Hollywood films (see Figure 10.4.5). The industry sells four billion tickets to the domestic population. The industry generated $26 billion in 2022. Bollywood dances and songs are popular at weddings and cultural events such as festivals. The vibrant nightlife of the Bollywood bars frequented by celebrities, gives Mumbai its glamour and excitement, part of the culture that the city exudes.

10.4.5 Posters of Bollywood films. They generally have a heroic storyline, a love interest and a happy ending. They are brightly-coloured productions with elaborate song and dance numbers.

Activities

Acquiring and processing geographical information

1 Compare the responsibilities of the central Indian government and the Maharashtra state government.
2 Name the municipal corporation that administers Mumbai.
3 Summarise the municipal corporation's specific duties in delivering public services to the city.
4 Explain the importance of the city's public services in ensuring Mumbai's competitiveness.
5 Explain why Mumbai is clearly established as the economic hub of India and how its influence is increasing.
6 List the leading industries in Mumbai and summarise the global reach of some of its businesses.
7 Describe the importance of Mumbai's jewellery industry and how the Maharashtra state government's plans may affect it.
8 Explain the fundamental importance of the Hindu religion to the city's inhabitants.
9 Describe the contribution of Mumbai's film industry to both the city's culture and economy.

Applying and communicating geographical understanding

10 Write a paragraph assessing the success of Mumbai's governance in delivering public services to all the city's residents.
11 Investigate an important religious festival in Mumbai. Share your findings with the class.
12 Using the internet, investigate the tourist attractions of Mumbai. Prepare a slideshow presentation promoting the city.

UNIT 10.5

Mumbai's regional and global links

10.5.1 Mumbai's trains are the key mode of transport for commuters travelling into the city centre for work. They are often overcrowded.

Mumbai is the most connected city in India, linking the country to the global economy. The city has a crucial role to play if India is to achieve the economic superpower status it desires. A significant part of this role will be built on its existing regional and global links. Mumbai is the leading city in India's urban hierarchy and is also considered the main global city in South Asia, dominating commerce, capital markets, financial services and industry. Such dominance has been enabled by its nodal location with its land, sea and air connectivity. Some consider that no other city in the world has influence over such a large area, with as many people, given the high population density of the region.

Hinterland connectivity

Mumbai has close links with its immediate hinterland. It is the city's magnetism as a leading industrial and commercial centre that provides employment opportunities for those living elsewhere in the state of Maharashtra. More than 3.7 million people commute each day for work on the central and western network of trains (see Figure 10.5.1). Similarly, 60 000 people drive the two hours from Pune to Mumbai for work daily.

Transport connectivity

Beyond Maharashtra, Mumbai has transport links to all the major industrial cities in India and beyond. Most of India's trade passes through Mumbai, with its port handling 70 per cent of the nation's maritime trade. Mumbai is on many shipping routes, including through the Suez Canal to the Mediterranean Sea and Europe. Mumbai has two main ports, both of which are linked to the rest of the country via roads and railways. The Mumbai Port Trust was established in the seventeenth century on the western side of Mumbai Harbour, initially servicing the British Empire. Over centuries, the trade that passed through this original port established the commercial dominance of Mumbai, especially with

10.5.2 Mumbai's international links

globalisation when the trade connections became more diversified (see Figure 10.5.2). The docklands were expanded with more wharves and cargo handling facilities, but any further growth was constrained by crowding in the city during the 1970s. This led to the establishment of the Jawaharlal Nehru Port Trust on the eastern side of the harbour in Navi Mumbai (see Figure 10.5.3). Most container traffic now flows through the new port.

Mumbai also needs airline connectivity to be competitive, as there is an increased demand for face-to-face interaction in the realm of global business. Airline networks and their associated infrastructure are the most visible manifestation of global interaction. In fact, airline links are an important part of a city's visible claim to world city status. The main aviation hub in Mumbai has been the Chhatrapati Shivaji Maharaj International Airport, with the new Navi Mumbai International Airport becoming operational in 2024. It will have the capacity to handle 90 million passengers by 2032.

10.5.3 The Mumbai Port Trust is the largest port in India. It handles bulk cargo traffic such as crude oil, petroleum products and liquid chemicals.

Financial and commercial links

India is one of the fastest-growing economies in the world. As Mumbai has become embedded in global production and financial networks, it has also been locked into competition with other cities to attract capital and the interest of transnational corporations. Mumbai has one of the largest numbers of international companies in Asia. Amazon, Google, Apple, Pfizer, Volkswagen, Disney and Bosch all have offices in the city. These global connections result in the flow of capital, ideas, commodities and people. India's own Tata Group's global footprint spans more than 100 countries across all six inhabited continents. Even small businesses like Stymeta Technologies, a web development and website design company, have international reach.

In 2023, Mumbai was ranked as the top emerging international contender in global financial flows of 120 global financial centres. This flow of capital has led to unparalleled growth of new financial institutions in the country. By 2023, there were 46 foreign banks operating in India, with the most important ones choosing Mumbai to establish their presence. They include American Express, Barclays, Bank of America, Citibank, Deutsche Bank, DBS Bank, India Limited, Emirates Bank, NBD, HSBC, and the Industrial and Commercial Bank of China. Foreign banks have enabled India to establish a stronger international presence.

The strength of a city's financial sector is fundamental in determining its influence, on both a national and global scale. Mumbai has significant financial institutions that regulate the national economy and link India to the global economy: the Reserve Bank of India, the Bombay Stock Exchange and the National Stock Exchange of India (see Figure 10.5.4). Mumbai's stock exchanges dominate India's share market, accounting for 92 per cent of trade. Collectively they represent most of the total market capitalisation of the corporate sector in India. They are also ranked as the 10th and 11th largest stock exchanges in the world. Prominent companies listed on the National Stock Exchange include Reliance Industries, State Bank of India, HDFC Bank and ICICI Bank. The size and capitalisation of a city's stock markets is a crucial measure of that city's economic authority, as it locks it into the 24-hour trading of the global stock market.

10.5.4 Mumbai's stock exchanges are the busiest in India.

Technological links

Connectivity, especially data connectivity in terms of speed and transmission, is of high importance in a globalised world. Mumbai is India's data centre hub, as it has the most undersea cables and **cable landing stations**, coupled with a well-developed system of carriers. All the major telecommunications service providers have laid down their fibre optic networks in Navi Mumbai. Hence, most data centre companies choose to start their Indian operations in Mumbai.

SPOTLIGHT

Centre for the Fourth Industrial Revolution India

The new and emerging technologies of the Fourth Industrial Revolution are expected to transform and even disrupt economies and the way people work, communicate and live. The C4IR India (Centre for the Fourth Industrial Revolution India) was announced in 2018. It is a collaboration between the World Economic Forum and the Government of Maharashtra, coordinated by the National Institute for Transforming India.

Located in Mumbai, the centre serves as a platform for technology governance to maximise the benefits of this wave of technologies while mitigating the risks. The centre brings together both local and foreign policymakers, technology experts and business leaders to address challenges and share insights on what the latest trends and applications will entail. Its mantra is 'Solve for India, solve for the world'.

Activities

Acquiring and processing geographical information

1 Explain why some consider that no other city in India can match Mumbai for its dominance.
2 Describe the strong links Mumbai has with its hinterland.
3 Give reasons for the dominance of Mumbai's ports.
4 Explain why airline connectivity is important in the realm of global business and how Mumbai has developed to provide this.
5 What recognition did Mumbai gain in 2023 for its place in global financial flows?
6 Describe the growth of new financial institutions that has taken place in Mumbai.
7 Describe the Fourth Industrial Revolution.

Applying and communicating geographical understanding.

8 Study Figure 10.5.2. Describe Mumbai's international links.
9 Study the box, Spotlight: Centre for the Fourth Industrial Revolution India. Use the internet to provide an update the latest trends and applications.

UNIT 10.6

Living in Mumbai: Challenges and responses

In its quest to become an influential world city, Mumbai faces daunting social, economic and environmental challenges. Many of these challenges are products of its immense size and rapid growth. They can be traced back to the way in which Mumbai has grown, embracing economic opportunities, which in turn attracted a flood of people looking to be part of it, and all this happening on a site that restricts the physical expansion of the city.

The economic success of Mumbai is clear. However, for residents living in its crowded informal settlements, there is little evidence of this success in their daily struggles to survive. In 2023, Mumbai was home to 66 billionaires, some of the richest people in the world. For a city that boasts stunning wealth, more than half its population live in informal settlements. Dharavi, one of the largest informal settlements in Asia, sits right next to the Bandra Kurla Complex, the financial hub of the city. Herein lies the main challenge Mumbai faces: inclusive development.

Housing

Around 53 per cent of Mumbai's population live in conditions of poverty, squalor and deprivation. In 1961, this figure was 10 per cent. The poor cram into informal settlements or live on footpaths, next to railway lines and pipelines, under bridges and in poorly drained marshland. These living arrangements have arisen out of necessity, and informal settlements such as Dharavi have morphed into spaces for both living and working.

Overcrowded living conditions in Mumbai can be traced back to British colonial rule in the nineteenth century. Multi-dwelling buildings, or **chawls**, were built by factory owners to house those working in textile mills. Each floor had multiple rooms, a common bathroom, and each single room was shared by up to five people. The British were not concerned about the growth of informal settlements, as their main interest was in the availability of cheap labour for industry. Despite the poor, unsanitary living conditions, chawls are still occupied today as they are cheap to rent.

The immense migration of people into Mumbai has overwhelmed the ability of city administrators to accommodate them. Urbanisation and the proliferation of informal and **squatter settlements** together pose the most daunting challenge for the city today. One of the most visible manifestations of urbanisation in Mumbai is the growth of informal settlements as migrants have poured into the city. Over 1000 migrants continue to arrive each day. In the absence of any effective, large-scale response by city authorities to accommodate them, the poor build their own makeshift structures out of materials such as discarded, rusted corrugated iron, timber planks, asbestos, cement and tarpaulins. As illegal settlements, they are not provided with any public utilities such as water, electricity, sewers, roads or garbage collection. Most significantly, the residents in these settlements do not have any security of tenure, which means that they can be forcibly removed from their homes by authorities at any time.

Conditions in informal and squatter settlements are exceedingly difficult for residents. Not only are they locked out of the formal housing market, but they are also usually dependent on informal employment, and this is often blended with their dwelling, as was seen in Dharavi in Unit 10.3. They live in a maze of buildings that are structurally dilapidated, where services are overburdened, and the environment degraded (see Figure 10.6.1).

10.6.1 The overcrowded informal settlement of Dharavi, where dwellings have been erected next to a water pipe that is used as a thoroughfare in crowded informal settlement. Waste accumulates next to the pipe, dominating the neighbourhood and creating a health hazard for residents.

10.6.2 Life is extremely hazardous for this young family sleeping on a footpath with their children. The extent of their poverty is evident with their meagre possessions alongside them.

For those who are pavement-dwellers in Mumbai, life is even harder. Some have assembled shelters out of bamboo scaffolding, repurposed metal and plastic sheeting. Others just sleep in the open (see Figure 10.6.2). The wet monsoon season is especially uncomfortable for them. Pavement-dwellers were some of the first migrants to Mumbai, initially single males living on the footpaths along roads close to industrial areas or railway stations, precariously close to traffic. They have been joined by their families and have lived there ever since.

Response of the Maharashtra state government

The government has been locked in conflict with the poor of Mumbai for decades. Until the late 1970s, the government attempted to rid Mumbai of its informal settlements in a slum clearance program. The poor clung to their neighbourhoods, but they were repeatedly evicted by force, as their dwellings were levelled and razed by fire (see Figure 10.6.3). In the mid-1990s there was a major shift in policy, with the introduction of a slum rehabilitation program. While the government continued to clear the informal settlements, residents were relocated to seven-storey blocks of flats on the periphery of the city. This did not suit the slum-dwellers, as there was no place to conduct their work. So, they left, to return to the streets or another informal settlement where they could engage in their informal micro-industries.

At the turn of the century, the wealthy elite of the city embraced the idea of a 'Mumbai Makeover.' Informal and squatter settlements were considered an obstacle to a city seeking global status. By 2004, the government returned to an informal settlement demolition drive with a US$8 billion campaign to modernise Mumbai. In the first year, more than 90 000 shanties were torn down across Mumbai without any rehabilitation plans. It was also in 2004 that the Dharavi redevelopment project was first proposed. The Government of Maharashtra envisaged transforming Dharavi into a cluster of high-rise buildings and, by moving residents into free apartments, they planned to develop a US$1.5 billion world-class business centre with hotels and riverside restaurants on the site. Dharavi was seen as a blight on the city, especially as it was under the path of international flights coming into Mumbai and sat alongside India's most affluent business district, the Bandra Kurla Complex.

It was this proximity to the business centre of Mumbai that meant Dharavi was sitting on some of the world's most expensive real estate. A new concept evolved, using the land underlying the informal settlements as a resource to subsidise the cost of development. Market forces were deciding the way forward. This was the incentive for developers to construct accommodation for the slum-dwellers, as they could then reap the profits from their new developments. The plan has attracted the interest of international investors and developers.

10.6.3 The slum clearance program involved evicting people from illegal settlements by flattening and burning the dwellings.

The plan faced numerous delays and setbacks and it was not until 2023 that the Maharashtra government officially announced that the Adani Group had won the bid to undertake the project. It will take seven years to complete and could count as the world's largest informal settlement redevelopment scheme. Each registered Dharavi slum-dweller family can expect a free dwelling of 38 square metres in a high-rise building, with amenities such as water, electricity, gas and sanitation. The developer then gets the site for commercial development. However, only those residents who can prove that they lived in Dharavi before 2000 are eligible for a free dwelling. There are about 59 000 families who are eligible, yet there are thought to be 100 000 families in Dharavi. Many of the families that are ineligible for housing will be displaced.

The Adani Group has indicated that it will include commercial areas of assorted sizes to accommodate industries. However, residents in Dharavi have expressed concern that they have not been consulted and that there appears to be a lack of clarity regarding the plans for home-based industries. The feasibility of running a leather tanning or a pottery business on the tenth

floor of a building seems unlikely. Most of the existing businesses rely on their ground-floor access. Many residents fear that the redevelopment could push them out and destroy the social fabric and the communal identity that currently characterises Dharavi.

Creating a slum-free city aligns with the aspirations of the officials and business magnates pushing Mumbai's development as an international centre for commerce and a rising world city. Historically, efforts to improve housing and provide basic services have proven inadequate for most of its inhabitants. Many believe that the cost of further displacement of people to modernise the city is not the answer.

Water and sanitation

As the population of Mumbai has soared, the Maharashtra government has found it difficult to provide basic services such as water and electricity supplies, sewerage connection and garbage collection to all the city's inhabitants. As in any developing country, there has been a lack of public funding, and this is compounded by all of those in the informal sector not paying taxes, which contribute to the government revenue for such public spending. It is only the wealthier suburbs that have the infrastructure in place to provide residents with municipal services.

The MCGM is responsible for the delivery of water to all households in Mumbai. Water connections in informal settlements are generally given to a group of households and accessed from a single standpipe (a tap on a post). Over 60 per cent of Mumbai's population depend on these communal taps, with as many as 30 households sharing one tap. In some areas, water is only released for two hours at a time, and it can be any time, day or night. It is typically women who wait hours for water and then must carry it home on their heads in heavy pots. Some informal settlements that have been recognised by the government are entitled to connect to the city water supply, but not those informal settlements that appeared after 2005 because the government views them as illegal. These informal settlements are the poorest and most wretched in Mumbai. In desperation, their residents can only survive by purchasing water from street vendors.

The sanitation in Mumbai is even worse. Only 60 per cent of households are connected to Mumbai's sewerage system. Few of the urban poor are connected, as little of the Maharashtra State government's budget is spent on providing sanitation in the informal settlements. There are limited, or no, toilet facilities and the narrow lanes have drains where sewage leaks into cracked water pipes, along with toxic chemicals from the micro-industries in the informal settlements. Children play among the waste. Disease is common, and in Dharavi there are 4000 cases of typhoid and diphtheria every day.

Response of the Indian Alliance

One of the largest Indian NGOs working on housing and infrastructure issues for the urban poor is the Society for the Promotion of Area Resource Centres (SPARC). It was formed in Mumbai in 1984 and began working with the most vulnerable and invisible of Mumbai's urban poor—the pavement-dwellers. SPARC's philosophy is that if solutions work for the poorest and most marginalised in the city, then these solutions can be scaled up to work for other groups of the urban poor across the country and internationally.

Since 1986, SPARC has worked in partnership with two community-based organisations, the National Slum Dwellers Federation and Mahila Milan, as the Indian Alliance. Together, these groups have made a profound difference to thousands of households who lack security of tenure over their dwellings. The Alliance supports these households by providing them with the tools they need to engage the city administrators to secure permanent housing. The Alliance also works on water and sanitation, and has provided hundreds of thousands of individuals with individual or community toilets. It supports communities to work together and explore a wide range of solutions that will improve their wellbeing and the quality of their lives.

● SPOTLIGHT

Community-managed toilet blocks in Mumbai

A 10-year program of community designed, built and managed toilet blocks was started in 2014 by SPARC in partnership with the National Slum Dwellers Federation and Mahila Milan. This toilet-building partnership with well-organised community groups, has been a realistic and achievable solution for the communities involved. In 2022, The Alliance constructed more than 10 000 seats in community toilet blocks, benefiting 500 000 slum-dwellers.

These community toilet projects work because the slum-dwellers have a stake in them. They have been involved in every stage from designing to building and maintaining the toilet blocks. They have also raised the money to pay for the project by forming savings groups where each member contributes a small amount each day. Community-managed savings and micro-credit groups underpin the approach of the NSDF and Mahila Milan. The women from Mahila Milan are also the designers, builders, financial managers and project supervisors. With the support of SPARC, the community negotiates with municipal councils to connect the toilet blocks to the main sewer line, and electricity and water supplies.

It is then the responsibility of the community to take care of the maintenance of the toilet block (see Figure 10.6.4). Surprising some, they are kept clean, and they even charge those outside the community one rupee to use a clean toilet.

10.6.4 Communities in informal settlements have successfully established their own toilet blocks with the support of the Indian Alliance.

Transport

Many of Mumbai's transport problems stem from the linear nature of its site, surrounded as it is by the Arabian Sea, which has limited its outward growth. As the city's suburbs expanded to the north and then east, the main ways people moved was in a north–south direction and then east across the harbour to Navi Mumbai. While Mumbai has more public transport than most other cities, it is severely overburdened. The city suffers from some of the worst traffic congestion in the world. There are just two highways connecting the north to the south, and these are banked up in peak hours.

10.6.5 Autorickshaws add to the traffic of cars, buses and taxis on the busy streets of Mumbai.

Mumbai's road network is used by commuters in cars, buses, taxis, motorcycles and autorickshaw drivers, who try and cram into any spot they can get (see Figure 10.6.5). The road density in the city is astonishing, with 1900 vehicles boxed into a 1-kilometre stretch of road. During peak hours when the roads are heavily congested, it can take 50 per cent longer to travel to a destination. Travelling just 4 kilometres can take an hour.

The city's extensive suburban railway network is spread over 390 kilometres and operates 2342 trains. It serves the outlying suburbs of the MMR. Most residents commute to work by train. Unfortunately, the railway network has not been able to keep up with demand as the city's population has continued to increase. The trains carry 8 million passengers daily, which is 2.6 times their official capacity. The crowding on trains inevitably causes accidents and 10 people are killed every day. People desperate to get to work will hang from doors or windows and fall off or hit a pole. Those that sit on top of the train often get electrocuted by overhead cables. Others have died in the overcrowded carriages as oxygen levels have dropped, causing suffocation, seizures and heart attacks.

As the city spread to suburbs in the east on the mainland, the Airoli and Vashi bridges were built across Mumbai Harbour to connect Mumbai and Navi Mumbai. However, the bridges have reached capacity and will struggle to cope with future traffic growth.

Improving the connectivity of Mumbai

The Mumbai Metropolitan Region Development Authority (MMRDA) has undertaken major infrastructure projects to improve the transport system in Mumbai. It is constructing a web of metro tracks across the city and connecting Mumbai with Navi Mumbai via the Mumbai Trans Harbour Link (MTHL).

The Mumbai Metro is a rapid transit system serving the Mumbai Metropolitan Region. It aims to supplement the overcrowded suburban rail network and reduce traffic congestion in the city. It is being constructed in three phases over 15 years and is due for completion in 2026. The metro rail lines will operate over 357 kilometres of track and be serviced by 286 stations.

10.6.6 The Mumbai Trans Harbour Sea Link bridge

As an island city, Mumbai is dominated by its north–south transport pattern, however, the east–west connectivity will also be boosted by the MTHL. It stretches 22 kilometres across the harbour, linking Mumbai and Navi Mumbai, cutting travel time between the two, from 3 hours to just 20 minutes (see Figure 10.6.6). It is also seamlessly connected to the new Navi Mumbai International Airport. The bridge's steel deck enables piers to be placed at three times their normal distance apart where there are navigational channels used by large ships.

The new Mumbai Coastal Project is an eight-lane expressway running for 22 kilometres along Mumbai's western coastline and is connected to the Bandra Worli Sea Link. It provides an alternative north–south trunk route between South Mumbai and the western suburbs. It is expected to reduce travel time from 2 hours to only 40 minutes.

Activities

Acquiring and processing geographical information

1. Summarise the main causes of the challenges faced by Mumbai.
2. Describe a chawl.
3. Explain why informal settlements have proliferated in Mumbai.
4. Describe the conditions within Mumbai's informal settlements.
5. Distinguish between a squatter settlement and an informal settlement.
6. Explain why the life of pavement-dwellers is the most difficult of all Mumbai's residents.
7. Summarise the history of the Maharashtra state government's conflict with those living in informal settlements in Mumbai.
8. Describe the Dharavi redevelopment project.
9. Summarise the state of water and sanitation in the informal settlements and shanty towns of Mumbai.
10. Describe the transport problems of Mumbai.
11. Explain how the major infrastructure projects undertaken by the MMRDA are designed to improve the transport system in Mumbai.

Applying and communicating geographical understanding

12. Access Google Earth. Familiarise yourself with the geography of the east and west coasts of Mumbai Island. Locate the major infrastructure projects designed to ease traffic congestion.
13. Using the internet, investigate an informal settlement or shanty town in Mumbai. Examine its history, challenges and any responses addressing those challenges.
14. Conduct a class discussion on the topic, 'The plight of those living in informal settlements and squatter settlements should be prioritised over investing in promoting Mumbai as a modern world city.'

SECTION

3 Ecosystems and global biodiversity

All life on Earth depends on the functioning of ecosystems. As a species, humans are unique because they can destroy whole ecosystems. For the first time in human history, we are on the brink of catastrophic environmental change in the form of anthropogenic climate change. If humans fail to act, there is a real danger that Earth's systems will collapse, and the rate of extinction will accelerate, bringing about changes that will radically alter our planet.

However, we also have the capacity to protect and restore ecosystems. Now, more than ever, we need to understand the nature of the interactions taking place within the biophysical environment, so that we can sustainably manage Earth's ecosystems. To do this, we must better understand the way ecosystems function and the way that they are responding to environmental stresses such as climate change.

Content focus

In this section of the text, students investigate the nature and complexity of ecosystem functioning and global biodiversity, the value of ecosystems, the relationship between ecological and human stresses, and the vulnerability and resilience of ecosystems, including ecological integrity and biocapacity. Students examine the state of global ecosystems and biodiversity, strategies for the sustainable management of ecosystems, and the role played by Indigenous peoples in contemporary management practices. Students contextualise this knowledge through the study of two different types of ecosystems, at least one of which is outside Australia. Case studies are provided for the Great Barrier Reef and the Fiordland of New Zealand.

In this section

Chapter 11 Ecosystems and biodiversity

Chapter 12 Ecosystem study: Great Barrier Reef

Chapter 13 Ecosystem study: Fiordland of New Zealand

CHAPTER

11 Ecosystems and biodiversity

At the beginning of the twentieth century there were 1.6 billion people on Earth, and while pollution and environmental degradation were common, these problems were generally local. By 2023, 8 billion humans inhabited Earth. The environmental problems resulting from this rapid growth affect the whole planet. Whole ecosystems are at risk and as habitats are destroyed, the species of plants and animals that depend on them become extinct.

The UN estimates that by 2050, the world's population will be 9.7 billion and the global economy will be at least five times its present size. To sustainably manage and protect the global environment, its habitats and biological diversity, solutions must be found that address the impacts of population and overuse of natural resources.

Human impact on the biophysical environment is not a recent event. Many indigenous peoples behaved in ways that transformed ecosystems in the past and led to the extinction of species. Such impacts were usually followed by long periods of environmental stability, during which the biophysical environment adjusted to human impact. Some experts argue that the Earth's ecosystems are in fact human artefacts: ecosystems modified by thousands of years of human use.

In this chapter, students investigate ecosystems, including the factors affecting their functioning, the impact of human activities on ecosystems and the management of ecosystems. A particular focus is placed on biodiversity and its importance and trends, both past and future, regarding biodiversity. There is also an examination of a successful conservation program using a case study of Faure Island in Western Australia.

> **For most of history, man has had to fight nature to survive; in this century he is beginning to realize that, in order to survive, he must protect it.**
>
> **Jacques Cousteau, French oceanographer and filmmaker**

11.0.1 Sea turtle swimming in the clear waters of a reef

Chapter glossary

autotrophic organism an organism that can manufacture carbon from inorganic material for the provision of energy and the building blocks of its growth, as most chlorophyll-producing plants

biocapacity the capacity of an ecosystem to regenerate after human interference

biodiversity the variety of species and the genetic variability among individuals within each species

biome the biological components of an ecosystem

biotic related to life, especially plants and animals

community a group of interdependent organisms living together in a common environment and interacting with one another

decomposer an organism that feeds by breaking down the dead organic matter in an ecosystem

dynamic equilibrium a situation in which stability is achieved in an ecosystem

ecological succession one species gradually taking over an environment from another as circumstances within the environment change; for example, as a climate becomes drier, drought resistant species will gradually take over

ecology the study of organisms and their relationship to one another and their surroundings

ecosphere the ecosystem of the planet; the totality of all ecosystems

ecosystem the dynamic complex of plant, animal and microorganism communities and their non-living environment as a functional unit

existence value the amount of money that people are prepared to spend or forgo to keep an ecosystem (or species within an ecosystem) in existence

extent relating to size

feedback loop occurs when an output of matter or energy is fed back into the system as an input and leads to changes in that system

food chain a series of organisms, each eating or decomposing the preceding one

food web a network of interconnected food chains

habitat the environment of a living organism

interdependence the dependence of organisms on each other for the survival of their species, within a habitat

leaching the removal, by water, of minerals from the upper layers of a soil to the lower layers

monoculture an environment where one plant species dominates totally

natural selection the theory that in nature, only the strongest will survive and therefore nature will naturally select the strongest and allow the weaker to die out, first put forward by Charles Darwin

opportunity cost an economic term meaning that to do one thing, something else must be given up; that which is given up is the opportunity cost

option value the money that people are prepared to pay to interact with an ecosystem or species

producer organism see, autotrophic organism

productivity the rate at which biological matter (biomass) is produced by an ecosystem or part of an ecosystem

remnant an area that remains from what was once a larger area

species all organisms of the same kind that are potentially capable of breeding and producing fertile offspring

tipping point a point at which even small changes can have significant consequences

UNIT 11.1

The nature and complexity of ecosystem functioning and global biodiversity

11.1.1 The quest for food drives all ecosystems

Ecosystems are systems through which incoming solar energy is captured and channelled through a hierarchy of life forms. Each ecosystem has its own characteristic plant and animal **community**. Plants, both on land and in the sea, convert sunlight (via the process of photosynthesis) into storable—and edible—chemical energy. Animals feed on these plants and on other animals (see Figure 11.1.1). The quest for food is the central organising principle within ecosystems.

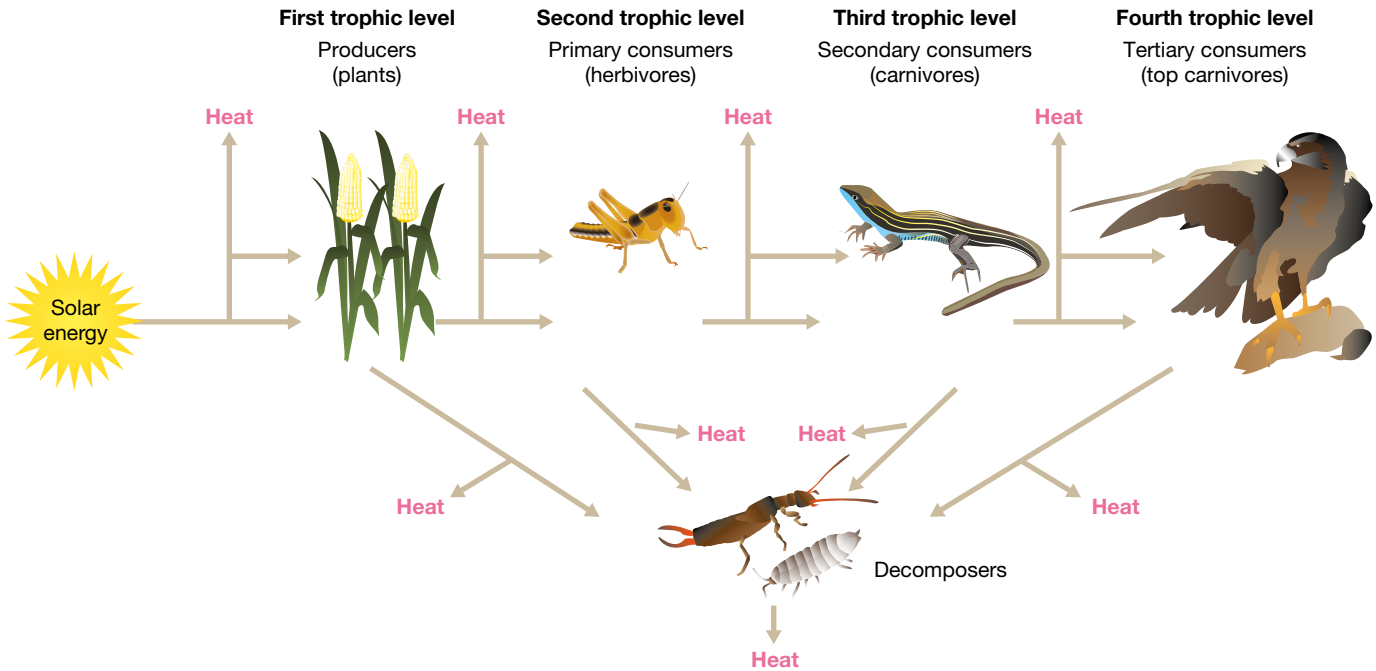
An important feature of each ecosystem is the set of processes by which nutrients are retained and recycled. Living things do not create new matter. Instead, they recycle nutrients obtained from air, soil, water and other organisms, using solar energy to build and maintain themselves.

Energy flows and nutrient cycles

The creation and consumption of energy is at the centre of the functioning of all ecosystems. The Sun is the source of energy that drives an ecosystem. This is why some of the most productive ecosystems, such as tropical rainforests and coral reefs, are found in the equatorial zones. It is in these locations that the amount of solar energy reaching Earth's surface (known as insolation) is at its highest.

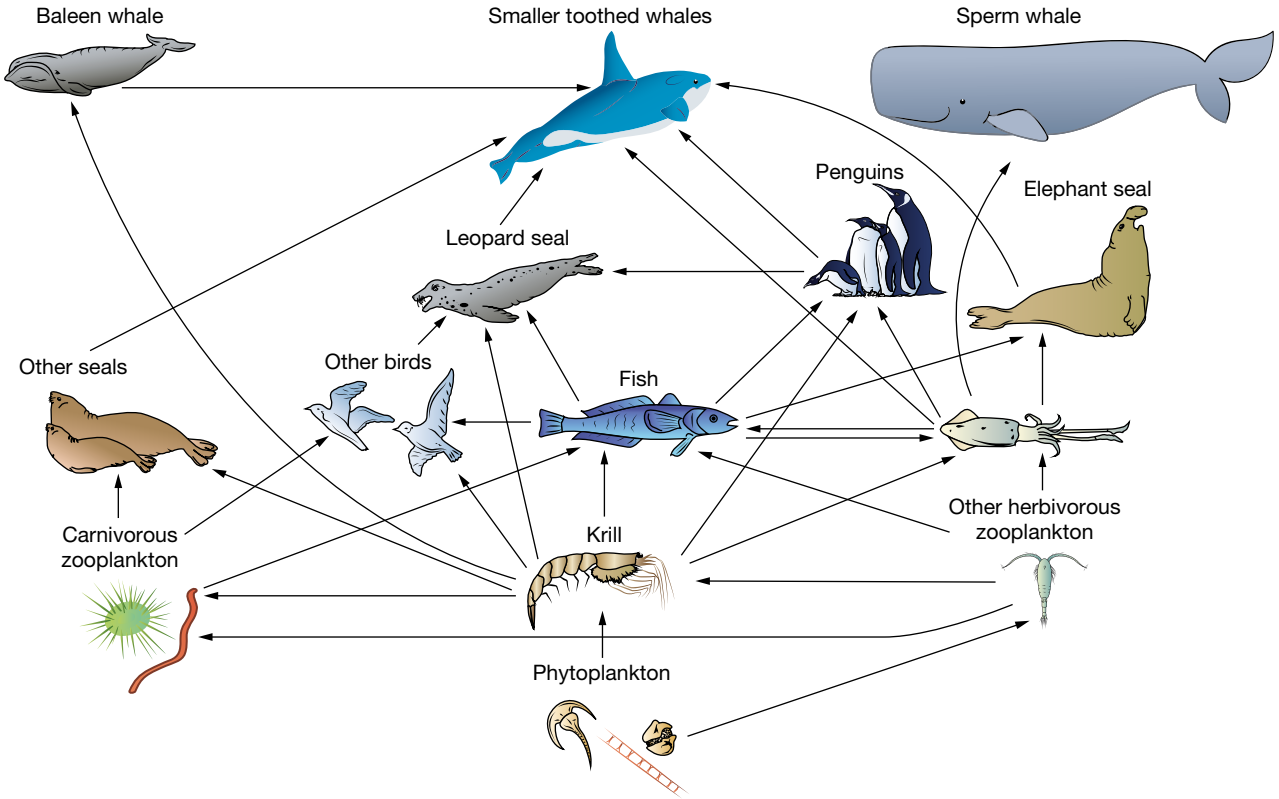
Producers, consumers and **decomposers** form a chain that facilitates the flow of energy from the sun, through plants, to the various animals within the ecosystem. At each level of the **food chain**, energy, in the form of heat, is lost to the atmosphere. Food chains also facilitate the recycling of nutrients from producers to consumers, to decomposers, then back to producers.

Organisms that share the same types of food in a food chain belong to the same trophic level. Producers belong to the first trophic level, primary consumers to the second, secondary consumers to the third, and so on. A simplified food chain is shown in Figure 11.1.2, showing energy and nutrient transfers and the different trophic levels.



11.1.2 A simplified model showing how solar energy is transferred through different trophic levels

Simple food chains, such as the one shown in Figure 11.1.2, are rare. Organisms in a natural ecosystem are usually part of a complex network of interacting food chains called a **food web** (see Figure 11.1.3). The various elements of the **biome** transfer energy by consuming each other: herbivores consume plants and are then consumed by carnivores, with carnivores being consumed by larger carnivores.



11.1.3 A highly simplified food web for Antarctica

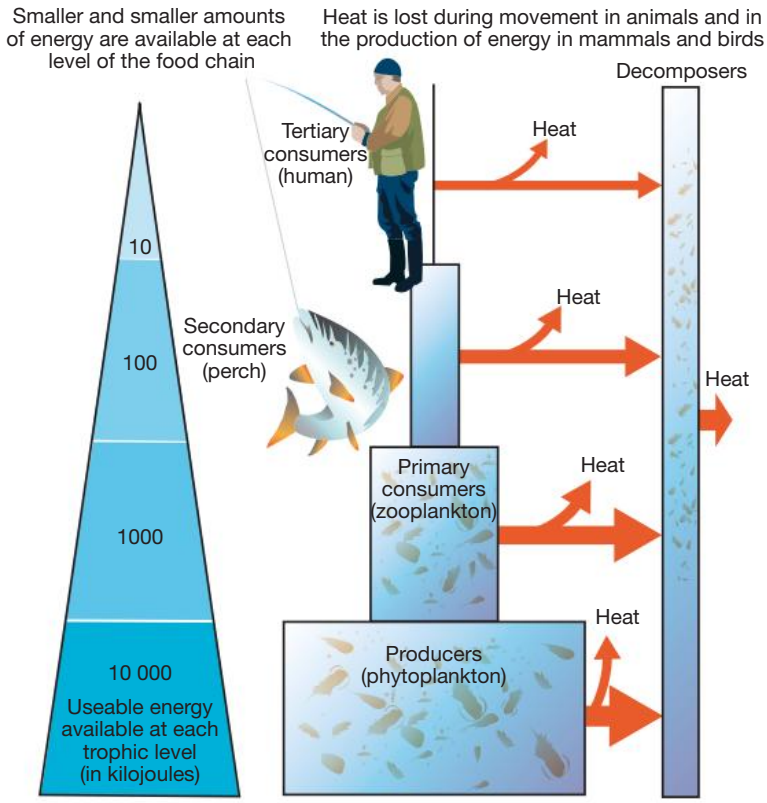
Energy in ecosystems

The Sun is the primary source of energy within ecosystems. The energy of the Sun is used by plants (**autotrophic organisms** or **producer organisms**) to turn carbon dioxide and water into glucose and oxygen via the process of photosynthesis. Plants then use the glucose as an energy source to make other substances. They also use glucose, in combination with dissolved nutrients, as a building block. Herbivores consume these nutrients, using them for growth and energy for life and movement. When herbivores are consumed by carnivores, these nutrients pass up through the food chain until they reach the largest carnivores, or tertiary consumers.

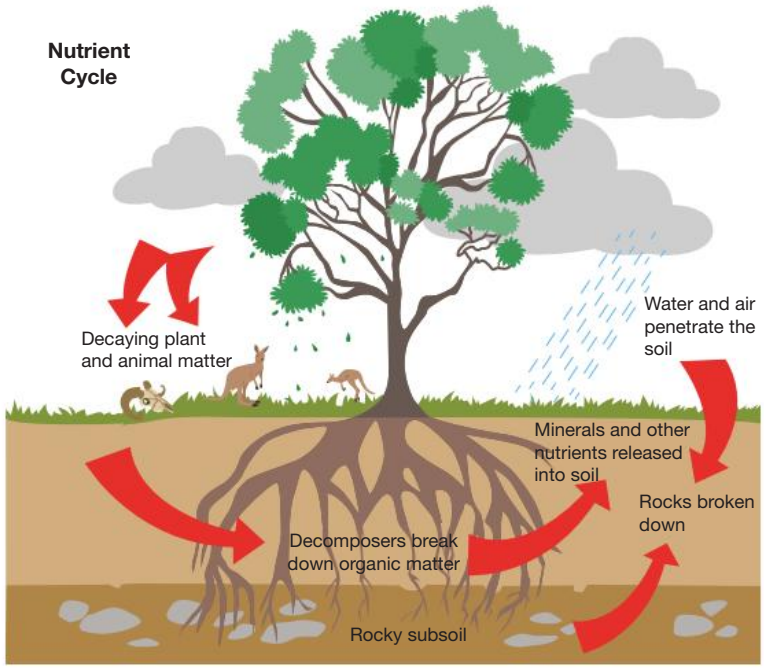
This process enables nutrients to be recycled from the non-living environment (reservoirs in the atmosphere, hydrosphere and lithosphere) to the living environment and then back to the non-living environment.

At each trophic level, significant amounts of nutrients and energy are lost, which results in a small number of tertiary consumers in all ecosystems, compared with the number of primary consumers. Ecosystems with the lowest levels of nutrients support the fewest consumers. Figure 11.1.4 shows the amount of energy lost as nutrients move up the levels of a food chain. This energy is lost as animals consume energy in search of food and in the production of heat during plant growth. The diagram also shows the significant decrease in the number of organisms that occur at each successive trophic level.

Ecosystems with high energy levels derived from inflows of nutrients will typically support more complex and diverse ecosystems. They will also support greater numbers and larger carnivores. For example, highly productive ecosystems like the African savanna have huge energy inflows derived from its vast grasslands.



11.1.4 How energy is lost at each trophic level



11.1.6 The nutrient cycle

11.1.5 High-energy ecosystems support large carnivores.

This supports huge populations of herbivores, such as zebra. This presence of herbivores supports sizeable populations of tertiary consumers, such as lions. Stalking and hunting prey requires vast quantities of energy, far more than a herbivore, whose food source is effectively the vegetation that surrounds them (see Figure 11.1.5). These ecosystems must have far more herbivores than carnivores to remain in balance.

The nutrient cycle

The **productivity** of all ecosystems depends on nutrients cycling through the system (see Figure 11.1.6). Chemicals are constantly being recycled through the ecosystem to support the biosphere. These chemicals move from the soil as plant nutrients, which are used by plants to grow and reproduce. In turn, these plants provide nutrients to the animals that feed on the plants. The animals that feed on the plants, in turn, provide nutrients to the animals that consume those animals. Ultimately, the nutrients are returned to the soil in the form of decaying plant materials, such as fallen leaves, and in the form of animal manure and the decaying carcasses of dead animals. This decaying organic matter is known as humus.

Human impacts on the nutrient cycle

Human activity can readily disrupt the nutrient cycle. Activities such as applying artificial fertilisers can add excess nutrients to the environment, and this excess is often carried into waterways by surface run-off. Once in the water, this excess of nutrients can encourage algae to grow, consuming the dissolved oxygen in the water, which can lead to the death of aquatic flora and fauna. This process is known as eutrophication.

Humans can also disrupt the nutrient cycle by depleting nutrients. The return of nutrients to the system is a long and slow process, and so soil requires a continuous circular flow. As plants consume the nutrients from the soil, it must be continually replaced. Land clearing is one of the most profound ways that humans disrupt the nutrient cycle. By clearing vegetation, humans remove the key source of returned nutrients to the soil—humus. Large-scale land clearing is most commonly carried out to create

space for agricultural activities and grazing. Not only does the loss of vegetation reduce the quality of soil, but it also takes away the root systems of trees that bind the soil together and make it less susceptible to wind and water erosion. The loss of vegetation also increases the rate of nutrient **leaching**. This is the process of rainfall 'washing' the nutrients out of the soil. As the water percolates into the ground, it dissolves many of the nutrient chemicals, removing them from the soil. The heavier the rain, the greater the impact this has. Leaf matter on the surface reduces percolation. When vegetation is lost, the reduction of leaf matter results in higher rates of percolation, removing even more nutrients from the soil.

● **SPOTLIGHT**

Desertification in the Sahel region

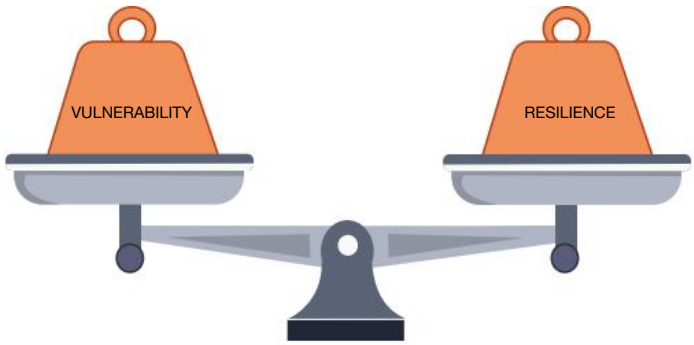
The Sahel region of Africa occupies a band of arid and semi-arid lands to the south of the vast Sahara Desert (see Figure 11.1.7). The region is home to some of the most impoverished countries on Earth and the local population is dependent on subsistence agriculture. Unfortunately, this area has also one of the highest rates of climate variability in the world and rainfall is highly unpredictable across the Sahel. The Sahel region is subject to significant desertification—the process of once-fertile land becoming less fertile due to unsustainable human activities (see Figure 11.1.8).

11.1.7 Location of the Sahel region. It crosses the African continent, from the Atlantic Ocean to the Red Sea, and includes parts of 10 countries.

As the population in the Sahel grows, the demands on the environment have also increased markedly. This, combined with a general drying of the climate, at least partly due to human-induced climate change, has led to an increase in desertification in the region. For thousands of years, the local inhabitants of the Sahel have engaged in nomadic herding of livestock. Herders have moved their cattle from one area to another, reducing their impact by constantly being on the move. However, this agricultural system is now declining and more sedentary forms of agriculture are beginning to dominate. There has been an increase in crop production, and, in some cases, these crops are being grown to feed livestock.

The combined effects of these changes to the climate, agricultural techniques and growing population pressure has been widescale soil degradation across the Sahel. Like all arid and semi-arid regions, the soils of the Sahel are less fertile than those in more vegetated regions. This is because soil fertility is closely aligned with the biosphere and the growth of plants. Decaying vegetation adds nutrients to the soil, which support plant growth, and this further enriches the soil. The limited vegetation of drylands, due to the harsh environment and lack of water, creates a more limited nutrient cycle. This does not mean that the soils of the Sahel are unproductive. However, it does mean that the soils are more fragile and more at risk of losing fertility. When human activities overwhelm the nutrient cycle, fragile environments like the Sahel are at increased risk.

11.1.8 Desertification in Niger, one of the countries in the Sahel region, has been caused by a combination of climate change and unsustainable agriculture which has disrupted the nutrient cycle.



11.1.9 Dynamic equilibrium exists when changes to an ecosystem are equal to the ability of the ecosystem to cope with or adapt to the change.

11.1.10 Australia's dry sclerophyll forests have adapted resilience to the regular threat of fire.

Dynamic equilibrium

All ecosystems are in a constant state of change (dynamism). For example, every time a wave breaks onto a rock shelf, weathering occurs, and the rock shelf is changed. However, nature will always attempt to restore a state of balance so that the ecosystem can continue to function. This restoration of balance is known as a **dynamic equilibrium**.

Geographers refer to the ease with which an ecosystem can be changed as vulnerability. An ecosystem's ability to cope with this change is known as resilience. Figure 11.1.9 symbolises these processes. When vulnerability is equal to resilience, an ecosystem is said to be in a state of dynamic equilibrium. Therefore, a highly vulnerable ecosystem that has equally high resilience will be able to cope with the vulnerability very well.

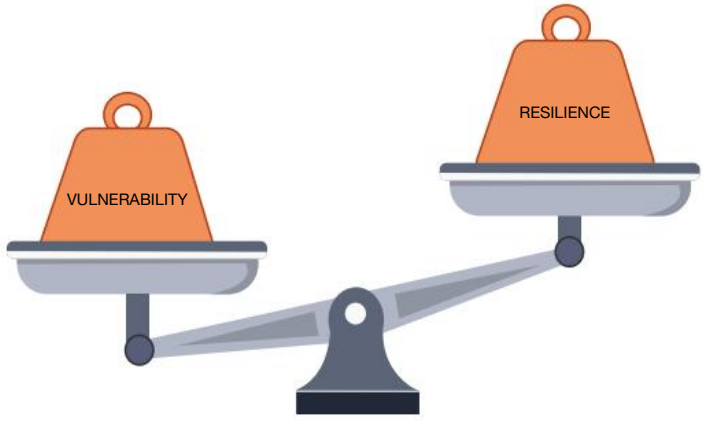
The dry sclerophyll forests of Australia are a good example of this. These forests are highly vulnerable to fire, but they have adapted and evolved to deal with fire, to the point that fire allows them to change and renew through new growth (see Figure 11.1.10). We can compare this to the temperate rainforests of the east coast of Australia, where fire is far less of a threat due to its wet climate and moist ground conditions. However, these forests also have relatively low resilience to fire. That is, if a fire did develop in these forests there would be greater long-term consequences compared to a fire in a dry sclerophyll forest.

Dynamic disequilibrium occurs when the vulnerability of an ecosystem exceeds its resilience (see Figure 11.1.11). There are three main components in determining the vulnerability of an ecosystem. They are:

- **location:** proximity to a hazard, for example, an active volcano or a human-induced hazard on the edge of an expanding urban area
- **extent:** the size of an ecosystem. As a rule, the greater the extent, the more resilient the ecosystem will be
- **biodiversity:** diversity adds resilience. For example, an ecosystem with a complex food web with many **species** and connections will be more resilient than one with fewer species and simpler webs.

Did you know?

In June 2023 the Nova Kakhovka Dam in southern Ukraine was intentionally destroyed. The circumstances of the destruction are disputed, with both Russian and Ukrainian authorities blaming each other. However, it is clear that this was a deliberate act, taking place in an active war zone. The dam's destruction led to the widespread flooding of the Dnipro River and surrounding towns, causing an ecological catastrophe. Long-term environmental consequences from the flooding include water contamination and habitat destruction.

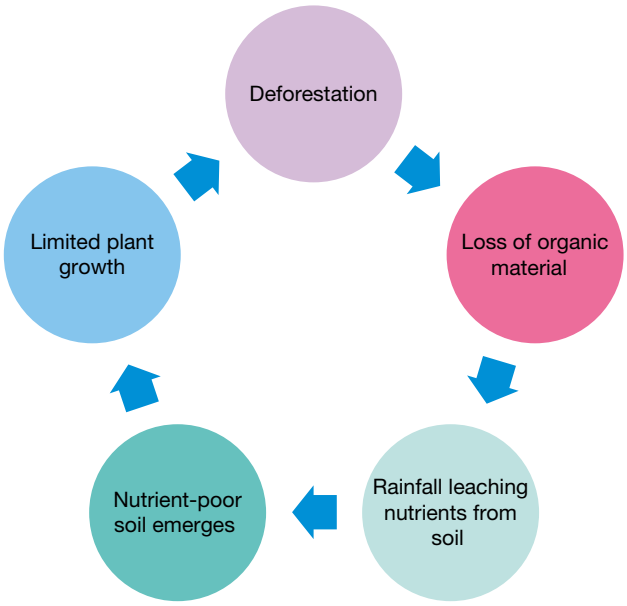


11.1.11 Dynamic disequilibrium occurs when an ecosystem's vulnerability exceeds its resilience.

Feedback loops

A **feedback loop** is the result of a causal relationship between two or more processes in nature. It results from one process giving rise to another, which then causes the original process to either accelerate or diminish (see Figure 11.1.12). Feedback loops can be either positive or negative. A positive feedback loop accelerates a natural response while a negative feedback loop decreases a natural response.

Feedback loops are naturally occurring, but they are also very susceptible to human activities. For example, when human activities alter ground cover, a feedback loop can emerge. Tropical rainforests have evolved a complex nutrient cycle that constantly has the nutrients added to the soil through the prolific plant life found in the forests. This constant topping up of nutrients is important as the high rates of precipitation leach nutrients out of the soil. When humans clear forests the vegetation is lost, and a positive feedback loop quickly emerges. The soil continues to lose nutrients through leaching, but nutrient replacement is no longer taking place. This means that the soil is less able to support vegetation, which means that even fewer nutrients are added and the cycle continues until the ability of the soil to support life is lost altogether.



11.1.12 An example of a positive feedback loop caused by deforestation, increasing the rate of leaching

SPOTLIGHT

Feedback loops and climate change

Feedback loops are often mentioned in relation to climate change. Here, positive feedback loops are things that accelerate warming, while negative feedback loops decelerate warming. One example of a positive feedback loop relates to icecaps. The vast icecaps of Antarctica, Greenland and the Arctic reflect large quantities of sunlight and its associated ultaviolet rays. This occurs because the ice is light coloured and highly reflective. However, as the planet warms, the ice melts, and this reveals the darker coloured land and water below. The darker surfaces that absorb more heat from the sun replace the lighter surfaces that reflected much of the heat. Consequently, a positive feedback loop is now formed—as more ice melts, more heat is absorbed, creating more heat, which melts more ice, and the loop continues (see Figure 11.1.13).

Climate change may also lead to some negative feedback loops, although these are less clear. One such negative loop relates to cloud cover. As sea surface temperatures rise because of climate change, so will evaporation rates, which should increase cloud cover. Heavy cloud cover reduces incoming solar radiation, and this could limit warming. However, this effect is generally limited to clouds at lower altitude, and it is not yet clear what types of clouds are more likely to form as a result of an overall warmer climate.

11.1.13 As ice melts due to climate change, more dark, heat-absorbing surfaces are revealed, melting more ice, thereby creating a positive feedback loop.

Relationships between natural systems

The functioning of every ecosystem and the processes of the natural world are the result of complex interactions. Ecosystems interact with each other, and processes overlap and impact on each other. The four spheres—atmosphere, lithosphere, hydrosphere and biosphere—constantly work in unison to create ecosystems. The ways in which they interact account for the uniqueness and diversity of ecosystems globally. No other planet in our solar system (or indeed, in any other known universe) has these four spheres working in unison as they do on Earth.

The relationships between the natural systems happens at all scales. On a global scale, systems such as the global heat budget ensure that conditions on Earth are neither too cold nor too hot to support life. By moving heat around via wind and ocean currents, warm air and water are carried away from the Equator toward the poles, and cool air and water move toward the Equator. This, in turn, impacts on climatic, vegetation and faunal patterns.

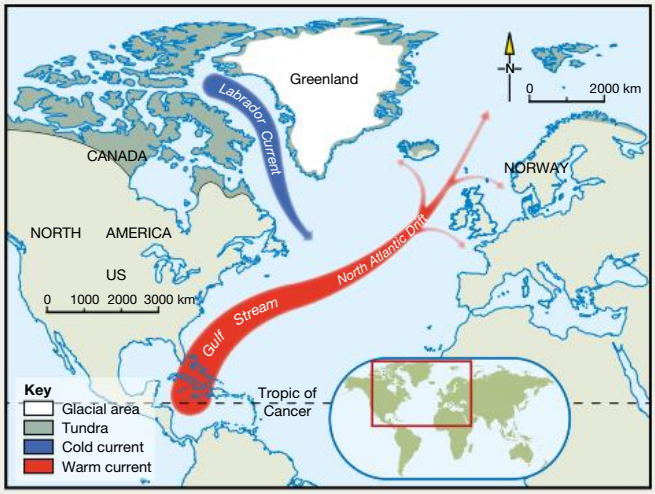
● **SPOTLIGHT**

Ocean currents of the North Atlantic

Ocean currents are an example of a natural process that can be altered by feedback loops.

The Gulf Stream is one of the best-known and most important ocean currents in the world. It is a surface current that forms in the Gulf of Mexico, the large body of water that lies south of the continental United States and east of Mexico. Warm water flows into the Gulf from the Caribbean Sea, where the hot tropical sun creates an average sea surface temperature of 27°C.

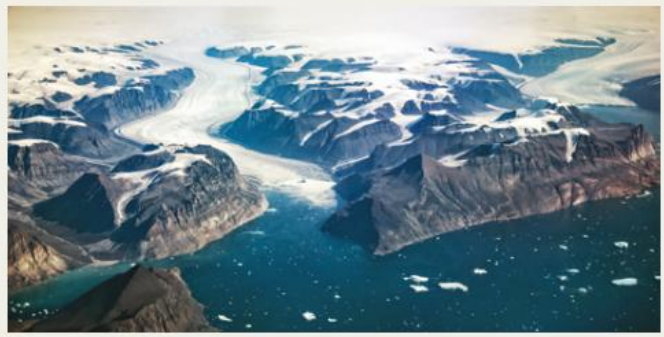
Southerly winds blowing northward from the Equator toward the North Pole then push the warm current up the east coast of the United States and Canada. Ultimately, the Gulf Stream continues to flow into the North Atlantic Ocean as the North Atlantic Drift. A counter-current—the Labrador Current—flows southward from the polar regions. This current draws colder water from the north toward the Equator (see Figure 11.1.14).



11.1.14 The Gulf Stream, North Atlantic Drift and the Labrador Current move heat around North America.

As an ocean current, the Gulf Stream is a feature of the hydrosphere. However, the current also moves heat and this affects climatic conditions, a feature of the atmosphere. The warm waters of the Gulf Stream help to moderate temperatures along the eastern coast of North America and across into Northern Europe. Without this moderating effect, these landmasses would be much colder than they are.

Figures 11.1.15 and 11.1.16 show the west coast of Greenland and west coast of Norway. Both areas share a similar latitude, however, they are very different environments. Greenland's west coast (Figure 11.1.15) is under the influence of the cold Labrador Current. Here, glaciers and icecaps dominate, with little opportunity for vegetation. Norway's west coast (Figure 11.1.16) is influenced by the North Atlantic Drift, which brings the warm waters of the Gulf Stream across the Atlantic and warms Norway's coastal waters. This allows a very different environment to thrive. Hence, a strong relationship has emerged between the ocean currents and the ecosystems that are found in each location. Each of the four spheres of the biophysical environment are influenced by and influence the other spheres.



11.1.15 Greenland's west coast is influenced by the cold waters of the Labrador Current, which draws cold water south from the polar regions.

11.1.16 Norway's west coast is influenced by warmer waters drawn north from the tropics by the Gulf Stream.

Activities

Acquiring and processing geographical information

1 Define an ecosystem.
2 Explain the importance of the Sun to the functioning of ecosystems.
3 Differentiate between a producer and a consumer in an ecosystem.
4 What is a trophic level?
5 Explain the relationship between energy and carnivores in ecosystems.
6 Summarise how humans can disrupt the nutrient cycle.
7 Explain the concept of dynamic equilibrium.
8 Define the terms vulnerability and resilience.
9 Briefly outline the factors that affect vulnerability.
10 Explain the operation of a feedback loop.
11 Describe how human activities impact feedback loops.

Applying and communicating geographical understanding

12 Write a report explaining the operation of food webs. Explain why an understanding of the operation of an ecosystem's food web would be essential for the sustainable management of that ecosystem.
13 Study Figure 11.1.3. Complete the activities below.
   a Which species are producers in this food web?
   b Which species are the primary consumers?
   c Which species are the tertiary consumers?
14 Study Figure 1.1.4. With the aid of an annotated diagram, explain what happens to the amount of useable energy at successively higher trophic levels.
15 Write a report outlining the operation of the nutrient cycle.
16 Study the box, Spotlight: Desertification in the Sahel region. Complete the activites below.
   a Explain why desertification began in the Sahel region.
   b How has desertification affected the environment of the Sahel?
17 Write a paragraph on how human-induced climate change impacts feedback loops.
18 Using the global heat budget as an example, explain the relationships between components of natural systems.

UNIT 11.2

The value of ecosystems and biodiversity

The diversity of life on Earth (see Figure 11.2.1) is of inestimable value. It provides the basis for the maintenance of planetary processes and the wellbeing of people. The protection of ecosystems is central to the future wellbeing of Earth and its inhabitants.

11.2.1 Biodiversity is essential for the functioning of ecosystems.

Attempts to protect Earth's biodiversity range from setting aside and protecting large areas of wilderness to the preservation of species in zoos, botanical gardens and seed banks. These measures alone will not be sufficient to save many species from extinction or prevent large areas from being degraded. What is needed is a reassessment of the relationships people have with their biophysical environment and with each other. Central to such a reassessment will be recognition of the need to adopt values, attitudes and practices that are compatible with the notion of sustainable development.

The reasons for managing and protecting ecosystems include:

- the maintenance of genetic diversity
- utility value (both current and potential)
- intrinsic value
- heritage value
- the need to allow natural change to proceed.

Maintaining genetic diversity

Ecosystems rich in diversity generally have greater resilience, and, as a result, are able to recover more readily from naturally induced stress, such as drought and fire, and human-induced **habitat** degradation. Where diversity is diminished, the functioning of ecosystems (and by association, the wellbeing of people) is put at risk.

The vast number of species that inhabit Earth represent a massive genetic 'database' of successful survival strategies developed over several billion years. Each species has its own gene pool from which an almost infinite number of combinations of individual characteristics can be selected. This diversity allows a species to adapt to changes in its environment. The more successful a species is at regeneration and adaptation, the less vulnerable it is to changes in its ecosystem.

Communities of plants and animals with high levels of genetic diversity often survive periods of stress because there are usually some organisms that are not adversely affected by the change. The organisms that survive are more likely to be those with the characteristics that enable them to cope with the nature of the stress. If these traits are genetic, the survivors pass them on to subsequent generations. In this way, a species

will, over time, adapt and change. This process is called **natural selection** and is often summarised as survival of the fittest. Fittest, in this sense, means having the characteristics that best fit the circumstances, which is not the same as the healthiest.

The loss of genetic diversity brought about by human-induced stress must be considered to be an **opportunity cost** of an ever-expanding human population.

Investigating genetic diversity

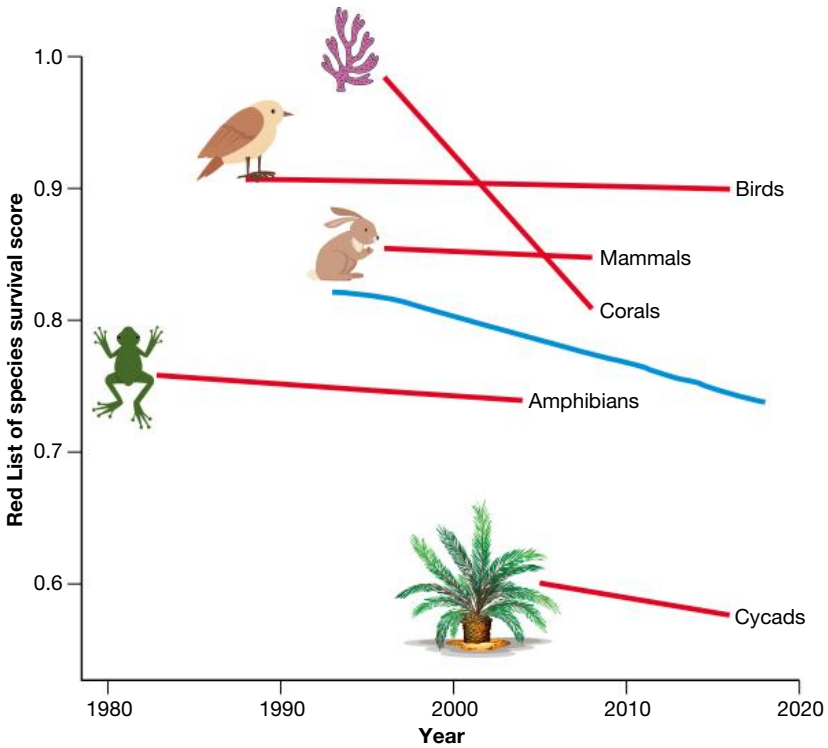
Our limited knowledge of ecological processes has only really become evident in the last few decades, as people have utilised more and more of Earth's natural ecosystems. Continental shelves and ocean depths, once thought to be devoid of life, are now known to be teeming with diverse life forms. People are only now starting to realise that there are tens of thousands of species still to be discovered.

The diversity of life on Earth is the result of millions of years of evolutionary change. The pool of living diversity is dynamic: it increases when a new genetic variation is produced, a new species evolves or a new ecosystem forms; it decreases when the genetic variation within a species decreases, a species becomes extinct, or an ecosystem is lost.

Ecologists say that of the estimated 5–30 million species that currently inhabit the planet, only 1.4 million have been identified. These represent only about 10 per cent of the species that have ever existed on Earth. The other 90 per cent have fallen victim to the evolutionary process of natural extinction. Evolutionary extinction is thought to have accounted for the loss of approximately one species per year.

The environmental NGO, the International Union for the Conservation of Nature (IUCN), currently lists than 42 000 species as threatened around the world on its Red List Index (RLI), which is the world's most comprehensive list of threatened, endangered and extinct species.

The IUCN created the RLI, which divides species into broad categories and scores the category in terms of the threat of extinction. The lower the score, the greater the risk of extinction. A value of 1 means all species within the category are unlikely to become extinct in the near future. An RLI value of 0 means all species within the category have gone extinct (see Figure 11.2.2). The RLI is reviewed regularly and can be broken down by country, ecosystem type and many other factors.



11.2.2 The IUCN Red List Index—a score of 1 means that all species in the category are not currently at risk. The blue line in the centre of the graph represents all species.

11.2.3 Fruit from the blushwood tree, endemic to Far North Queensland, may contain cancer-fighting compounds.

Why diversity matters

Earth's plants, animals and microorganisms constitute a vast store of chemical compounds, some of which have medical applications. Many of our modern medicines are derived from plants. For example, in late 2016 trials began on a new medicine, EBC-46, to treat cancer. The medicine is derived from the berries of the blushwood tree, which grows in the rainforests of Far North Queensland (see Figure 11.2.3). If the trials prove successful, this may replace the current chemotherapy treatments that have lots of negative side effects. In late 2022, researchers at Stanford University in the United States announced that they had developed the technology to synthetically make the EBC-46 compound, which may allow the mass production of a medicine in the future.

In highly competitive ecosystems, such as tropical rainforests, many organisms depend on chemical protective mechanisms for their own survival. These naturally produced chemicals constitute a major pharmacological resource. The loss of even a small area of rainforest could therefore mean the loss of disease-conquering chemical compounds. Medical scientists have estimated that they have managed to examine only about 5000 of the estimated 250 000 plants on Earth that could have pharmacological value.

Threats to biodiversity

Biodiversity is under constant threat. Habitat destruction, introduction of species and hunting are all major threats to biodiversity. Nearly 40 per cent of animal extinctions since 1600 are attributed to habitat destruction. Land clearing for agriculture and urban development is a key cause of habitat destruction. More recently, climate change has been radically altering the natural environment, causing the loss of habitat for many species.

SPOTLIGHT

Impact of cane toads on Australia's biodiversity

Cane toads (*Bufo marinus*) were introduced to the sugar cane fields of north-east Queensland in 1935 (see Figure 11.2.4). They are a native species of the rainforests of Central and South America. They were introduced to help manage the cane beetle, which damages Queensland's sugar cane crops. Only 102 cane toads were originally brought to Australia. After a breeding program, around 2400 were released. Today it is estimated that there are more than 200 million cane toads in Australia. The species quickly spread westwards into the Northern Territory, Western Australia and even southwards, with some found in Northern NSW. They have proved to be highly adaptable survivors, even being found in semi-arid areas.

Cane toads are highly toxic throughout their entire life cycle, even as eggs. The adults are particularly toxic and this creates significant change in the food chains of ecosystems where they are found. Larger predators, such as quolls and goannas feed on adult toads, which have the highest toxicity, resulting in the death of these apex predators. Over time, this changes the food chain. With fewer predators, the cane toads (and other native prey species) grow in number. The toads also compete with native species for shelter and food. For example, studies have shown that the rainbow bee-eater, a bird which nests on the ground, has had nesting sites infested with toads. This infestation impacts the birds' breeding process. The toads also eat the eggs and young hatchlings.

11.2.4 Introduced into Australia in 1935, there are now more than 200 million cane toads, causing major disruptions to biodiversity.

Utility value

Utility relates to the usefulness of something; the utility value of an ecosystem is therefore its usefulness in supporting the wider functions of Earth's natural systems. All the living and non-living components of Earth's **ecosphere** have either an existing or potential utility value, or usefulness. By maintaining and protecting ecosystems we

maximise humanity's ability to adapt to change. The sheer diversity of life represents a vast store of genetic material that can be tapped as human needs change. The loss of a species—whether plant, animal, fungus, bacterium or virus—denies humanity a possible future source of food, medicine, chemicals, fibres or other materials. Australia's flora and fauna make substantial contributions to the national economy through forestry, pastoralism, fisheries, tourism, land reclamation, beekeeping, wildflower harvesting and the kangaroo trade.

Environmental services

At a global scale, the components of the various ecosystems play a vital role in protecting catchments, purifying water, regulating temperature, regenerating soil, recycling nutrients and wastes and maintaining the quality of the air we breathe (see Figure 11.2.5). Their protection is critical to the physical wellbeing of humanity.

11.2.5 Coastal sand dunes have an important utility value by providing the environmental service of absorbing the power of waves during storms, thereby protecting inland areas.

Our immediate survival depends on very few species; principally a few grasses (wheat, rice, sorghum, millet, maize, barley, rye and oats) and a few tubers (such as potato, sweet potato, taro, cassava and manioc). Despite genetic engineering, plant breeders rely on old-fashioned selective breeding to develop varieties of these (and other) crop plants that can withstand climate stress, salinity, disease and insect attack; are suited to more efficient agricultural practices; or give higher yields.

Almost all the important food crops are native to environments that are at risk in the developing world. For example, wheat is from Afghanistan, potatoes from the highlands of Peru, and sorghum and coffee come from Ethiopia and the Sudan. Plant breeders rely on the traditional varieties grown in these regions as a source of the genetic material they need to transform varieties. This vital resource can only be maintained by preserving the environments in which the wild species grow and supporting farmers to continue growing their traditional food crop varieties.

Both these needs highlight one of the moral dilemmas of preserving biodiversity: who owns the genetic resource? Is it the developing country and the poor farmer who has preserved it until now, or is it the multinational company that has the technology and the money to exploit the resource?

Did you know?

The Svalbard Seed Vault in Norway opened in 2008, and holds seeds from thousands of plant species, many essential to human agriculture, to ensure that the genetic material is protected.

Economic value of ecosystems

In a world where almost everything is measured in terms of its monetary value, it is not surprising that some economists should attempt to value ecosystems in terms of what people are prepared to pay, either to consume them or preserve them. The **existence value** of an ecosystem is defined as the value a community is prepared to place on the ecosystem in its natural state. Many national parks occupy areas that could otherwise be used for farming or urban development. They also contain resources, such as timber and minerals, that could be exploited. The amount that people would be willing to pay for the land plus the cost of maintaining the parks is known as its existence value. The community, through government authorities, must be prepared to accept this cost.

Given that ecosystems have an economic value, it follows that they also have an **option value**. The option value is the cost of keeping the ecosystem or species in its natural state, as opposed to exploiting its resources. The World Economic Forum's *The New Nature Economy Report* series calculated that about US$44 trillion worth of economic output is moderately or highly dependent on nature. This represents about half of the world's economic activity.

Research carried out in the United States found that in 2021, the economic benefit of bees to the US agricultural sector was US$435 million annually. This was the result of the free pollination that bees provide to agricultural crops (see Figure 11.2.6). This massive amount represents the option value of bees.

11.2.6 The pollination that bees provide to commercial crops for free is worth millions of dollars.

11.2.7 Unique landscapes such as Uluṟu hold enormous intrinsic value to First Nations Australians by way of cultural and spiritual connections.

Intrinsic value

Ecosystems have their own intrinsic and ethical value. That is, ecosystems have a right to exist irrespective of their utility value. While few would disagree with such an idea, and most people would support the view that we need to protect ecosystems for the benefit of future generations, there is still no generally agreed mechanism or strategy by which this can be achieved.

Central to concept of the intrinsic value of ecosystems is a recognition that the biophysical environment provides for many of the inspirational, aesthetic and spiritual needs of people, such as the importance of Uluṟu (see Figure 11.2.7). In an increasingly urban society, intrinsic values make important contributions to emotional and spiritual wellbeing. By interacting with elements of ecosystems, humans are reminded that they are part of an interdependent natural world.

The aesthetic qualities of ecosystems are also valued for their recreational potential. Activities such as photography, trekking, bushwalking, birdwatching and field studies draw heavily on the aesthetic qualities of the biophysical environment. The growth of ecotourism is also closely linked to the growing appreciation of the aesthetic and ecological qualities of environments. This can add to the utility values (as an economic value) of an ecosystem.

Aboriginal and Torres Strait Islander perspectives

The links between First Nations peoples and the biophysical environment are particularly strong. Throughout the world, Indigenous peoples derive spiritual strength from their relationship with the biophysical environment. This is also the case with Australia's First Nation peoples.

Aboriginal and Torres Strait Islander peoples regard themselves as part of the environment; they have an ecocentric world view. This means that the natural world is viewed as being at the centre of society rather than an anthropocentric view, which places humans at the centre. This world view is expressed in the cultural beliefs and traditions of the Aboriginal and Torres Strait Islander peoples and their managed use of Earth's resources. Aboriginal and Torres Strait Islander peoples can have an acute appreciation of the natural world in which they live. They acknowledge, through their behaviours and beliefs, that they are responsible for the continuity of their world. Each individual is obliged to protect and preserve the spirit of the land and all things that live upon it. Beliefs about creation and spiritual and physical existence form the framework upon which people live. These beliefs govern hunting and food-gathering activities, as well as song, dance, storytelling and art, and establish the rules governing relationships between people, the land and all things.

11.2.8 Australia's Blue Mountains are on the World Heritage List.

Heritage value

The UNESCO World Heritage Conservation Council considers natural heritage to be 'natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view' (see Figure 11.2.8). The Australian Heritage Council regards natural heritage that is worthy of National Estate listing, to include 'those places, being components of the natural environment of Australia or the cultural environment of Australia, which have aesthetic, historic, scientific or social significance or other special value for future generations, as well as for the present community'.

In Australia, the concept of 'natural heritage' is broad. It includes large areas of pristine wilderness, as well as those sites that are more readily accessible to humans. Education has played a critical role in developing public support for heritage listing. As support

has grown, more sites (particularly those near human settlements) have been added to the list. In some cases, the listing was granted after a public controversy arose from a development proposal that would have degraded the heritage values of an ecosystem. Preserving important elements of our natural heritage for the enjoyment and wellbeing of future generations is a responsibility that we must all share.

The need to allow natural change

The diversity of life forms on Earth is a product of ongoing evolutionary processes. Many ecologists and environmentalists argue that humans have an ethical responsibility, and selfish requirement, to see that this evolutionary process continues relatively unimpeded. To ensure that this process continues, it will be necessary to protect large areas of representative ecosystems from human interference. To achieve the desired objectives, these areas should:

- be large enough to protect and conserve intact ecosystems effectively and to allow evolutionary processes to continue
- have boundaries that reflect environmental rather than political needs (e.g. they should be based on the boundaries of a catchment area)
- take into account the interests of local people—when the people who once depended on the resources of an area are excluded, they may resort to destructive activities, such as poaching, because they have no other way of providing for their families
- be well managed and effectively resourced
- be surrounded by a 'buffer zone' where human activity is carefully managed, as changes in areas around protected zones may interrupt breeding and migration patterns and affect water and air quality.

Activities

Acquiring and processing geographical information

1 Summarise why genetic diversity is important for ecosystem functioning.
2 Explain the importance of biodiversity.
3 Define the term environmental services.
4 Define the intrinsic value of ecosystems.
5 Describe the nature of the relationship that Aboriginal and Torres Strait Islander peoples maintain with the biophysical environment.
6 Define the term natural heritage.
7 Summarise the conditions necessary for unhindered evolutionary change.

Applying and communicating geographical understanding

8 Study Figure 11.2.2. Describe the patterns shown in the chart.
9 As a class, discuss whether putting an economic value on an ecosystem assists in its protection. Write a short report outlining the arguments made and conclusions drawn.
10 In a small group, discuss which areas of your local area are undisturbed. Write a list of ways that your local community could enhance the protection of these areas.
11 Write an extended response on the topic, 'Analyse the need to protect ecosystems at risk'.

UNIT 11.3

Ecosystems and stress

All ecosystems function in a state of dynamic equilibrium or a continual state of balanced change. This dynamic but balanced state is the result of the interactions between elements in the ecosystem: the atmosphere, lithosphere, hydrosphere and biosphere. Change occurs because the interactions between minerals, energy and communities vary over time.

The **interdependence** of these four elements also means that ecosystems are vulnerable. A change beyond the limit of the equilibrium, in any of these elements, means that the system cannot exist in its original state. All ecosystems are vulnerable, but the level of vulnerability depends on how small a change in any element is likely to upset the equilibrium overall. Ecosystems are not equally at risk, and some are more resilient than others.

Ecological and human stress

Ecosystems are constantly adjusting in response to changes within the total environment (see Figure 11.3.1). These adjustments could be in response to changes in the availability of water, average temperature, or many other natural events. In nature, these changes usually take place very slowly. The biome gradually adapts as animals and plant species that have characteristics unsuited to the change die out and those more suited to the new environment remain alive to breed and pass on their characteristics to successive generations. This process is known as natural selection.

Ecological stress is typically slow, allowing time for the environment to adapt. While sudden natural disasters have occurred from time to time throughout Earth's history and have caused whole species to die out almost instantly because they had no time to adapt, they are rare. Volcanic eruptions, tsunamis and meteorite strikes are examples of this.

Human stress on ecosystems is typically fast. The damming of a river, the draining of a wetland or the clearing of vast tracts of natural vegetation for agriculture are sudden and drastic changes that can result in a loss of habitat and the extinction of a species.

The ability to instigate large-scale environmental change means that people can push the state of dynamic equilibrium beyond its limits. As a result, people have created situations where they are required to maintain a state of equilibrium by introducing resources found elsewhere. The maintenance of an agricultural **monoculture** may rely on inputs of fossil fuels, fertilisers, pesticides and herbicides. Without them, the monoculture would fail. Today, human activities destroy or seriously threaten species and, more importantly, destroy or degrade their habitat.

	Catastrophic	Gradual
Ecological sources of environmental stress	■ Drought ■ Flood ■ Fire ■ Volcanic eruption ■ Earthquake ■ Landslide ■ Change in stream course ■ Disease ■ Tsunami	■ Natural climatic changes ■ Immigration of new species ■ Adaptation/evolution ■ **Ecological succession** ■ Disease
Human-induced sources of environmental stress	■ Deforestation ■ Overgrazing ■ Ploughing ■ Erosion ■ Pesticide application ■ Fire ■ Mining ■ Toxic contamination ■ Urbanisation ■ Water and air pollution ■ Loss and degradation of wildlife activity	■ Anthropogenic climate change ■ Irrigation: salinisation and waterlogging of soils ■ Soil compaction ■ Depletion of groundwater ■ Water and air pollution ■ Loss and degradation of wildlife habitat ■ Elimination of insects and predators ■ Introduction of exotic species ■ Overhunting/overfishing ■ Toxic contamination ■ Urbanisation ■ Excessive tourism

11.3.1 Ecological and human changes affecting ecosystem functioning by cause and rate

The nature of human stresses on the environment

Human stresses on the environment can be categorised into two broad types, as outlined below.

- **Intentional changes:** some human activities are specifically designed to alter an ecosystem. For example, when we clear land to make way for agriculture or urban development, we are intentionally changing the landscape. Sometimes while the change may be intentional, there may also be unintended consequences. For example, in clearing the land of trees, people have also unintentionally caused erosion or salinity.
- **Inadvertent changes:** meeting the needs and wants of a rapidly increasing human population is bringing about massive environmental change at local and global scales. In many cases, humans do not intentionally seek to cause these environmental consequences, but they result from our careless or ill-informed actions. For example, in many places using large quantities of fertiliser in agriculture to enhance the production of food, people have inadvertently changed the nutrient cycle, adding more nutrients to waterways, increasing algae and decreasing oxygen levels, resulting in major impacts to aquatic life. Similarly, by burning fossil fuels, such as coal and oil, humans have inadvertently disrupted the carbon cycle, which is directly impacting global climate patterns, resulting in climate change.

SPOTLIGHT

Shipping inadvertently killing whales

For centuries, humans hunted whales for their meat and oil, resulting in several whale species approaching extinction. It is estimated that across the twentieth century alone more than 3 million whales were hunted globally. Today, very little whale hunting takes place, but a new threat to whales from human activity has emerged—ship strikes (see Figure 11.3.2).

Worldwide, the number of ships has increased by more than four times since the 1990s, with thousands more ships sailing the world's oceans as global trade and the cruise industry have both exploded. For example, since 2010 there has been a more than 30 per cent increase in the number of ship movements between ports in Europe.

With this increase in shipping comes a significant increase in the number of whales being struck by ships. The Canadian Wildlife Federation reports the number of fatal ship strikes on whales now numbers at least thousands, but is more likely tens of thousands per year. Many whales that are struck have their spines broken and die a slow and painful death. Virtually all species of whale, including the massive blue whales, the largest animal to have ever lived, are at risk.

There are strategies to reduce the risk, most notably the use of speed limits in major whale zones to give ships more time to sight and avoid whales. Detection equipment on ships is also another strategy, and when used in conjunction with reduced speeds, significantly reduces the risk of striking a whale.

11.3.2 Ship strikes have become a common cause of whale deaths and are an inadvertent impact of the massive growth of shipping and the cruise industry globally.

Measuring the effects of ecological and human stresses

There is no standard to measure the effects of stresses on ecosystem functioning other than to look at the ecosystem itself and note changes. For example, we can study the impact on flora and fauna before and after an event, and consider the amount of natural habitat lost or the impact on biodiversity. All such measures require a baseline measurement. This is a starting point from which to measure the extent of change.

There are two key factors to consider when examining the impact of ecological or human stresses: the magnitude of change and the rate of change.

THE MAGNITUDE OF CHANGE

In terms of ecosystem functioning, magnitude of change refers to the extent to which an ecosystem has been stretched beyond its state of dynamic equilibrium. The change might be slight, or it could be so extreme as to destroy the ecosystem, leaving an area lifeless. Human activities, such as human-induced climate change, have the potential to change the functioning of whole ecosystems.

Measuring the magnitude of change requires a comparison between known data and whatever benchmark data may be available. It is preferable for the benchmark data to be collected before the change commences.

THE RATE OF CHANGE

The rate of ecosystem change is the speed at which the change is occurring. Ecological change typically occurs over longer periods of time, sometimes measured in thousands or even millions of years. Human changes, on the other hand, can be very quick; for example, clear-felling of forests can take place in a matter of days and an oil spill from a tanker can occur in the manner of minutes (see Figure 11.3.3).

11.3.3 The rate of change for human stresses, such as oil spills from shipping accidents, is rapid.

● SPOTLIGHT

Ecological stress: Mt St Helen's eruptions

In 1980, Mt St Helens, a volcano in Washington, United States (see Figure 11.3.4), had been dormant for over a century. In the months April to May, scientists became concerned about tremors beneath the mountain. Aerial observers noted an opening on the summit of Mt St Helens where ice quickly blackened with ash. What caused the most concern was the development of a bulge on the side of the mountain's northern slope.

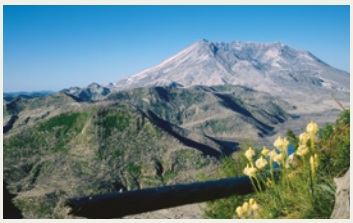
On 18 May at 8.32 a.m., an earthquake measuring 5.1 on the Richter Scale, rocked the ground directly below the mountain. The earthquake initiated an avalanche, which was followed by a massive blast of gas, rock, ash and ice (see Figure 11.3.5). One part of the avalanche slammed into Spirit Lake, causing the water level to rise 60 metres. Another mass of debris crashed down into the Toutle River, filling it to a depth of 45 metres in minutes.

The effects on the surrounding ecosystem were devastating:

- 120 metres of the summit vanished, leaving in its place a crater 2 kilometres wide, 4 kilometres long and 1.5 kilometres deep (see Figure 11.3.6).
- 380 square kilometres of land to the north of the mountain was devastated by the blast and covered by hot volcanic debris.
- large areas of coniferous forest were destroyed (see Figure 11.3.7) and countless numbers of wild animals were killed.
- volcanic ash, carried by the prevailing winds, was spread for 1500 kilometres to the west.
- 100 people were killed.

11.3.4 Mount St Helens, before the 1980 eruption

11.3.5 Eruption of Mt St Helens, 18 May 1980



11.3.6 Mt St Helens after the eruption, which was a significant ecological stress.

11.3.7 The eruption of Mount St Helens caused massive environmental impact.

Within just a few years of the eruption, scientists found evidence that pioneering flora and fauna were starting to colonise the ash-grey volcanic landscape seen in Figure 11.3.8. Plants such as lupin, Indian paintbrush, pearly everlasting and fireweed took root among the coarse grey rock. Willow and elder trees had grown to a height of 1–2 metres. The roots and decaying leaves and stems of the vegetation provided the organic material needed to convert volcanic grit into sustaining soil.

11.3.8 This image taken in 2022, 42 years after the eruption, shows the slow yet gradual recovery of the environment around Mt St Helens.

The plants and trees had adapted to the extremes of season and altitude, and were equipped to stake a claim in the harsh conditions. Lupins played a key role; bacteria on their roots released nitrogen, necessary to all plants. Alders produced winged seeds that could ride the wind. Birds and animals helped the process by eating, transporting and depositing seeds in their droppings. Burrowing gophers penetrated the ash blanket and brought former topsoil back to the surface.

The area represents a miniature fast-forward version of what has happened over vast time frames in our planet's evolution. Scientists have enjoyed an unparalleled opportunity to observe the cycles of regeneration (see Figure 11.3.8).

● SPOTLIGHT

Human-induced stress: The Deepwater Horizon explosion

The Deepwater Horizon was an offshore oil rig operating in the Gulf of Mexico almost 70 kilometres off the coast of Louisiana, in the southern United States. The rig was drilling a well below the water's surface at a depth of more than 1500 metres. The well was 5486 metres below the seabed when a surge of natural gas exploded out of the wellhead on 20 April 2010. The explosive gas roared up the pipe to the rig itself, causing an explosion that killed 11 workers and injured 17 more (see Figure 11.3.9).

Despite efforts to close the wellhead, oil gushed in huge quantities out of the destroyed wellhead located on the sea floor. Millions of litres of oil flowed out of the well. It took until mid-September for engineers to successfully fully seal the well using special concrete. The disaster became the biggest oil spill in history. It had a catastrophic impact on the surrounding ecosystem. The National Oceanographic and Atmospheric Administration (NOAA), a special scientific agency of the US Government, calculated that around 610 million litres of oil were released into the environment.

As the spill originated at the seafloor, it impacted all layers of the marine ecosystem from the sea floor all the way up to the surface (see Figure 11.3.10). At the surface, an area of almost 150 000 square kilometres was impacted by the oil slick. An estimated 1800-kilometre length of coastline was impacted by the oil. This had a massive impact on ecosystems across the Gulf of Mexico. Millions of marine creatures were killed, along with thousands of seabirds and many other animals. Between 8000 and 12 000 people lost their jobs after the fishing and tourism industries collapsed along the coastline.

11.3.9 A massive explosion engulfed the Deepwater Horizon offshore rig.

11.3.10 Pelicans covered in oil from the Deepwater Horizon explosion

Ecological and human stresses are often interrelated. A natural stress may already exist, but can be made more extreme by human activities. For example, bushfires are a naturally occurring stress in the Australian environment. However, human-induced climate change has increased both the intensity and the frequency of fires. Similarly, storm events are a common ecological stress. Altering climate patterns through human-induced climate change has meant bigger storms occur more regularly.

Vulnerability and resilience of ecosystems

All ecosystems have some ability to withstand stress. They tend to resist being disturbed or altered and will restore themselves to their original condition if not disturbed too drastically. Ecosystems can maintain themselves within a tolerable range of conditions. This was discussed in Unit 11.1, and is known as dynamic equilibrium.

Factors affecting an ecosystem's vulnerability

A number of factors affect an ecosystem's vulnerability to stress. These include location, extent, biodiversity and linkages.

LOCATION

The location of an ecosystem affects its functioning. At a global scale, latitude, distance from the sea and altitude all play decisive roles in determining climate and the nature of particular ecosystems.

The microclimatic features of a location can be significant enough to create a range of distinctive ecosystem types within relatively small areas. The aspect of a slope is one such microclimatic variable, since the aspect will affect the amount of sunlight and rain it receives.

EXTREME OR UNIQUE ECOSYSTEMS

Some ecosystems are in environments considered extreme: deserts (extreme heat and/or aridity), the polar regions and high mountain peaks (extreme cold), hypersaline lagoons (extreme salinity) and areas of nutrient deficiency. Organisms capable of living in such conditions have adapted to survive the extreme conditions and are therefore highly specialised. The more specialised an organism is within a particular set of environmental conditions, the more vulnerable it will be to changes in those conditions.

Corals are highly specialised organisms that flourish in the shallow, nutrient-deficient waters of the tropics. Any increase in nutrient levels promotes the growth of algae. This reduces the amount of sunlight available for coral growth. If the elevated nutrient levels are sustained, the corals become stressed, reefs contract in size and the number of coral species declines. Corals are also sensitive to changes in water temperature. They normally flourish at temperatures between 25°C and 29°C, depending on their location. This narrow temperature range is very close to their upper lethal temperature. An increase of just a few degrees above the usual summer temperature can be devastating. The coral polyp dies, leaving only the white calcium carbonate skeleton. This is known as coral bleaching. Many coral reefs are now under significant stress due to ocean warming caused by to climate change.

PROXIMITY TO HUMANS

An ecosystem's location in relation to large concentrations of people is another important contributing factor to its vulnerability (see Figure 11.3.11). As human populations grow, so does demand for land, making ecosystems increasingly vulnerable because of urban development. Urban, industrial and agricultural land uses affect and sometimes destroy natural ecosystems, while the oceans, rivers and the atmosphere become dumping grounds for pollutants. For coral reef ecosystems, run-off that has been polluted by sewage, agricultural fertilisers and land clearance is a major source of excess nutrients and increased turbidity.

11.3.11 The mangrove forests located in and around the Indian megacity of Mumbai are highly vulnerable to clearing and impacts from pollution as the city continues to grow.

EXTENT

The extent (size) of an ecosystem is the result of a variety of factors. Recent research has shown that the boundaries of ecosystems tend to overlap each other. River ecosystems extend beyond the river channel to include the whole drainage system. Human activity in the drainage basin can impact the river itself, even when it occurs some distance from the channel. It may, for example, increase soil erosion. A study of the Flathead River, Montana, in Western United States, showed that stoneflies and other creatures living in shallow wells on the floodplain of the river, up to 2 kilometres away from the river, mated along the riverbanks before returning to lay their eggs in the wells. While at the riverbank, they were preyed upon by fish. This example demonstrates how these are two interrelated parts of the same ecosystem that rely on each other.

Ecosystems that are restricted to small areas or have already been extensively disturbed are especially vulnerable. Tropical rainforests have small populations of a large number of species confined to relatively small, localised communities. The loss of even a small area of rainforest can lead to the extinction of plant and animal species. Savanna grasslands have large populations of a small number of species spread over much larger areas. The loss of a small area of grassland may not result in the extinction of species. However, the large herbivores typical of these regions require extensive grazing areas.

BIODIVERSITY

When an ecosystem is diverse, there is a range of pathways for the ecological processes, such as nutrient recycling. If one pathway is damaged or destroyed, an alternative may be found, and the ecosystem can continue to function at its normal level. If the level of biodiversity is greatly diminished, such as through the extinction of a species, the functioning of the ecosystem is put at risk. The greater the level of diversity means the greater the opportunity to adapt to change.

GENETIC DIVERSITY

Genetic diversity is the variety of genetic information contained in all the individual plants, animals and microorganisms. Genetic diversity occurs within and between populations of species, as well as between species.

High levels of genetic diversity favour the survival of a species, because it increases the chance that some members of the species will have characteristics that aid their survival if the population experiences stress. Genes have costs as well as benefits. For example, a British study has shown that peach potato aphids that are resistant to common pesticides are less able to survive British winters than aphids that are not resistant to pesticides. This situation may change with global warming.

Species diversity

Species diversity is a measure of the number of species at each trophic level of an ecosystem. The greater the species diversity, the more robust the ecosystem. If the population of one producer or consumer organism declines dramatically there are likely to be other producers or consumers available that can fulfil a similar function in the ecosystem.

Ecosystem diversity

Ecosystem diversity refers to the diversity within an ecosystem regarding habitat differences, **biotic** communities and the variety of ecological processes.

● SPOTLIGHT

Vulnerability of Minnamurra Rainforest

Minnamurra Rainforest is a small pocket of rainforest located on the South Coast of New South Wales, near Kiama (see Figure 11.3.12). The extent, biodiversity and location of the rainforest all work together to make this a vulnerable ecosystem.

11.3.12 Minnamurra Rainforest is a vulnerable ecosystem on the NSW South Coast.

The forest is located close to urban development and is surrounded by farms. This increases the level of pollutants entering the system and has led to significant weed infestation, particularly lantana, which, despite extensive management efforts, remains a significant challenge.

Minnamurra is a **remnant** forest of only about 160 hectares, meaning it is a small remaining portion of what was once a much larger forest, in fact, less than 10 per cent of the original forest remains. Its small extent significantly increases the vulnerability of the ecosystem because weeds, pests and diseases are more easily spread throughout the whole forest.

The biodiversity of the forest is threatened by non-endemic (introduced) species, such as lantana, which have invaded the forest and created pockets of monocultures. Additionally, with such a small extent, the number of individuals of species that can be supported by the forest is significantly reduced.

Factors affecting an ecosystem's resilience

Resilience is the ability of an ecosystem (or a component of an ecosystem) to adapt to a changing environment and to restore function and structure following an episode of natural or human-induced stress.

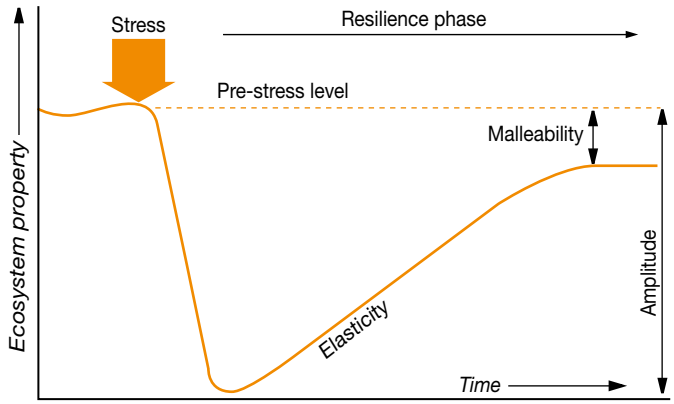
A number of factors affect an ecosystem's resilience to stress. These include biodiversity, ecological integrity and **biocapacity** extent and linkages.

BIODIVERSITY

Ecosystems rich in biodiversity generally have greater resilience than those with little diversity. They can recover more readily from naturally induced stress (including drought and fire) and human-induced habitat destruction. The more successful a species is at regeneration and adaptation, the less vulnerable it is to changes in its ecosystem. Long-term ecosystem degradation occurs when the magnitude and duration of the stress exceed the ability of the component to repair itself.

In some cases, natural sources of stress play an important role in the functioning of ecosystems. Stress-dependent organisms and processes rely on changes in their environment to produce or stimulate a growth of their systems. Some eucalypt species, for example, rely on fire to initiate a stage in their reproduction cycle and many perennial desert plants rely on the occasional fall of rain to activate their growth cycle.

As with change, resilience is a natural part of ecosystem functioning (see Figure 11.3.13). The intensity and duration of stress is important in terms of the effect it has on an ecosystem.



Elasticity is the rate of recovery of an ecosystem property following disturbance.
Amplitude refers to the threshold level of strain beyond which return to the original state no longer occurs.
Malleability of the ecosystem is the difference between the ecosystem's final recovery level and the pre-stress level; the greater the difference, the less resilient is the ecosystem.

11.3.13 The impact of stress on the resilience of an ecosystem

ECOLOGICAL INTEGRITY

Ecosystems are complex, with processes and components that are interrelated. Each ecosystem has evolved to function within the unique relationship between the four spheres found there. Therefore, when human or ecological stresses disrupt these relationships, an ecosystem becomes more vulnerable as it loses some of its resilience.

The concept of ecological integrity was first developed by in the late 1940s by US ecologist Aldo Leopold, who is often referred to as the founder of wildlife **ecology**. Ecological integrity exists when an ecosystem is whole and unaltered by human activity. This is because all the functions of the ecosystem can perform as they should and allow for the linkages and connections between the elements of the ecosystem to operate unhindered.

In reality, it is impossible to find any ecosystem that has no human influence, so great has our reach become. However, ecosystems that have more ecological integrity will have greater resilience than those that have been greatly altered by humans. This is why remnants, small parts of once much bigger ecosystems (such as Minnamurra Rainforest), are more vulnerable.

BIOCAPACITY

Biocapacity relates to the regenerative capacity of an ecosystem. This means the ability of the ecosystem to replace the resources used by humans and to absorb the pollutants emitted by human activities. Biocapacity relates directly to vulnerability and resilience of an ecosystem. The higher the biocapacity of an ecosystem, the more resilient it is to the stresses created by human activities. These stresses are often referred to as a society's environmental footprint. If humans use renewable resources at a rate equal to or less than the ability of the ecosystem to replace (or regenerate) them and emit pollutants at a rate equal to or less than the ability of the ecosystem to absorb them, then we are operating within the biocapacity of Earth.

SPOTLIGHT

Wild rivers of New South Wales

Wild rivers are special places as they are waterways that are in near pristine condition. The flora, fauna and waterflow are all close to a natural system. Importantly, they are found in areas with little or no significant human development. In NSW, a wild river can be declared under a special law the *National Parks and Wildlife Act 1974* (NPW Act). Once declared a wild river, the waterway has additional protections that importantly include the areas surrounding it, not just the river itself.

A small number of rivers, including some close to Sydney, have been declared wild. For example, the Grose and Colo rivers, which form tributaries of the Hawkesbury Nepean River, have been declared wild (see Figure 11.3.14). They flow through areas that are mostly national park with very little or no human development. These rivers are examples of ecosystems with high levels of ecological integrity and are among the least vulnerable rivers in the state.

11.3.14 The Grose River in the Blue Mountains west of Sydney is a wild river with high ecological integrity.

● SPOTLIGHT

Earth Overshoot Day

Earth Overshoot Day is a unique way to calculate Earth's biocapacity. Hosted by the Global Footprint Network, each year they calculate the date by which humanity's demands on Earth exceeds its biocapacity for the entire year. In other words, the calculation compares the environmental footprint of humankind with the capacity of the planet to regenerate resources and absorb our wastes.

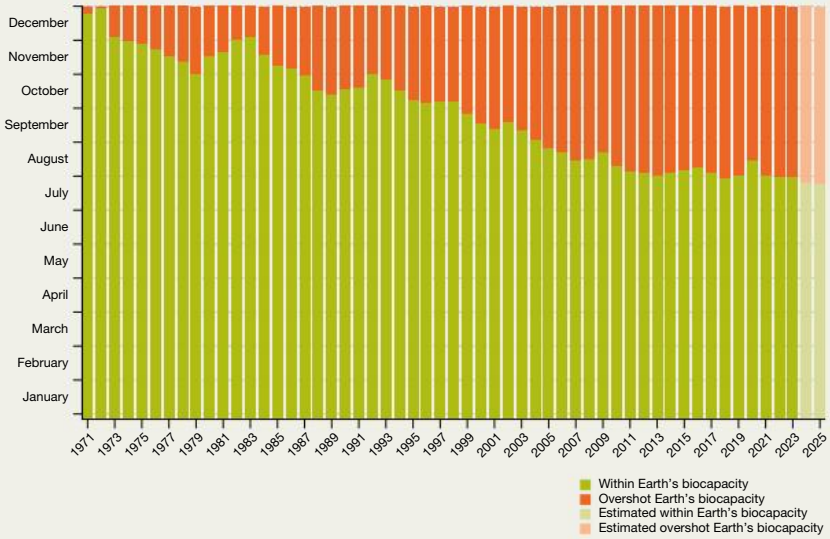
The first Earth Overshoot Day took place in 2006, and human demand on Earth's resources reached biocapacity on 21 August in that year. Using the same methodology, Global Footprint Network was able to calculate that in 1971 it was 25 December. In fact, every year since 1970, Earth's biocapacity has been in deficit.

Interestingly, in 2020 the day was not reached until 22 August, even though in 2019 it was reached on 29 July. This delay coincided with the severe restrictions on human activity in 2020 due to the COVID-19 lockdowns around the world and the massive decline in economic activity that was associated with it.

It is thought that 2022 may have marked a turning point in the trend of ever earlier overshoot days (see Figure 11.3.15). As awareness of human impacts grows and more and more initiatives begin to limit global emissions, a slow but gradual delay in the overshoot date is anticipated.

Overshoot Day data is also calculated for individual countries. This represents a way to examine the environmental impacts of individual nations. For example, if every person on Earth lived how Australians currently live, we would need 4.5 Earths to sustain everyone. By contrast, if everyone in the world had the same impact as India currently does, humanity would require about 0.8 of a single Earth to sustain us all (see Figure 11.3.16). In 2023, Australia reached Overshoot Day on 23 March.

11.3.16 The environmental footprint of various countries is seen in this comparison of how many Earths' biocapacity would be required if every person in the world lived like the people who live in each of these countries.



11.3.15 The date each year, from 1971 to 2025, when human demand exceeded Earth's biocapacity

Activities

Acquiring and processing geographical information

1 Differentiate between an ecological and a human stress.
2 How are the effects of ecological and human stresses measured?
3 Describe the difference in rate between typical human and typical ecological stresses.
4 Explain how location can impact the vulnerability of an ecosystem.
5 Outline how extent affects an ecosystem's vulnerability.
6 Explain why genetic diversity decreases the vulnerability of an ecosystem.
7 Explain what ecosystem resilience refers to.
8 List the types of ecosystems that have greater resilience.
9 What is ecological integrity?
10 Explain why high levels of ecological integrity reduce an ecosystem's vulnerability.
11 Define biocapacity.
12 How does biocapacity relate to the resilience of an ecosystem?

Applying and communicating geographical understanding

13 Using examples, write a paragraph to explain the difference between an intentional and an inadvertent human stress.
14 Study Figures 11.3.4 to 11.3.8. Explain the impact of volcanic eruption on the natural environment around Mt St Helens.
15 Study the box, Spotlight: Human-induced stress: The Deepwater Horizon explosion. Complete the activities below.
   a Summarise the nature of the disaster.
   b Describe the magnitude and rate of the change.
   c Explain why this disaster was even more damaging than most oil spills.
16 Write a short report on the importance of biodiversity in reducing the vulnerability of ecosystems.
17 Study the box, Spotlight: Vulnerability of Minnamurra Rainforest. Complete the following activities.
   a Summarise how location has made this ecosystem more vulnerable.
   b Describe the extent of Minnamurra and how this impacts on its vulnerability.
   c Explain the impact that lantana has had on the ecosystem.
18 Study Figure 11.3.13. Explain the process shown in the diagram.
19 Study the box, Spotlight: Earth Overshoot Day. Write a paragraph outlining how this date demonstrates biocapacity.
20 Write an extended response on the following topic. 'Analyse the factors that cause ecosystems to become vulnerable and explain how an ecosystem's resilience can be maintained.'

UNIT 11.4

The global state of ecosystems and biodiversity

Biodiversity is a collective term used to describe the vast multitude of life on Earth. It relates to all living things, including plants, animals and bacteria. Scientists have identified around 1.2 million discrete species across the world's ecosystems, but it is estimated that there are more than 8.7 million in total, meaning most are yet to be discovered.

Biodiversity is not uniform. Some ecosystems have far greater biodiversity compared to others. These are often referred to as biodiversity hotspots and include places such as the Amazon Rainforest, Africa's savanna grasslands and Madagascar (see Figure 11.4.1).

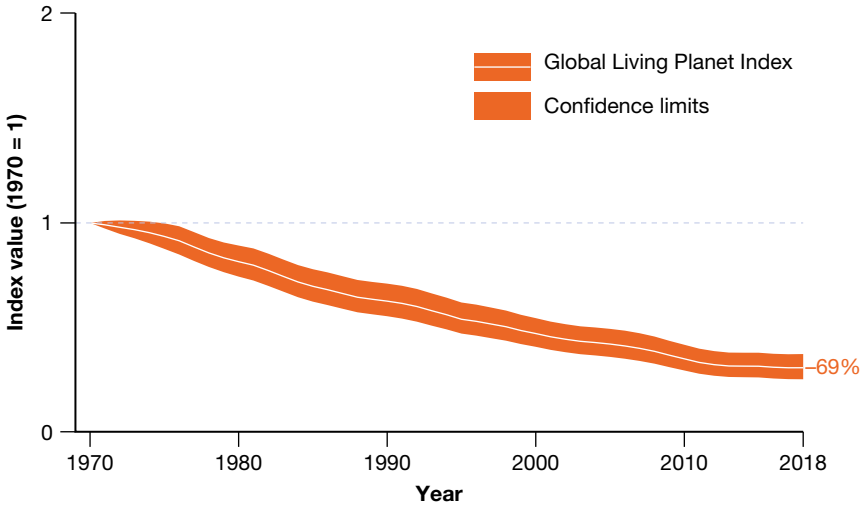
Biodiversity is critically important to the functioning of an ecosystem and indeed the functioning of Earth's natural processes. Ecosystems that have complex food webs with multiple linkages are far more resilient, making them less vulnerable to change. Biodiversity is therefore one of the key factors that shield ecosystems from changes.

11.4.1 Madagascar's unique environment is one of the world's biodiversity hotspots.

Current trends in biodiversity

The global trend in biodiversity over last two centuries or more has been one of decline. The Living Planet Index (LPI) is a useful tool for examining the extent of this decline The LPI is a measure that tracks the state of populations of vertebrate species across the globe. Vertebrates are animals that have a backbone and are usually considered more complex animals. The LPI is compiled by the Worldwide Fund for Nature (WWF) and the Zoological Institute of the Zoological Society of London.

The LPI is compiled by using the Living Planet Database, which holds data on more than 31 800 populations of mammal, fish, bird, reptile and amphibian species from around the world. This information is gathered from reliable sources, including academic journals and government reports. The LPI has been adopted by the Convention on Biological Diversity as a key indicator on biodiversity trends. The *Living Planet Report 2022* provides recent data on the LPI up to 2018 (see Figure 11.4.2). Using 1970 as the baseline, there has been a 69 per cent decrease in biodiversity in vertebrates in the 48 years to 2018. The white line on the index represents the index values, with the shaded areas either side indicating the statistical certainty around the trend—with 95 per cent certainty.



11.4.2 The Living Planet Index, 1970–2018

● SPOTLIGHT

Biodiversity loss in the Atlantic forests

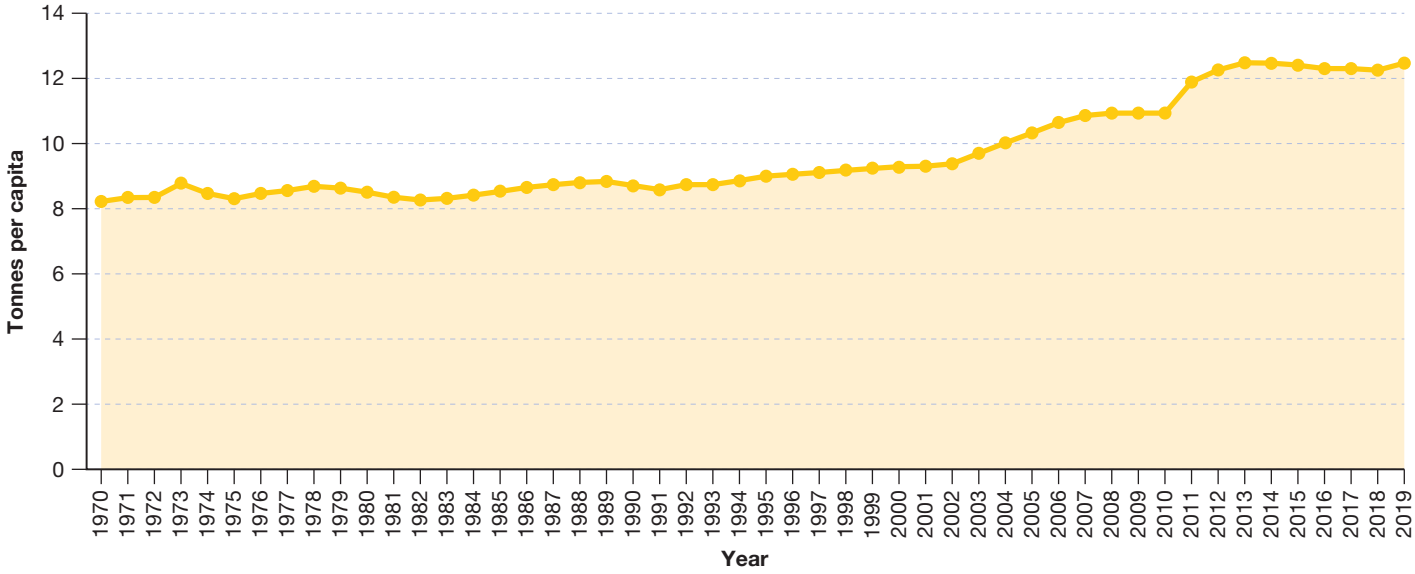
Recording a Living Planet Index decline of 94 per cent, the sub-tropical regions of Latin America were the worst affected areas for loss of biodiversity in the 2022 report. Located in Central America and the northern half of South America, these are places rich in biodiversity. Big declines in amphibian, fish and reptile numbers were behind the huge decline in overall biodiversity in this region. Draining of wetlands, rainforest clearing and overfishing, especially freshwater species, were among the main causes.

The Atlantic forests of Brazil are an important habitat in this region, with more than 100 known species of frogs and a massive plant diversity; three new species were found by scientists in 2017 alone. The forest is also home to a number of unique frogs that are remarkable for their tiny size, with some adults being no more than 1 centimetre in length (see Figure 11.4.3). Just a small area of 2.5 acres of pristine forest is said to have at least 450 different plant species. However, the region, which stretches along the eastern coast of the country on the coastal plain, has been reduced by more than 85 per cent since the arrival of Europeans in the 1500s. The region is home to 150 million people and houses the megacities of Rio de Janeiro and São Paulo.

The remnants of this once massive forest, that previously covered 141 million hectares, are now highly fragmented in small pockets, typically isolated from each other. Around 70 per cent of these are less than 101 hectares in size. Extent is one of the key drivers in reducing the resilience of an ecosystem and such small pockets are very vulnerable. Two species of frog have already become extinct in this region and 46 are currently threatened or endangered. Disease from chytrid fungus, which is a major threat to amphibians worldwide, is more widespread than usual due to the overall environmental stresses on the Atlantic forests' ecosystems.

11.4.3 *Brachycephalus nodoterga*, a tiny amphibian recently discovered in the Atlantic forest

Figure 11.4.4 shows data on the material footprint of humankind from 1970 through to 2019. The material footprint is a way of measuring the environmental pressure created by human economic and social demands. It shows the impact in tonnes per capita for each person, effectively how many resources each person uses. It is useful to consider this graph in conjunction with Figure 11.4.2, as it shows how the increase in material footprint of humankind correlates with a decline in biodiversity over the same time period.



Source: UN Environment Programme International Resource Panel, WESR /Global Material Flows Database

11.4.4 Humans' environmental footprint 1970–2019.

It is important to note that Figure 11.4.4 shows per capita rates. This means not only has the amount used by each person globally increased significantly, but so has the actual number of people. In 1970, the global population was around 3.7 billion and had increased to around 7.7 billion by 2019.

The extent of the human footprint is found in many different measures. Since 1960, the amount of land used by humans for agriculture has increased by 50 per cent. Agriculture is one of the main reasons for land clearing. On average, each year since 1950 around 130 000 square kilometres of Earth's forests have been cleared. This is roughly twice the size of Tasmania cleared every year. The loss of habitat associated with land clearing is the single biggest reason for the loss of biodiversity globally.

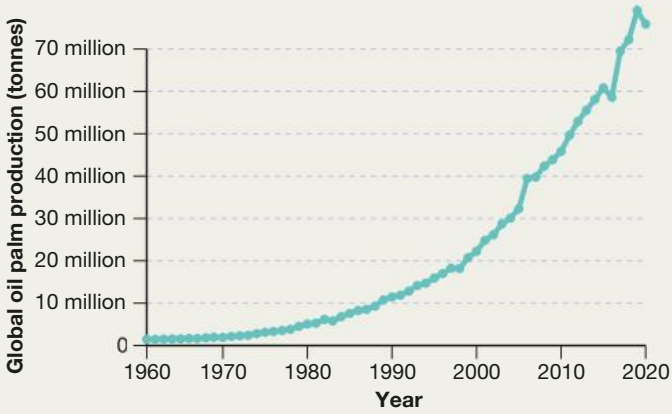
● SPOTLIGHT

Palm oil and habitat destruction

Palm oil is one of the most widely consumed products in the world. Palm oil is cheap to produce, and it is estimated that around half of all packaged products contain some palm oil, everything from cosmetics and shampoo to chocolate and ice cream. Palm oil is derived from oil palm trees, which grow best in tropical environments with their high rainfall, warmth and sunlight.

Palm oil production exploded in the early 2000s and it is now the most used vegetable oil in the world, with more than 70 million tonnes produced annually (see Figure 11.4.5). Together, Indonesia and Malaysia account for around 85 per cent of world palm oil production.

In 1980, around 4 million hectares of land were used to grow oil palms. By 2020, this had increased to around 19 million hectares. Much of this increase has come through the clearing of rainforests, especially in Borneo. About one-quarter of all deforestation in Malaysia and Indonesia is the result of land clearing for oil palm plantations (see Figure 11.4.6). These forests have very high levels of biodiversity. They are home to the critically endangered Bornean orangutan, which has lost more than 80 per cent of its habitat since 1980.



Source: Food and Agriculture Organization of the United Nations

11.4.5 Global palm oil production, 1961–2020

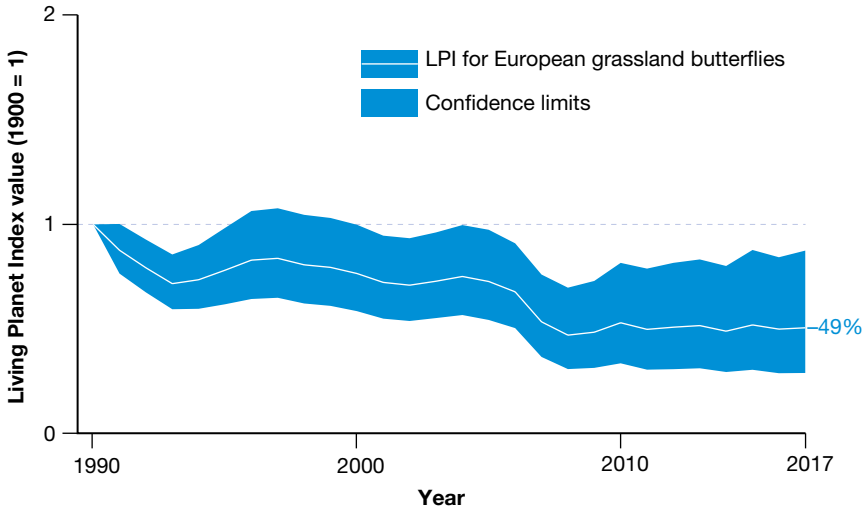
11.4.6 Clearing for oil palm plantations is the key driver of deforestation in Borneo.

Insect diversity decline

Insects dominate the world's known species, with more than 1 million species described by scientists and possibly 5.5 million species in existence. Insects provide invaluable environmental services to terrestrial ecosystems. They pollinate many plant species, they regulate pest species and they play a key role in recycling nutrients as part of the nutrient cycle. Of course, they are also a major source of food to many other species higher up in the food chain.

Studies from around the world have shown significant declines in insects since the 1960s when large-scale studies began. For example, studies in the UK have found that large moths have declined there by around one-third between 1969 and 2016.

Studies in Germany put the decline of insects in the country's grasslands at more than three-quarters between 2008 and 2017. Almost one in five known butterfly species are threatened. In Europe's grasslands, butterfly species have a Living Planet Index decline of 49 per cent since 1990 (see Figures 11.4.7 and 11.4.8).



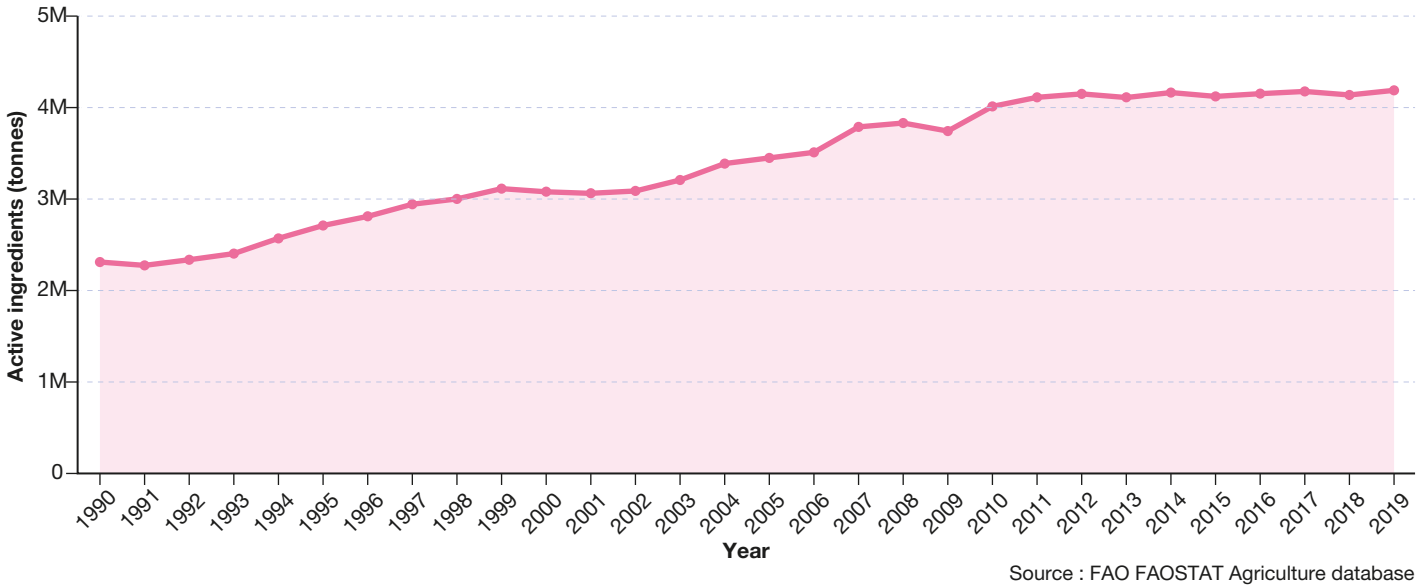
11.4.7 Decline of butterflies in Europe's grasslands 1990–2017

11.4.8 The large skipper butterfly is an important species in Europe's grasslands. Its population has declined by around one-quarter since 1990.

However, some studies have also shown an increase in populations within some species, for example, freshwater insects have expanded at a rate of around 11 per cent per decade since the 1920s. It has been theorised that this positive result is due to improved water quality in inland rivers and lakes, especially in Europe and North America.

One of key reasons for the decline in insect numbers overall is the widespread use of pesticides in agriculture. These are chemicals that are used to reduce pests and maximise crop yields, but they also unintentionally kill many other insect species.

Figure 11.4.9 shows the amount of pesticide used globally, according to the UN Food and Agriculture Organisation (FAO). The graph shows that there has been a steady increase since the 1990s, although this increase is beginning to slow down and there are expectations that more environmentally-friendly practices will help to reduce its use further into the future.



Source : FAO FAOSTAT Agriculture database

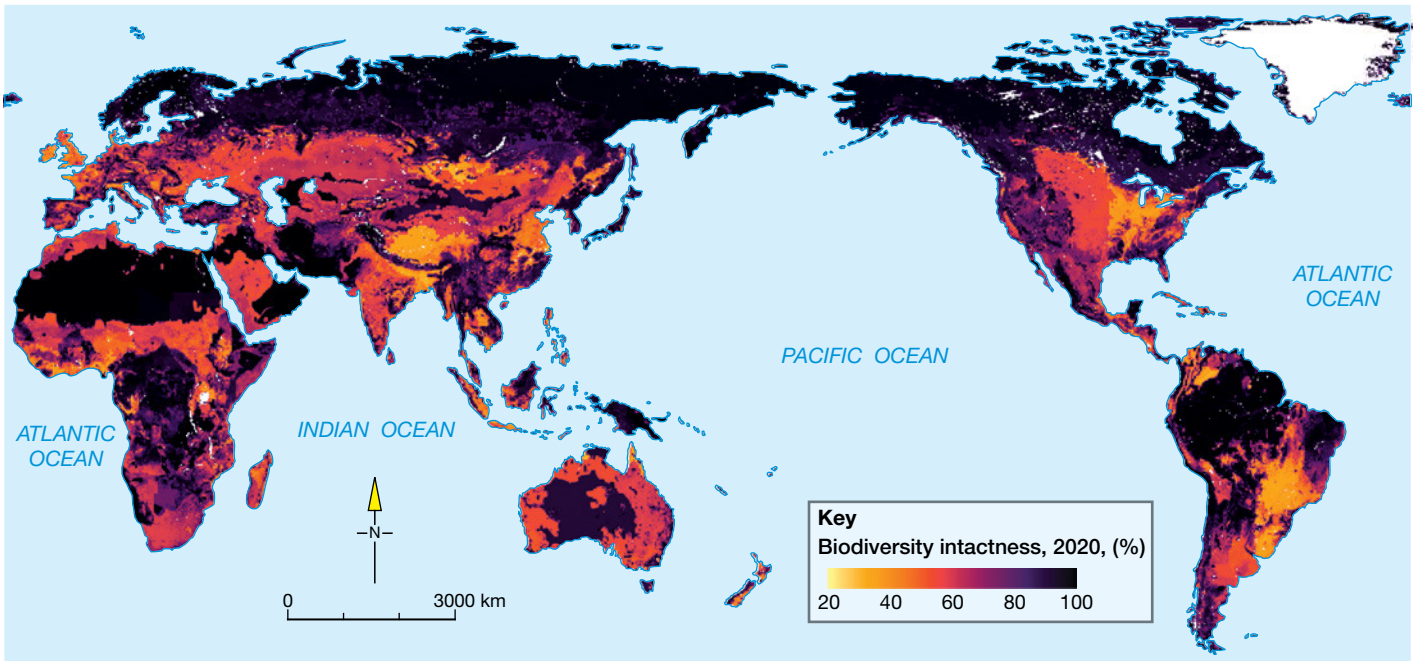
11.4.9 Global pesticide use, 1990–2019

Biodiversity Intactness Index

The Biodiversity Intactness Index (BII) is another useful tool for geographers to use, to understand how human activities impact the biosphere and biodiversity. It is an estimated percentage of the original number of species that remain and their abundance, regardless of human impacts. The BII can be averaged to provide data at various scales, global, regional and national. The BII is calculated by a special team of scientists from the Natural History Museum in the UK.

The closer a location scores to 100 per cent on the BII, the more intact its biodiversity is said to be. Very few parts of the world score 100 per cent, as this would indicate a virtually undisturbed natural environment with little or no human footprint present. A score of at least 90 per cent indicates that the area has sufficient biodiversity to be considered a resilient and well-functioning ecosystem. An area with a BII score of 30 per cent or lower is an ecosystem that is very vulnerable and may collapse.

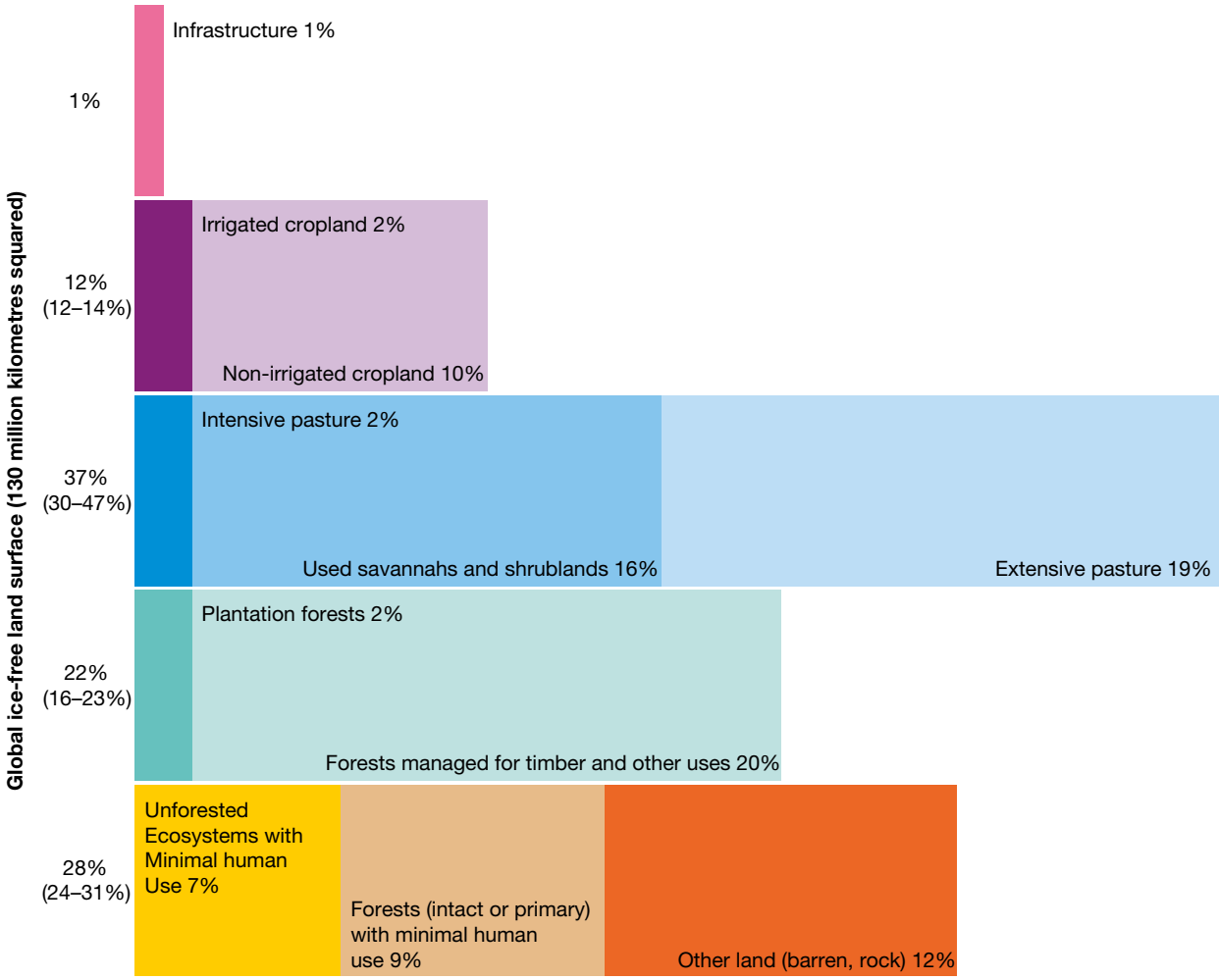
Figure 11.4.10 shows the BII scores from 2020, reported in 2022. Large areas of the world have BII scores below 50 per cent and many are now at the 30 per cent threshold for being at risk of collapse.



11.4.10 The Biodiversity Intactness Index, 2020

Future trends in biodiversity

Human activities have had an enormous impact on global biodiversity, especially since the widespread industrialisation of the nineteenth century. Only a little over a quarter of Earth's terrestrial landmass (excluding Antarctica) is considered to have minimal human impact. The remainder is used to satisfy the demands of humans, with agriculture accounting for nearly half of all land on Earth (excluding Antarctica) (see Figure 11.4.11). Even within the world's vast oceans, the impact of humans can be seen almost everywhere. The accumulation of microplastics, the over-exploitation of fisheries and the impacts of climate change are being seen across the world's oceans and marine ecosystems.



11.4.11 Global land use (excluding Antarctica)

Against this backdrop, it can be hard to have anything but a negative outlook regarding the future trends of biodiversity. However, there is some reason to be hopeful that trends of decline will gradually stabilise, and that eventually more positive trends towards increased biodiversity may emerge. However, this will require a substantial commitment at all scales—global, national, local and even individual—to achieve such a transformation.

The impact of climate change

11.4.12 Large areas of koala habitat were burnt in the 2019–20 bushfires in Australia.

Climate change is now the single biggest threat to biodiversity globally. The impact that climate change will have on ecosystems and the species that inhabit them is only now becoming clear as the effects of human-induced climate change begin to take effect. Changing precipitation patterns, an increase in the frequency and intensity of severe weather events, such as droughts and storms, and the acidification of the world's oceans, place enormous pressure on species, which, in many cases, are already greatly threatened by human activities.

The devastating bushfires that took place in Eastern Australia in 2019–20 were made more severe by the effects of climate change, highlighting the impacts of climate change on biodiversity. In NSW alone, the fires burnt through 5.4 million hectares of land, including 37 per cent of national parks and 42 per cent of state forests. The areas that burnt are home to 293 threatened animal species and 680 threatened plant species. Around a quarter of the state's prime koala habitat was affected by the fires (see Figure 11.4.12).

Rising temperatures across the world have the potential to change ecosystems over long time frames. As ecosystems change in response to the warmer conditions, flora and fauna that have evolved and adapted to the original ecosystem are affected, altering the biodiversity. Perhaps the most frequently cited example of this is polar bears, which rely on extensive sea ice floes to hunt for their main prey, seals (see Figure 11.4.13). As sea surface temperatures in the Arctic regions increase, sea ice becomes less prevalent and lasts for shorter periods of time, reducing the polar bear feeding season and leading to catastrophic consequences for the bears.

The impact of climate change is increasingly evident in the world's marine ecosystems. For example, coral reefs only survive in specific water temperatures and are particularly vulnerable to climate change, as was highlighted in Unit 11.3.

The threat caused by climate change to biodiversity is expected to increase in the future, yet maintaining thriving ecosystems with extensive biodiversity is also one of the key strategies for reducing the impacts of climate change. For example, many scientific studies have found that old-growth natural forests (see Figure 11.4.14) absorb more carbon dioxide (the main climate change-causing greenhouse gas) than human-developed plantation forests. This is because of the far more complex ecosystems that exist within natural forests.

11.4.13 Sea ice that polar bears rely on is being reduced by climate change.

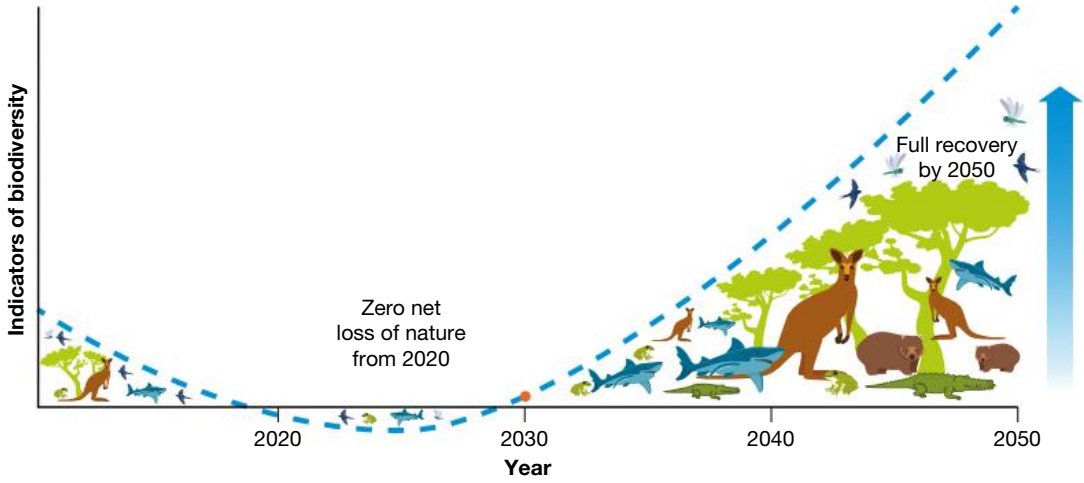
11.4.14 Old-growth forests absorb more carbon dioxide compared to plantations.

Biodiversity recovery

While the impacts of human activities, including climate change, have had a devastating impact on biodiversity, there is still an opportunity for recovery, but this window of opportunity is rapidly closing. Scientists believe that if decisive action is taken by 2030 then there is real opportunity to help recover biodiversity at a global scale by the middle of this century.

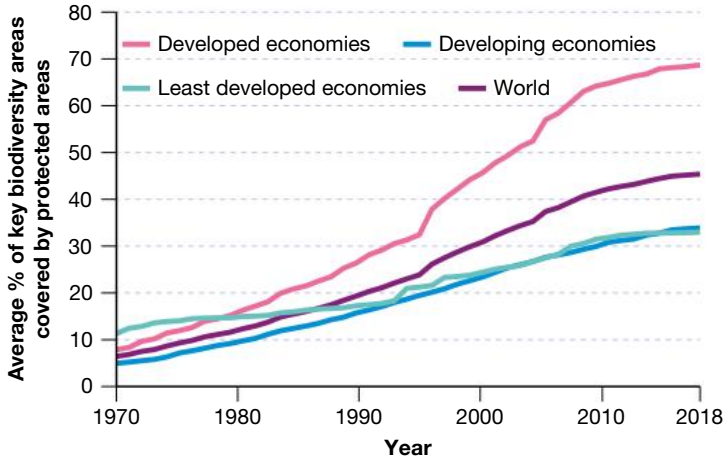
In late 2022, world leaders met in Montreal Canada for the 15th Conference of the Parties to the Convention on Biological Diversity (known as COP15). They adopted a landmark pathway to biodiversity recovery. This included a commitment to designating at least 30 per cent of Earth's land surface to protected areas and restoring 30 per cent of Earth's degraded coastal, marine, terrestrial and inland water ecosystems. This approach is referred to as 'nature positive' and places environmental protection as a key goal for governments in their decision-making. Encouragingly, 90 world leaders committed their countries to this goal, including the G7 nations, the most economically developed countries. For example, in April 2023, US President Joe Biden announced that the United States would provide financial support to developing countries to reduce deforestation, particularly in Brazil and other South American countries.

This model is sometimes known as the Sharing the Planet model. If the model is implemented soon, together with efforts to tackle climate change and more sustainable approaches to agriculture, it will help biodiversity recover (see Figure 11.4.15). A more ambitious model, known as Half Earth, would increase protected areas to 50 per cent. This would have an even faster and more profound impact on biodiversity, but it has not attracted as much support. Any pathway to recovery must include strategies to reduce the impacts of climate change by lowering emissions greatly, along with the protection of existing ecosystems and strategies to restore degraded systems.

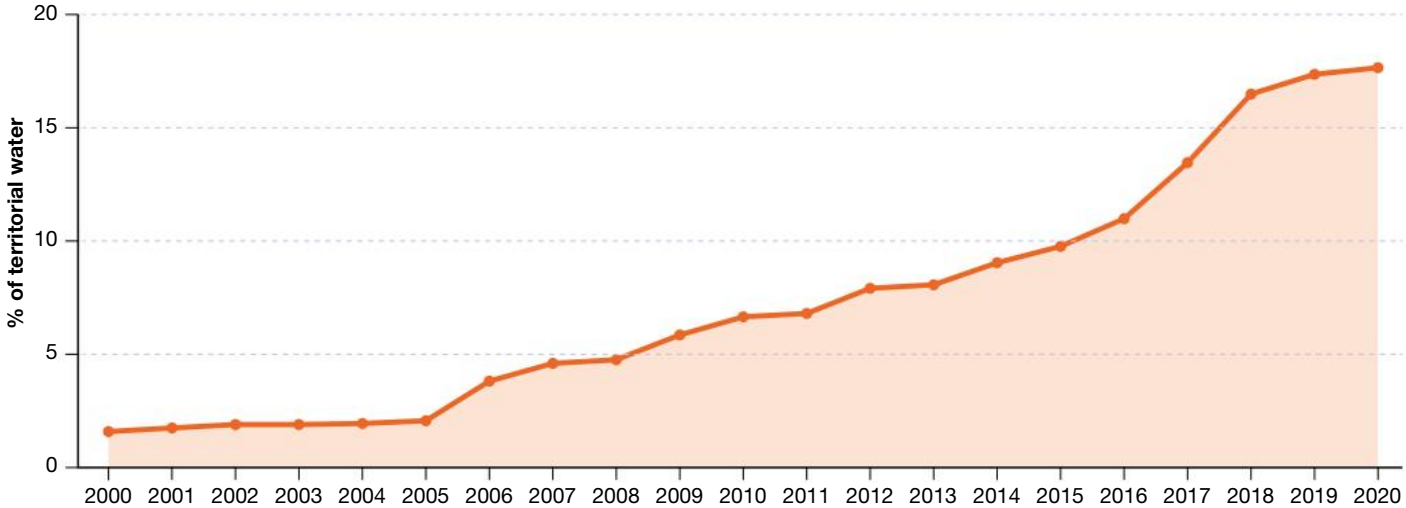


11.4.15 The path to biodiversity recovery under COP15

As knowledge and scientific understanding of the importance of biodiversity to the overall health and operation of Earth expands, so too have efforts to protect, rehabilitate and enhance biodiversity. Figure 11.4.16 shows the extent of protection of key biodiversity areas around the world. As can be seen, significant steps have been taken since 1970 to protect these areas. Similarly, Figure 11.4.17 shows the growth in the protection of marine environments within the exclusive economic zones of countries. This is an area up to 390 kilometres from the coastline of a country.



11.4.16 Protection of key biodiversity areas



11.4.17 Percentage of protected marine areas within exclusive economic zones (EEZs), 2020

Shifting baselines

Scientists and geographers often refer to baseline data when they use statistics. Baseline data is the set of information against which to compare subsequent data. For example, we may want to know how many koalas are found in a forest. If we conducted a survey in January 2023 and calculated that 14 koalas lived in the forest, this would become our baseline data. We can then use this to make future comparisons. In this example, we might go back to the forest five years later, in January 2028, and find that there are now 18 koalas in the forest, so we could say that the population has increased by 28 per cent. Hence, the baseline gives us a starting point against which to measure change.

However, the use of baseline data can sometimes skew our perceptions of changes to the environment. In 1995, French biologist Daniel Pauly used the term shifting baseline syndrome when referring to how fish stocks have declined over the generations. He said that we collectively forget about the condition of the natural environment in the past and gradually accept the new condition as the norm. In this way, what we might think of today as a healthy environment would in the past have been looked upon as a very degraded environment.

The extent and impact of shifting baselines is hard to gauge. However, psychologists working with conservationists have begun to do research into the phenomenon. One study involving traditional fishers in Indonesia provides a useful and interesting example. In the research, younger fishers tended to report lower levels of environmental impact than older fishers. This was because the older fishers could remember a time when fish were far more abundant. They were in fact using a different baseline to make judgements about the environmental impacts compared to their younger colleagues. Similar research conducted in other parts of the world found similar examples. In Alaska, Indigenous youth reported less impact of climate change on their water resources than older members of the community, as the younger members had less knowledge of the past.

Knowing that perceptions of the environment can be influenced by shifting baselines reinforces the importance of scientific research that is well documented and accessible. Longitudinal studies that take place over extended periods are especially useful, as are studies that show us what the situation was like in the distant past. For example, when considering the impacts of climate change it is powerful to have scientific research that shows climate patterns from thousands or even hundreds of thousands of years ago. This research often involves taking ice core samples and using them to study trapped chemicals that indicate climatic patterns (see Figure 11.4.18). Such studies can help to dispel myths and misinformation that climate change skeptics will often use. Such myths include the belief that current climate change is associated with natural processes. The data dispel this myth, as they show the rapid acceleration of global warming since the widespread use of fossil fuels, which began in the 1800s.

11.4.18 A scientist working with ice core samples taken from the icesheet in Greenland

Tipping points

In terms of ecosystem geography, a **tipping point** is a situation where even small changes can cause profound changes. There is a growing concern that many ecosystems have reached a tipping point and may no longer have the resilience to deal with even relatively low levels of vulnerability. This is caused by the accumulated impact of human activities on the ecosystem. Similarly, individual species may also reach a tipping point. This may be the result of the number of breeding pairs falling so low that the population can no longer reproduce at a rate equal to or greater than the death of individuals. This will, of course, ultimately lead to the species becoming extinct.

● SPOTLIGHT

The last of a species

Human activities have caused the extinction of countless species, but perhaps there is no greater evidence of the impact of humans on the natural world than a species becoming extinct in front of our very eyes. The thylacine, or Tasmanian tiger, is one such example. Hunted into extinction because the species was blamed for killing livestock on Tasmanian farms, the last known thylacine died a lonely death in a cage in Hobart Zoo in 1936 (see Figure 11.4.19).

11.4.19 Benjamin, the last known thylacine, in Hobart Zoo

In more recent times, Sudan, the last male northern white rhinoceros died in 2018 aged 45. The species was hunted by poachers who kill the rhino for their horn to sell on the black market for use in traditional medicines. During his last years, Sudan was constantly accompanied by armed guards to protect him from poachers (see Figure 11.4.20). The species has three females left, but Sudan's death meant they can only reproduce by artificial insemination.

11.4.20 Sudan, the last male northern white rhinoceros, accompanied by armed guards

These are just two of many extinctions and they highlight how human activities can push a species to a tipping point from which there is no chance of survival.

Throughout Earth's history, scientists believe there have been five mass extinction events and some argue that we are currently living through the sixth now. About 250 million years ago, the worst of these events happened. This period is called the Permian–Triassic extinction event, but is often referred to simply as the Great Dying. During this period, 96 per cent of marine species, 70 per cent of terrestrial vertebrate species and countless insect species became extinct. The reason is not known for certain, although there are many theories. The key point, however, is that despite this massive extinction event nature was able to eventually recover over millions of years, highlighting its resilience.

However, as discussed in Unit 11.1 in relation to dynamic equilibrium, there reaches a point at which vulnerability is so great that it exceeds resilience, and this causes an ecosystem to collapse. The event that causes the shift into disequilibrium is the tipping point. Scientists often refer to a climate tipping point—this is the point at which the global climate is so changed by the actions of humans that it can no longer properly function.

Among scientists there is considerable debate as to whether a loss of biodiversity can lead to ecosystem collapse. Some argue that species decline and extinction are natural processes and events such as the Great Dying demonstrate that ecosystems are resilient and can recover, but will evolve to meet a new and different set of circumstances. This view is countered by others who argue that eventually there is a tipping point at which so much biodiversity is lost that the system will inevitably collapse. Many conservationists argue that regardless of this debate, humans do not have a right to destroy other species for our own gain. Furthermore, it is prudent to take a precautionary approach—if we are uncertain as to the actual impact or where the tipping point might lie, then it is only logical to proceed cautiously and avoid ever reaching such a point.

Activities

Acquiring and processing geographical information

1 Define biodiversity.
2 What is a biodiversity hotspot?
3 Explain why biodiversity is an important element in ecosystem functioning.
4 Describe the concept of human material footprint.
5 Explain the impact of human activity on insect populations.
6 Outline the purpose of the biodiversity intactness index.
7 Explain the threat that climate change poses to biodiversity.
8 Why are coral reef ecosystems so threatened by climate change?
9 Explain how biodiversity can help to reduce the effects of climate change.
10 What is a baseline?
11 Summarise what is meant by shifting baselines.
12 Explain how shifting baselines can be problematic when considering environmental impacts.
13 Define the term tipping point.

Applying and communicating geographical understanding

14 Study Figure 11.4.2. Describe the trends evident in the graph.
15 Study the box, Spotlight: Biodiversity loss in the Atlantic forests. Complete the following activities.
   a Describe the value and importance of the Atlantic forests.
   b Explain the main reasons why the Atlantic forests are so vulnerable.
16 Study Figure 11.4.4. Complete the following activities.
   a Outline the key trends in the data shown.
   b Write a paragraph comparing the trends shown in Figure 11.4.4 with those in Figure 11.4.2.
17 Study the box, Spotlight: Palm oil and habitat destruction. Write a paragraph summarising the link between palm oil production and biodiversity loss.
18 Study Figure 11.4.10. Complete the following activities.
   a Explain the key used in this map.
   b Describe the global patterns shown on the map.
   c Outline the regions with the highest BII scores.
   d Do you think there is a link between human population density and the data shown on the map? Write a paragraph justifying your conclusion.
19 Prepare a short report on the pathways to recovery for global biodiversity.

UNIT 11.5

Strategies for the sustainable management of ecosystems

Throughout the world there is a growing recognition that people must accept responsibility for protecting and managing ecosystems, especially ecosystems considered to be at risk. This awareness is seen in the growth of environment-based political parties, moves by many businesses to become more environmentally sustainable, and the growth in environmental activism through protests and other means (see Figure 11.5.1). Environmental issues, including climate change and the threat it poses to the planet, impact government, corporate and individual decision-making more today than at any other time in history.

11.5.1 School Strike 4 Climate protest in Sydney, 2019

Approaches to ecosystem management

A management strategy is a plan of attack, a response to a problem or concern. It is a way of achieving specific goals and objectives. Fundamental to any discussion about the management of ecosystems at risk is the distinction between the various management approaches and the philosophies that underpin them.

Four broad approaches can be identified: preservation, conservation, utilisation and exploitation (see Figure 11.5.2).

- **Preservation** refers to the protection of a habitat (or species) in its existing form. It often involves the prevention of all human activities in the protected area.
- **Conservation** involves active resource management, and the planned use of natural resources to minimise waste and environmental damage.
- **Utilisation** involves the replacement of an ecosystem with a human-made environment that can provide a sustainable yield; for example, sustainably managed commercial agriculture.
- **Exploitation** occurs when an ecosystem's resources are used irrespective of the ecological consequences. Ecosystems are often destroyed, or reduced in extent, because of exploitation.

Preservation	Conservation	Utilisation	Exploitation
■ Ecosystems quarantined ■ People denied access ■ Resources remain unused	■ Resource uses limited to those that will not damage ecosystems, such as ecotourism ■ Resources used without significant impact on ecosystems ■ Resources used sustainably ■ Flora and fauna not threatened	■ Natural resources used ■ Natural ecosystems replaced by a built environment that provides a sustainable yield ■ Flora and fauna disrupted	■ Resources exploited without regard for the ecological consequences ■ Flora and fauna devastated

Philosophies of ecosystem management

Radical environmentalism — Romanticism — Stewardship — Utilitarianism — Environmental imperialism

11.5.2 Approaches to ecosystem/natural resource management

Environmental attitudes

Underpinning the approaches to ecosystem management are five key attitudes that help to define the relationship that people have with the environment.

- **Environmental imperialism** is an anthropocentric worldview that everything in nature is subordinated to the needs and wants of humans. Ecosystems exist as resources to be exploited for profit. Such a view often sees ecosystems exploited, based on the economic gain that humans will attain from the exploitation (see Figure 11.5.3).

11.5.3 This photo shows the consequences of unsustainable and illegal logging in the Amazon Rainforest, Brazil

- **Utilitarianism** is based on the belief that things only have value if they contribute to the happiness and wellbeing of people. This view relies heavily on the utility value of an ecosystem and the environmental services it provides.
- **Stewardship** contends that humans occupy a privileged position in relation to the rest of nature. People have a responsibility to protect and nurture the land for the benefit of future generations. They are the custodians of the land. This attitude aligns closely with those typically seen in indigenous cultures.
- **Romanticism** values the beauty of nature. Advocates support the protection of wilderness areas; that is, those places unaffected by the activities of people. Efforts around rewilding often stem from this perspective (see the box, Spotlight: Rewilding).
- **Radical** environmentalism includes a wide range of views ranging from the belief in the right of all species to survive, to the argument against all forms of development.

SPOTLIGHT

Rewilding

Rewilding is an approach to ecosystem management that has become more common in recent years. Rewilding aims to rebuild ecosystems that have been heavily modified by past human activities. Its key goal is to return the ecosystem to a more natural state.

Rewilding programs are seen as a key strategy to enhance biodiversity and restore the environmental services that an ecosystem in a more natural state can provide. This approach often involves the reintroduction of species that have become locally extinct, to restore some balance to the ecosystem. There are many examples of this approach around the world.

The reintroduction of wolves is a well-known example. Wolves are apex predators in many ecosystems, but hunting and habitat loss saw their numbers decline and, in many places, they became locally extinct. Reintroduction programs have seen wolves returned to locations where they were once commonly found; for example, in Yellowstone National Park in the north-western United States (see Figure 11.5.4) and many parts of Europe, including Spain, Italy, Romania and Poland.

11.5.4 A grey wolf in Yellowstone National Park, USA

Rewilding can be controversial and is not always appreciated. For example, the reintroduction of wolves in Yellowstone and parts of Europe was opposed by some farmers with properties close to the reintroduction sites, who feared attacks on their livestock. Similarly, hunting groups also opposed the reintroductions on the basis that the wolves would compete with the hunters for the same prey. However, ecosystem managers pointed out that the wolves help to return a balance to the ecosystem's food chain.

Evaluating environmental management strategies

Contemporary approaches to the management of ecosystems focus on the extent to which the strategies adopted promote, or are consistent with, the principles of ecologically sustainable development.

At a global scale, the ultimate measure of successful ecosystem management will be the achievement of higher standards of living for the world's poor within the context of sustainable development—sustainable in the sense that it does not threaten the integrity of the Earth's ecosystems or natural processes. In other words, people living in harmony with nature.

Sustainable development is achieved by maximising people's economic and social wellbeing (their quality of life) while maintaining and protecting the quality of the biophysical environment. Sustainable development and good environmental management go hand in hand. There are differing definitions of sustainable development (see Figure 11.5.5).

- Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

  Our Common Future (Brundtland Report), UN, 1987

- Improving the quality of human life while living within the carrying capacity of supporting ecosystems.

  Caring for the Earth: A Strategy for Sustainable Living, The World Conservation Union, 1991

- Ecologically sustainable development—development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

  National Strategy for Ecologically Sustainable Development, AGPS, Canberra, 1992

11.5.5 Different definitions of sustainable development

The principle of sustainable development incorporates four important concepts that can be used as criteria against which to evaluate the success of environmental management approaches. The criteria include the following.

- **Intra-generational equity:** people within the present generation have a right to benefit equally from the utilisation of Earth's natural resources. At a very minimum it means that people in the developing world have a right to have their basic needs met; that is, food, clothing, shelter, a healthy environment and the fulfilment of their cultural and spiritual needs.
- **Intergenerational equity:** the present generation should not use resources or degrade environments in ways that leave future generations in a worse position than the present generation.
- **The precautionary approach:** where there are threats of serious or irreversible environmental damage, lack of scientific certainty should not be used as a reason for postponing measures that could prevent environmental degradation. In other words, where there is doubt, we should always err on the side of caution.
- **Biological diversity:** this is the diversity of life in all forms, levels and combinations. A distinction is often made between species diversity, ecosystem diversity and genetic diversity. Biodiversity is seen to be essential for the evolution and maintenance of Earth's life-support systems, as well as having both an aesthetic and cultural value.

Strategies at different scales

Ecosystem management involves strategies that operate at a range of scales. Actions need to be taken at a global scale to manage the whole of the planet's environmental concerns. For example, an environmental issue such as climate change is a global-scale problem that requires a global-scale response. However, actions at a local level and even at the scale of the individual are important for the sustainable management of ecosystems. For example, the decisions we make as a consumer about the products we buy, the amount of waste associated with them and the resources they use, can play an important role in the protection and management of ecosystems.

Strategies at a global scale

Global environmental concerns, such as global warming, are often referred to by geographers as wicked problems as they are incredibly complex and rely on many different countries working collectively to solve them. However, getting many different countries, with differing perspectives and differing priorities to work towards a common goal is extremely difficult, hence they are considered wicked problems.

The main strategy adopted at the global level to deal with such wicked environmental problems is to use international agreements. These are a special type of international law that require the countries that sign one, becoming party to the agreement, to abide by the goals, conditions and regulations set out in the agreement. There are many different international agreements that relate to environmental issues.

The Convention on Biological Diversity dates from 1992 and currently has 196 parties to it. The preamble of the convention provides a broad perspective on why biological diversity matters and what countries that become party to the Convention stand for regarding biodiversity. The opening of the preamble states:

> The Contracting Parties,
>
> - Conscious of the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components ...
>
> Convention on Biological Diversity, 1992

11.5.6 Parties to the Convention on Biological Diversity met in Montreal, Canada, December 2022

Parties to the convention meet regularly and provide updates and share information. In December 2022, the parties met in Montreal Canada for their 15th meeting, and it was here that the landmark commitments towards biodiversity, discussed in Unit 11.4, were made (see Figure 11.5.6).

Climate change is the most significant threat to ecosystems globally. Since 1997, countries have met regularly to discuss, plan and make commitments regarding climate change. While these discussions have not always been successful, each meeting has been an important step in moving forward the discussion about climate change. In 2015, the Paris Agreement on Climate Change saw the announcement of targets towards net zero emissions by 2050. The 27th Conference on Climate Change held in the Egyptian city of Sharm el-Sheikh in late 2022, saw many more countries announce their commitment to net zero emissions. At this conference, there was also a commitment from several developed nations to provide financial support for less developed nations to move towards a zero emissions target.

Strategies at a regional scale

11.5.7 The Parana River, which forms part of the border between Brazil and Paraguay, is an example of a transboundary river.

The boundaries of ecosystems rarely align with the borders of countries. Ecosystems that cross borders are referred to as transboundary ecosystems (see Figure 11.5.7). This represents a major challenge for ecosystem managers. Ecosystems that extend over national borders require strategies at a regional level.

In West Africa, a large forest ecosystem extends across southeast Guinea, west into Sierra Leone, south into Liberia and into Côte d'Ivoire in the east. This ecosystem is rich in biodiversity, but it is also under pressure from a growing population. The non-governmental organisation Flora and Fauna International is working with local communities and authorities to help better manage the landscape. A key role for the organisation is to liaise between the different governments across the region to coordinate efforts.

Around 60 per cent of freshwater flows in the water cycle happen in a transboundary river or lake basin. In fact, 153 countries have territory in

one of these basins. There are also 592 transboundary aquifer systems. The actions of one country in such a basin can have significant consequences for other countries and the ecosystems within them. United Nations Water is an intergovernmental organisation within the UN that coordinates UN agencies in assisting countries to manage transboundary water resources and the environmental services that they provide.

Strategies at a national scale

Ultimately, it is governments that make key decisions around environmental protection. National governments make decisions around policies such as carbon emissions and biodiversity targets, and they also have the power to create and enforce laws around environmental protection.

Here in Australia, policy decision-making around the environment is shared between federal and state and territory governments. Between these two layers of government, key laws are made and enforced. The *Environment Protection and Biodiversity Conservation Act 1999* is the key federal law on the environment. It enshrines Australia's obligations under the Convention on Biological Diversity. The *Environmental Planning and Assessment Act 1979* (NSW) is an example of a state law that regulates and minimises the impacts of urban and other development.

Strategies at a local scale

Local communities play a key role in the protection and conservation of local ecosystems and natural areas. These communities often have strong vested interests in caring for their local environments. Local communities gain economic and social benefits from their local environment.

In Australia, many local councils have created Bushcare groups to help manage and restore local bushland areas. Bushcare groups are volunteers who carry out work such as removal of weeds and rubbish and bush regeneration through planting (see Figure 11.5.8). This work is important as it provides critical habitat for native species, often providing refuge for animals in otherwise highly altered landscapes.

11.5.8 Bush regeneration, such as this planting, is often conducted by Bushcare volunteers.

SPOTLIGHT

Protecting Blue Gum High Forest in Sydney

Hornsby Shire Council area sits on the northern boundary of Sydney. Despite the shire's location in Australia's largest city and a population of more than 90 000, there are a number of important habitats within the shire. The shire has a very active Bushcare group, which is one of the oldest and largest in Australia. It was formed in 1989 and has over 400 active members, who work across 65 sites.

The shire is home to the critically endangered Blue Gum High Forest (see Figure 11.5.9). These forests have evolved to grow in very specific locations. They require the rich, deep soils that form from weathered shale and at least 1100 millimetres of average annual rainfall. Less than 5 per cent of the shire's original forests remain and those areas are highly fragmented, spread across 21 sites throughout the shire. Working with specialists from Hornsby Shire Council, the local Bushcare group is very active in protecting and restoring the remnants of the forest. The areas are also given additional protections, with careful planning being required for any developments close to the remnant forests.

11.5.9 Blue Gum High Forest

11.5.10 Plastic bottles are a major source of environmental pollution, especially along coastlines and in waterways.

Strategies at an individual scale

At a local and individual scale, the actions of communities and their members can play an important role. At the individual level, strategies that target decision-making, especially about the goods and services we consume, are important. Advertising campaigns and programs that encourage recycling are examples of simple, yet effective strategies. For example, the container deposit scheme in NSW that refunds 10 cents for eligible drink containers sees around 180 million containers recycled each month, resulting in around 165 000 tonnes of materials being recycled annually. Prior to the scheme, a large portion of this material would have been dumped into landfill or made its way into the environment (see Figure 11.5.10).

Individuals also have power when they act collectively. Political movements around environmentalism have grown significantly since the 1980s. In many countries, environment-based political parties, including here in Australia, are significant forces in mainstream politics. In this way, individual voters can have significant influence over government policy.

SPOTLIGHT

Impact of fast fashion

Humankind is consuming Earth's resources at an unsustainable rate and has been doing so for decades. Much of this consumption is driven by an economic system that encourages constant growth: more needs to be made so more can be sold. In the first 15 years of the twenty-first century, clothing production worldwide doubled. In the same period, consumers began to buy 60 per cent more clothing but only wear each item for as half as long as before.

Clothing production requires significant resource inputs. For example, the cotton used in single pair of denim jeans requires between 5000 to 10 000 litres of water alone. Then there are the impacts of the transport, the land clearing that allowed for the cotton farm and even the blue dye that releases chemicals into the environment.

Today, around two-thirds of all clothes produced end up in landfill or burnt in incinerators within 12 months of being manufactured. This is the equivalent of a truckload of used clothing being dumped every second. Many of these clothes are consumed in the developed world, but end up as waste in the developing world. A rubbish dump in Ghana's capital city Accra is piled up to 20 metres high in places. Sixty per cent of the material in the dump is used clothing, much of it sent from Europe.

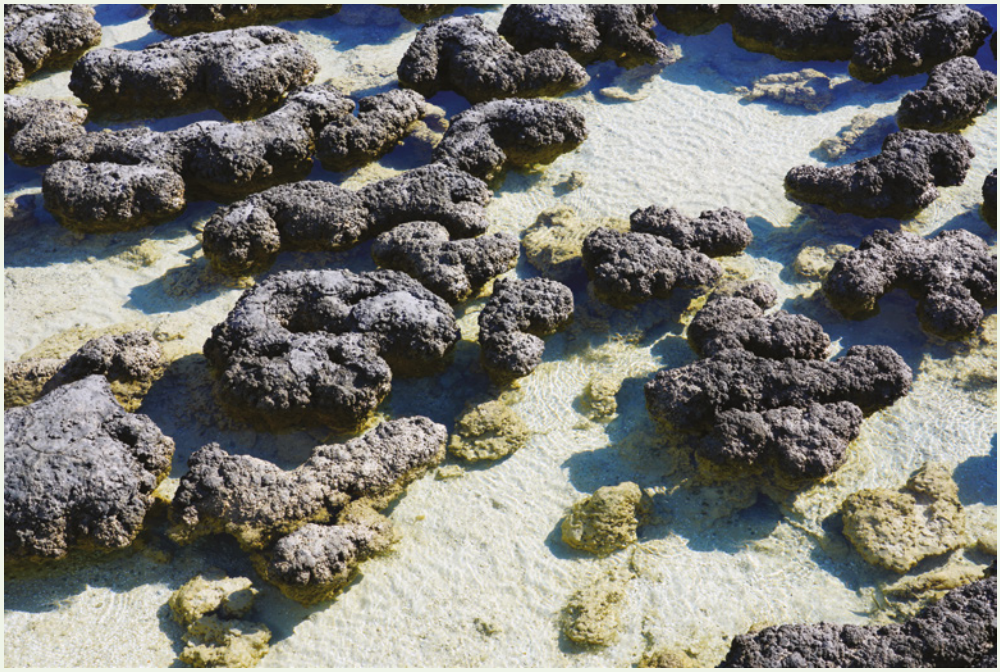
Another unlikely dump is found in an isolated part of Chile's Atacama Desert. The dump is near the duty-free port of Iquique. Each year thousands of tonnes of clothing are brought through the port, mostly arriving from Asia, Europe and North America. The clothes are sorted, some resold and a very small portion recycled, but many of the imports are dumped (see Figure 11.5.11).

11.5.11 The enormous used clothing dump in the Atacama Desert, Chile

■ CASE STUDY

Faure Island: A successful conservation program

Faure Island is in the majestic world heritage area of Shark Bay in Western Australia. This is the most westerly point on the Australian continent, around 700 kilometres north of Perth. This is an ecologically rich and ancient part of the continent that contains some of the oldest lifeforms on Earth—stromatolites. These are colonies of algae that form into dome-shaped deposits (see Figure 11.5.12). They form in shallow waters and fossil evidence indicates that they were common around 1.25 billion years ago.



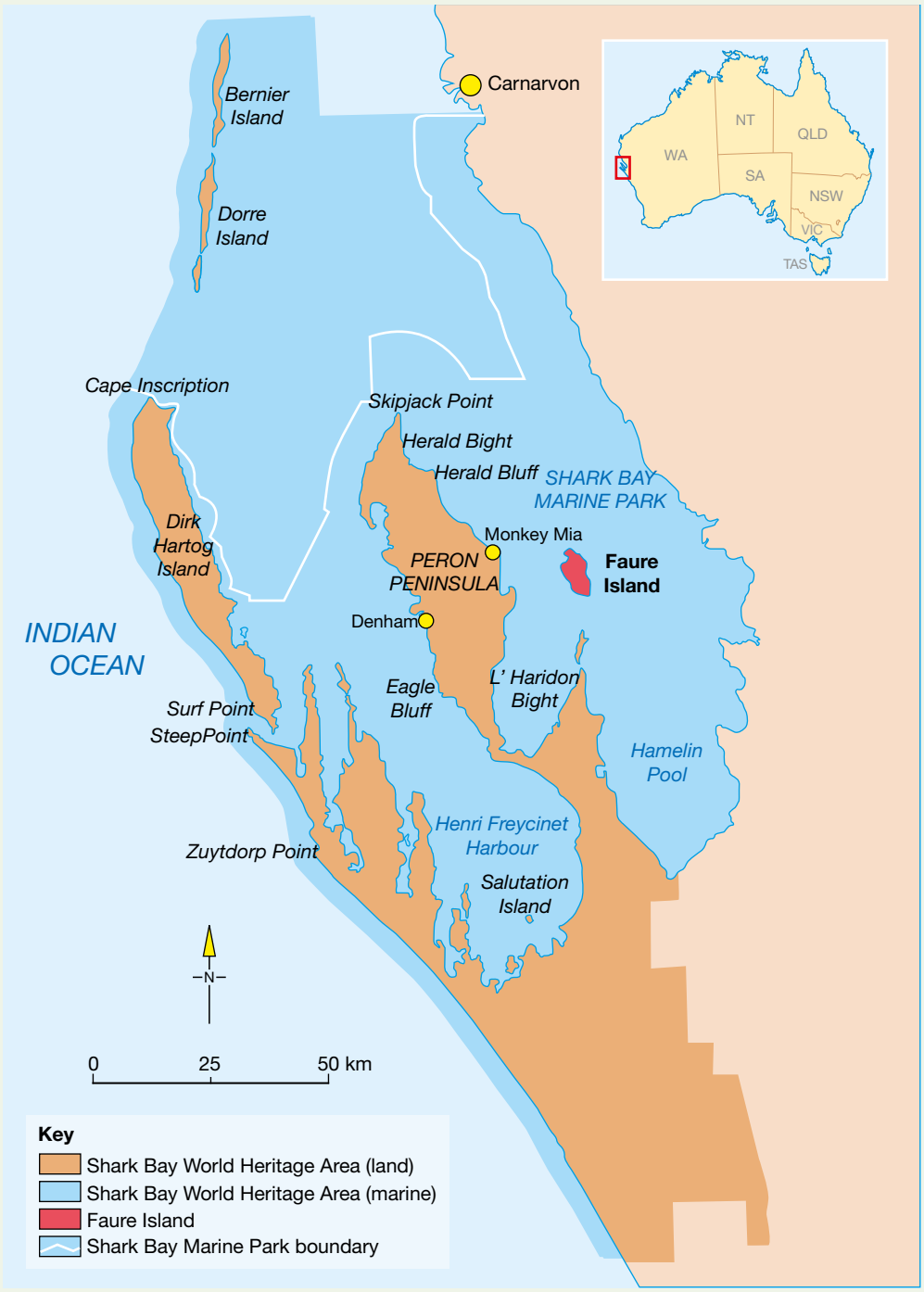
11.5.12 Stromatolites, Shark Bay, WA

Faure Island is one of the major islands within Shark Bay with an area of 4553 hectares (see Figure 11.5.13). It lies on the landward side of the Peron Peninsula to the north-west of Gladstone, the main town in the region. Its position between the peninsula and mainland gives the island considerable shelter from the Indian Ocean. It is a flat expanse, and, like the rest of Shark Bay, is a semi-arid environment with an average rainfall of around 230 millimetres per year.

Environments of Faure Island

The island forms part of a geological feature known as the Faure Sill. This is a sandbar that lies atop a layer of sandstone and crosses the eastern area of Shark Bay from the mainland to the Peron Peninsula. This acts like a wall, restricting water flow and creating the hypersaline shallow water in which the stromatolites grow. There are three main landforms across Faure Island that create distinct zones and habitats.

- **The littoral zone:** this is the boundary environment between the marine and terrestrial ecosystems. It contains mangrove forests and wetlands, beaches and coastal dunes. These are key breeding areas for many seabirds, including the pied cormorant and the critically endangered far eastern curlew (see Figure 11.5.14). A number of migratory birds also use the island, including the red-necked stint and the grey-tailed tattler, two rare species.



11.5.13 Location of Faure Island

- **Birrada:** these are rare environments and are saltwater lakes and claypans that have become cut off from the sea. Saline flats and salt marshes are also found on the island, supporting samphires (small fleshy plants that thrive in saline soils) and saltbushes.
- **Sandplains:** these are undulating areas that dominate the inland of the island and support heathland and shrublands. These regions create important habitats for highly endangered mammals, including the very rare burrowing bettong (see Figure 11.5.15).

11.5.14 Far eastern curlew

11.5.15 The highly endangered burrowing bettong

Conservation of Faure Island

At the end of the nineteenth century, Faure Island became a pastoral station, where sheep and goats grazed on the island. In 1999, the island was bought by an environmental non-profit organisation called Australian Wildlife Conservancy (AWC). This organisation has the mission of reducing extinction among Australia's native flora and fauna. It forms partnerships with governments, landowners and First Nations communities to manage ecologically important landholdings across Australia. It relies heavily on donations that enable it to purchase degraded areas and begin to rehabilitate them and restore their natural environments. At present, AWC owns and works in partnership with other landowners to manage nearly 13 million hectares across Australia.

Once acquired by AWC, work began to rehabilitate the environment on Faure Island. One of the first key steps was working in partnership with the Government of Western Australia to eradicate all feral animals on the island. In 1999, it was estimated that more than 2000 feral goats roamed the island, having a major impact on the natural flora. There were also extensive populations of feral cats and foxes, which had destroyed the populations of native mammals, leaving only a single species of bat, the northern freetail bat, as the only mammal on the island. Through trapping and shooting, the feral animals were gradually removed, and Faure Island became one of the largest feral animal-free islands in the world.

Once the island was declared feral animal-free, five species of threatened and endangered mammals were reintroduced to the island. This took place in 16 separate translocation missions. This is where animals are moved from one site and reintroduced carefully into another one that was once part of their habitat range. Of the five reintroductions, four were outstanding successes. However, the reintroduction of the greater stick-nest rat has not appeared to be successful, with no individuals recorded on the island for some years.

The other four species are thriving in their protected habitat with healthy populations. The burrowing bettong now has an estimated population of 20 000 on the island, representing half of the global population. There are also self-sustaining and stable populations of banded hare-wallabies (see Figure 11.5.16), western barred bandicoots (see Figure 11.5.17) and djoongaris (see Figure 11.5.18)—a small native mouse. All these species had become locally extinct on the island due to the feral animals and past grazing. All these mammals were once widespread across large areas of Australia, but are now confined to tiny populations, such as those on Faure Island.

Another legacy of the island's past as a grazing property is a significant infestation of weeds. Buffel grass (see Figure 11.5.19) is found across more than one-third of the island and creates a significant fire risk as it dries out. AWC staff undertake regular spraying of the buffel grass and other weeds, such as boxthorn and lupins. To protect against grass fires, fire breaks have been built and are maintained on the island to minimise the risk of fire spreading if one does break out.

11.5.16 Band hare-wallaby

11.5.17 Western barred bandicoot

11.5.18 Djoongari

11.5.19 Buffel grass is a major weed on Faure Island.

Faure Island: A mammal arc

Translocation of mammals to Faure Island has been so successful that the populations of the species there have allowed for translocation to other areas. For example, in late 2017, 60 banded hare-wallabies were translocated from Faure Island to Mt Gibson Wildlife Sanctuary. This 7800-hectare property around 370 kilometres east of Perth is a fenced feral-free sanctuary, owned and operated by AWC. Until this translocation, the species had been extinct on mainland Australia for more than 100 years. Also in 2017, translocations of the western barred bandicoot took place to Mt Gibson, followed by further translocation in subsequent years. In time, the translocation to Mt Gibson is expected to increase the global population by around one-third. Research and planning are also underway to translocate djoongari from Faure Island to Mt Gibson.

Scientific monitoring and research

A feature of high-value and effective conservation projects is the use of data and research to inform conservation practices. This features heavily in the approaches adopted by AWC at Faure Island. Ecologists conduct regular surveys across the island. This includes live trapping and conducting bird and vegetation surveys. These surveys provide data on biodiversity and the abundance of individual species.

Environmental managers use this data to make decisions. For example, when vegetation surveys indicate that areas have been overgrazed by mammals, exclusion fences are installed to protect the native vegetation.

Prior to translocation programs, extensive research was conducted, including trapping and using radio-collars on individuals. This data helped to ensure that the translocation programs were successful.

Activities

Acquiring and processing geographical information

1 Differentiate between preservation and conservation.
2 Explain the approach of exploitation.
3 Define the concept of sustainable development.
4 Explain the difference between intergenerational and intragenerational equity.
5 Describe the concept of the precautionary principle.
6 Summarise the key management strategies for dealing with global-scale issues.
7 What is a transboundary ecosystem?
8 Explain the challenges transboundary ecosystems create for management. What strategies can be used to overcome these challenges?
9 Describe the work of Bushcare groups.

Applying and communicating geographical understanding

10 Write a short report explaining the different environmental attitudes that exist.
11 Study the box, Spotlight: Rewilding. Complete the following activities.
   a Define rewilding.
   b Explain why rewilding can be controversial.
12 Write a short answer response on the role of the individual in the management of ecosystems.
13 Study the case study of Faure Island. Complete the following tasks.
   a Describe the location and character of Faure Island.
   b Describe the different environments on the island.
   c Outline the impact of pastoral activities on the environment of Faure Island.
   d Describe the importance of making the island feral-free.
   e Define translocation. Explain how translocation has been used on Faure Island.
   f Write an extended response to the following. Evaluate the conservation program at Faure Island. In your answer, be sure to use the evaluation criteria for ecosystem management explained on page 355.

UNIT 11.6

Indigenous peoples and contemporary land management practices

Indigenous cultures generally have a much closer affinity with the biophysical environment than contemporary industrialised societies. A feature of this affinity is the careful way in which they interact with their environment. This interaction is governed by attitudes that emphasise respect and coexistence.

The philosophy that often reflects the relationship between Indigenous peoples and ecosystems is stewardship. Indigenous peoples believe that they have a responsibility to protect and nurture the land for the benefit of future generations. They are the custodians of their land.

The goals and objectives of ecosystem management focus on the collection of food and the provision of shelter within the context of respect for the Earth, its fragile nature and the interdependent relationship of people and the environment. Their aim is self-sufficiency. By taking only what is needed, they eliminate waste.

Interdependence with the land

Indigenous peoples often have their own working definition of ecosystem management built into their culture, through spiritual ties to the land, daily practices, seasonal calendars, choice of tools and weapons, artistic interpretation and the division of labour. The accumulated experiences of human interaction with nature are passed down from generation to generation in laws, codes of conduct, customs, rituals, ceremonies, stories and teachings. The separation of many indigenous populations from their land has meant that some of this knowledge is at risk of being lost. The continuation and progression of the cultures and associated management philosophies is dependent on the ability of the peoples to once again use the land.

Management units and boundaries are often determined through the creation of territories, each with its own distinct political systems and laws. The Aboriginal and Torres Strait Islander peoples, for example, had 600 to 700 distinct nations before 1788. These Language Groups were composed of several clans, each of which was responsible for a certain area of land. Each clan had a link with a specific plant, animal or natural feature with which they shared their spirit. Each clan was charged with the responsibility of caring for their ancestor's spirit. This is sometimes referred to as totem. This heightened the feeling of interdependence with the land.

Recognition and respect for individual ecosystems

Historically, Aboriginal and Torres Strait Islander food-gathering technologies differed from region to region. In areas where resources were scarce and difficult to find and capture, such as in the desert, the most appropriate technologies were those that provided hunters with the flexibility and mobility to deal with their harsh and unpredictable environment. In contrast, more elaborate technologies were used in areas where resources were seasonally abundant and reliable, and included species that are even more difficult to capture. In short, the technologies innovated by Aboriginal and Torres Strait Islander peoples were closely related to the conditions in which they were used.

Close affiliation meant Indigenous peoples were familiar with the cycles and processes of the ecosystem in which they were living. Hunting, gathering, farming and food production were differentiated, as were tools, technologies, customs and laws. This demonstrates that the people recognised the unique characteristics of each environment. They also accepted the ecological constraints or limits of the environment. As a result, the plants and animals eaten at particular times of the year, the degree of mobility and the nature of seasonal movements, varied from region to region.

These approaches allow Indigenous peoples to understand the ecological constraints or limits of the environment in which they live. For example, Aboriginal groups in drier environments tended to be more nomadic, moving across their lands to ensure that resources were not depleted. The historical use of sacred sites—in which hunting of certain species was forbidden, creating sanctuary areas—has some parallels with the ways in which national parks organise contemporary management planning. Rules around when certain flora and fauna could be eaten, and by whom, created sustainable harvesting practices that allowed for regeneration and recovery. One cultural rule held by Aboriginal people was that it was taboo for anyone to kill or eat their own totem. This helped to prevent species from being hunted and eaten by everyone. Again, this is a concept adopted in contemporary ecosystem management through the concept of biocapacity.

● SPOTLIGHT

Ancient land management practices in Australia

For tens of thousands of years, Aboriginal manipulation of Australia's ecosystems included building artificial dikes, digging trenches, damming rivers and using firestick burning. Generally, these interventions did not diminish the resilience of ecosystems. However, some practices did have long-term impacts, such as the burning of the bush to flush out game and facilitate movement, which resulted in a modification of Australia's vegetation. These impacts were minor compared to the widespread degradation caused by large-scale farming, mining, and industrial and urban land uses.

Management practices included planting parts of yams back into the holes from which they were dug so the plants would regenerate, artificially fertilising flowers, seeding river flats to re-establish plant populations, settling native bees into tree hollows to start new hives, and digging pits that filled with water and provided breeding places for frogs.

While these examples highlight the ability of Aboriginal and Torres Strait Islander peoples to manage specific resources, the majority of Indigenous Australian management practices were directed towards the conservation of species. Strategies included:

- restrictions on species caught
- closed seasons
- taboos against eating certain animals
- designated areas for individuals and groups
- leadership according to age, enabling ecologically sound practices to be handed down from one generation to the next
- limits to population growth
- sustainable methods of hunting.

Indigenous knowledges and contemporary land management

Increasingly, governments and environmental organisations recognise the value of indigenous land management practices. Globally and in Australia, there are examples of governments and other agencies working with local indigenous communities to encourage the sharing and blending of indigenous and scientific knowledges in the planning and execution of environmental sustainability projects, as well as encouraging indigenous land management projects and initiatives.

● SPOTLIGHT

Indigenous Land and Sea Ranger program

The Indigenous Land and Sea Ranger program is conducted by the Queensland Government. It commenced in 2007, with 20 rangers. By the early 2020s, it had grown to over 150 rangers, working across 37 different locations across Queensland. The program assists First Nations organisations to employ and train rangers and offers additional support through networking and partnerships with government and non-government agencies.

Indigenous Land and Sea Rangers work across many different areas of Queensland, from the outback Gulf Country, Cape York and even on the Gold Coast (see Figure 11.6.1). The key concept behind the program is to combine First Nations, cultural knowledges and understanding that the rangers have, from the land and sea where they work, with specialised training, drawing on the knowledge and experiences of scientists and environmental managers. The ranger teams work on special projects that reflect the First Nations traditional owners' needs and priorities in the land and seas where they work. Typical projects include fire management, feral animal and weed control, threatened native species monitoring and the protection and preservation of cultural heritage sites. The rangers also deliver many different education programs.

11.6.1 An Indigenous Land and Sea Ranger working on species monitoring program at Mapoon, Cape York Peninsula, Queensland

Etuaptmumk: Two-eyed seeing

Etuaptmumk is a word from the Mi'kmaq language, an indigenous Eastern Algonquian language spoken across the north-eastern United States and eastern parts of Canada. The word means two-eyed seeing. It is a term first coined by an elder of the Eskasoni First Nation, Albert Marshall, whose traditional lands are found in the Cape Breton region of Nova Scotia, Canada.

Etuaptmumk is a concept that recognises the value of considering multiple viewpoints. It is the idea of seeing with one eye the strengths of indigenous ways of knowing and to see from the other eye the strengths of Western ways of knowing and then bringing these two ways together to create the best possible approach. Etuaptmumk has been adopted in many areas of Canadian policy development, including in health and education. It is a very powerful way to consider approaches to environmental management. When used well, Etuaptmumk means not only working with indigenous knowledge, using it as a valuable source of evidence in the same way we would use scientific research and understanding, but also working with and involving indigenous people actively in the work of ecosystem management.

The Māori people are the Indigenous peoples of New Zealand. Mātauranga Māori is a key tradition and spans knowledge, culture, values and worldview. A key idea within Mātauranga Māori is that when the environment is in poor health, people cannot be in good health. To the Māori, there is an inherent interconnectedness and interdependency between people and the natural world. Kaitiaki, or guardians, are people, groups or a being (such as a god) who have a responsibility to care and protect. This includes caring for and protecting important places, such as lakes or mountains.

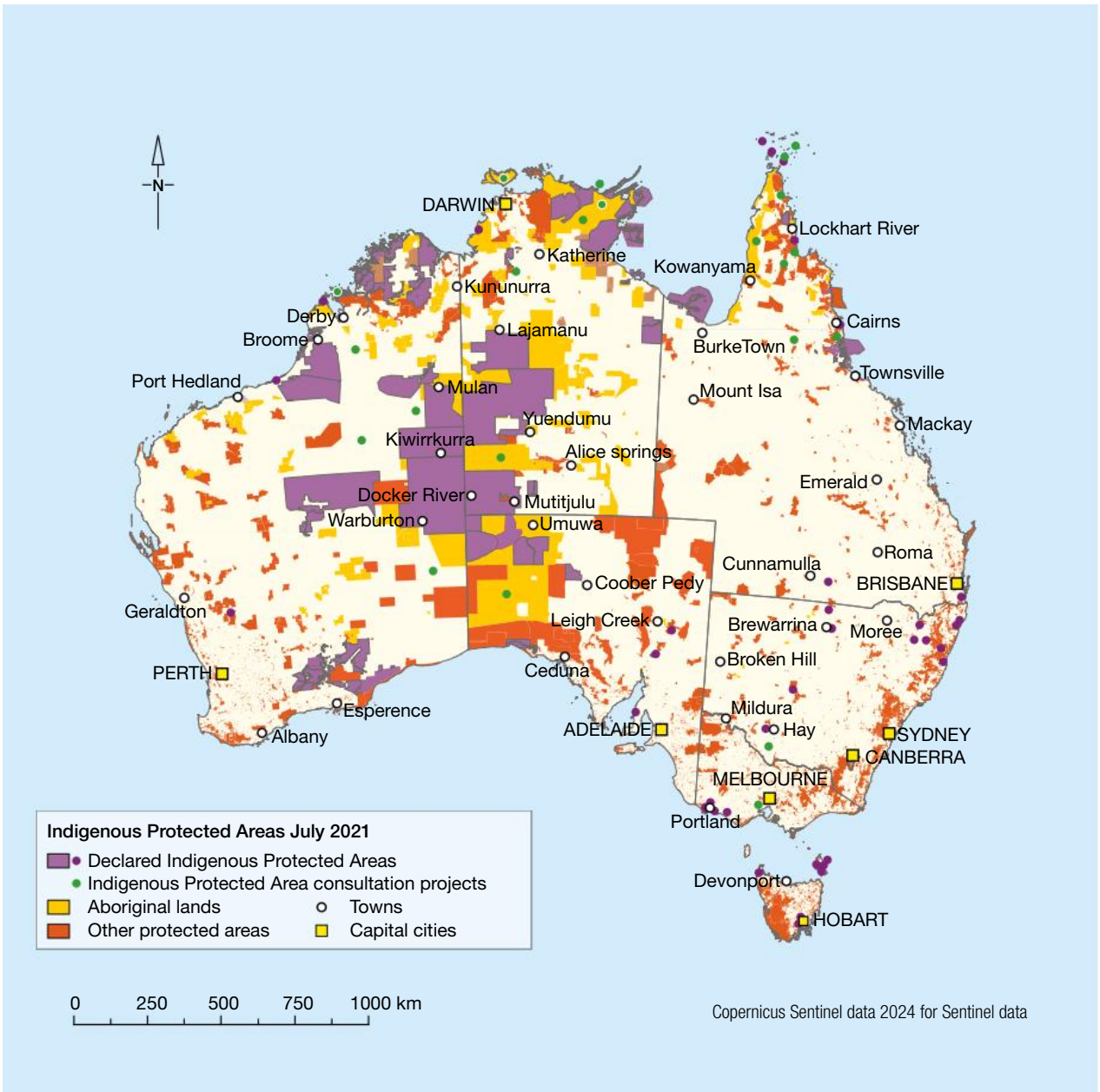
Māori, like many indigenous peoples around the world, live in two worlds. The Māori world which is viewed through Mātauranga Māori and the western world, which is referred to as Tauiwi. Yet non-Māori New Zealanders rarely step into or see the world from a Māori perspective, as it is unfamiliar. This is true of non-indigenous people the world over, for example, in Canada and, of course, here in Australia. However, many geographers and environmental scientists in New Zealand are now beginning to appreciate the power of a Mātauranga Māori mindset when considering how best to manage the fragile and degraded environment of New Zealand.

Australia's Indigenous Protected Areas

An Indigenous Protected Area (IPA) is defined as an area of land or sea where Aboriginal and Torres Strait Islander owners promote biodiversity and cultural resource conservation, according to an agreement with the Australian Government. IPAs make a significant contribution to Australian biodiversity conservation. The goals of the IPA element of the Caring for Our Country initiative are to:

- support Indigenous landowners to develop, declare and manage IPA on their lands as part of Australia's National Reserve System
- support Indigenous interests to develop cooperative management arrangements with government agencies managing protected areas
- support the integration of Indigenous ecological and cultural knowledge with contemporary protected area management practices.

There are now more than 80 declared IPAs and over 40 consultation projects across Australia (see Figure 11.6.2). IPAs now account for over 50 per cent of the National Reserve System.



11.6.2 Indigenous Protected Areas, 2021

SPOTLIGHT

Indigenous knowledge protecting Zimbabwe's wetlands

Years of persistent drought have put great stress on water resources in Zimbabwe, especially in the south of the country. Wetlands are a key ecosystem, absorbing water that infiltrates the soil, allowing groundwater aquifers to be recharged (see Figure 11.6.3). These are crucial for long-term water supplies for the local communities.

11.6.3 Wetlands across southern Africa are crucial for recharging underground aquifers.

Local communities in the Matobo District in Matabeleland South Province in the south-west of Zimbabwe identified two key wetlands—the Ntunjambili and Gulati wetlands—as having particularly high importance. They also identified the need for these wetlands to be protected and rehabilitated. Years of unsustainable use and the impacts of climate change had left them highly degraded.

Local committees were formed to begin the restoration work. A key strategy was fencing off the wetlands, which was done with the help of an external NGO. The committees also turned to long-neglected indigenous knowledge to manage the wetlands environment. Designing environmental protection plans for the wetlands based on indigenous knowledge and rules became a key strategy. These rules, which forbade unsustainable uses of the wetlands, such as livestock grazing and cutting down trees, were reinstated and incorporated into local laws.

There has been a significant recovery of the wetlands with significant increases in biodiversity noted. Some species that had not been seen in the wetlands for over 30 years have returned, including the giant pouched rat. The wetlands have become an important source of grass, which local farmers are allowed to harvest sustainably to feed their livestock under indigenous laws.

Using financial support provided by the United States Government, the Dambari Wildlife Trust (DWT) is using the success of the wetland projects to highlight the benefits of wetland protection across the province. Tafadzwa Tichagwa, a field officer at DWT noted, 'We are looking at an opportunity whereby we marry the cultural methods while we bring in a scientific method to add into the existing knowledge system ...'.

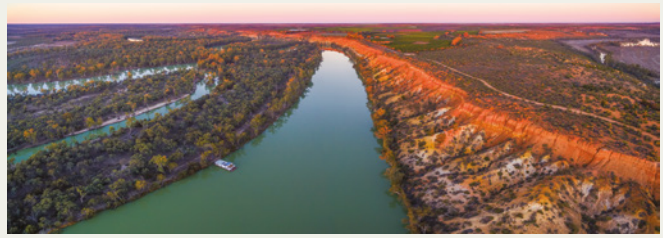
SPOTLIGHT

The National Cultural Flows research project

The National Cultural Flows Research Project (NCFRP) is an indigenous science project that was conducted in south-eastern Australia, centred around the Murray–Darling River basin (see Figure 11.6.4). The NCFRP drew on both scientific research methodologies, as well as the deep cultural knowledge of Aboriginal people, to best inform practice. It could be seen as an example of Etuaptmumk.

The project had three important outcomes.

- It provided a better understanding of the importance of natural resources, particularly water, to the First Nations peoples of the areas studied.
- It better equipped First Nations peoples with the information and tools to enable them to participate in the development of water policy.
- It better informed approaches to how water management policy is developed, to ensure that it incorporates First Nations perspectives.



11.6.4 The Murray River

The NCFRP involved many different groups and organisations, including local First Nations people, such as the Murray Lower Darling Rivers Indigenous Nations; state government agencies, such as the Victorian Department of Environment, Land, Water and Planning; and federal government agencies, including the Murray–Darling Basin Commission. While the project focused on the Murray–Darling Basin, it has become a case study in how to conduct such research in a way that can be transferred to many different ecosystems worldwide.

Activities

Acquiring and processing geographical information

1 Describe the nature of the relationship that Australia's First Nations peoples have with the biophysical environment.

2 Explain the goals of ecosystem management, as used by First Nations peoples.

3 Summarise the working definition of ecosystem management used by First Nations peoples.

4 Describe the parallels between traditional sacred sites and contemporary ecosystem management.

5 Explain the concept of Etuaptmumk.

6 Outline the Māori tradition of Māori Mātauranga.

Applying and communicating geographical understanding

7 Write a paragraph describing the key management strategies adopted by Australia's First Nations peoples.

8 Study the box, Spotlight: Indigenous Land and Sea Ranger program. Complete the following activities.

   a Briefly describe the nature of the program.

   b Explain the key concepts adopted by the program.

9 As a class, discuss how the concepts of Etuaptmumk and Māori Mātauranga can be used to inform contemporary ecosystem management. Record your ideas in a graphic organiser or a summary table.

10 Study Figure 11.6.2. Write a paragraph summarising the locations of IPAs around Australia.

11 Using the examples in this unit, write a report on how traditional indigenous land owners are playing an active role in the contemporary management of ecosystems.

CHAPTER

12 Ecosystem study: Great Barrier Reef

Coral reefs are one of the most complex ecosystems on Earth. They are predominantly found in the Indian Ocean and on the western edges of the Pacific and Atlantic oceans. Several factors influence the global distribution of coral, including sunlight and sea surface temperatures.

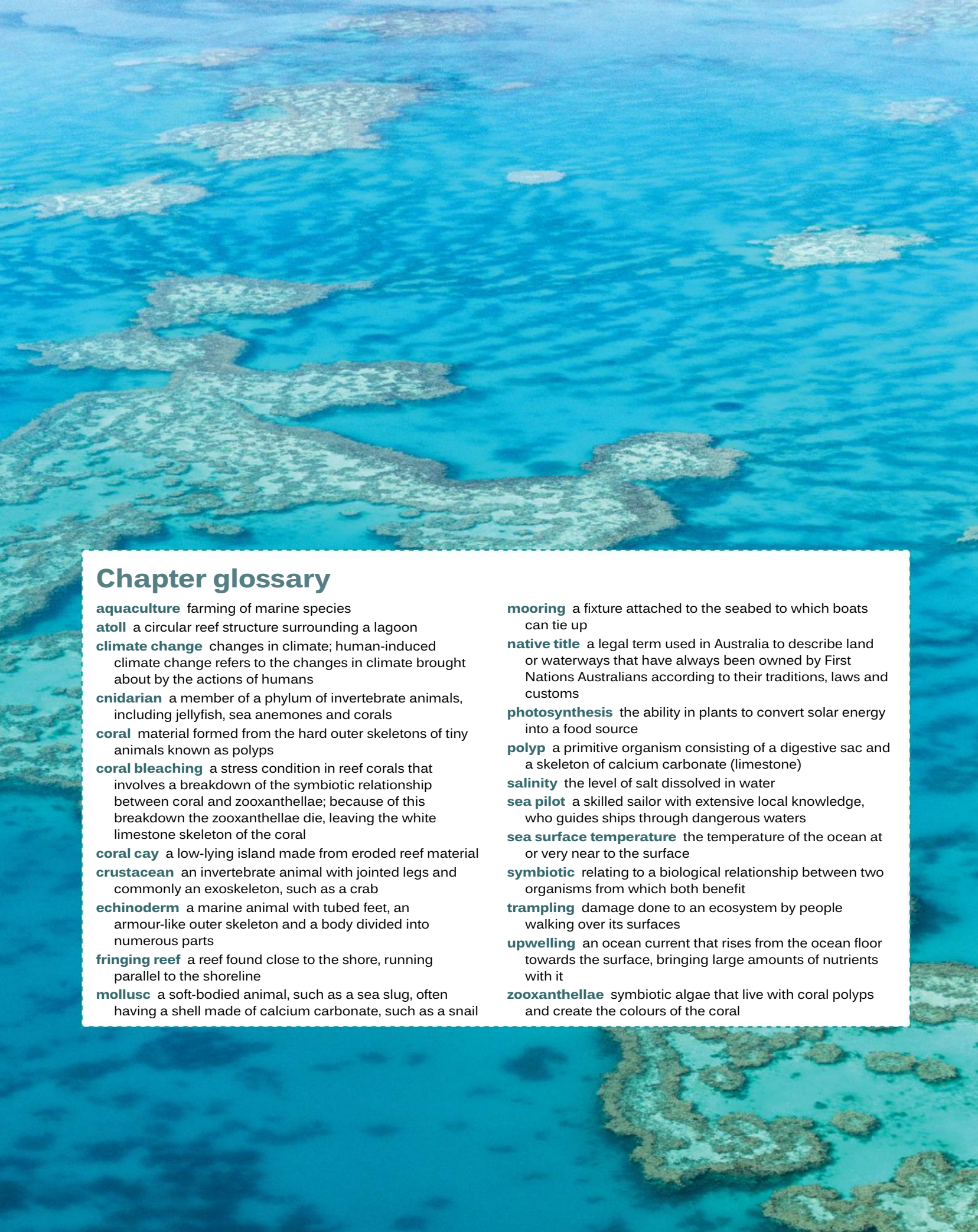
Coral reefs require such a unique set of biophysical interactions that they are highly vulnerable to human-induced change. For example, just a small change in sea surface temperature is enough to result in the collapse of a whole reef system.

Despite its name, Great Barrier Reef is not a single reef. Instead, it is a complex collection of more than 2000 individual reefs. It is the largest coral reef system in the world and is regarded as one of the most significant and spectacular environments on Earth.

This chapter investigates the ecosystem of the Great Barrier Reef, its spatial patterns, its biodiversity, the dynamics of its functioning, and its vulnerability and resilience to natural and human-induced modifications. Human responses and strategies to maintaining the reef's ecosystem functioning are examined, including a comparison of the management of the Great Barrier Reef and the coral reefs of Florida, USA, and an exploration of the role of research and innovation in the sustainable management of the Great Barrier Reef.

> **The Great Barrier Reef is in grave danger. The twin perils brought by climate change—an increase in the temperature of the ocean and in its acidity—threaten its very existence.**
>
> **Sir David Attenborough, British naturalist and broadcaster**

12.0.1 The Great Barrier Reef



Chapter glossary

aquaculture farming of marine species

atoll a circular reef structure surrounding a lagoon

climate change changes in climate; human-induced climate change refers to the changes in climate brought about by the actions of humans

cnidarian a member of a phylum of invertebrate animals, including jellyfish, sea anemones and corals

coral material formed from the hard outer skeletons of tiny animals known as polyps

coral bleaching a stress condition in reef corals that involves a breakdown of the symbiotic relationship between coral and zooxanthellae; because of this breakdown the zooxanthellae die, leaving the white limestone skeleton of the coral

coral cay a low-lying island made from eroded reef material

crustacean an invertebrate animal with jointed legs and commonly an exoskeleton, such as a crab

echinoderm a marine animal with tubed feet, an armour-like outer skeleton and a body divided into numerous parts

fringing reef a reef found close to the shore, running parallel to the shoreline

mollusc a soft-bodied animal, such as a sea slug, often having a shell made of calcium carbonate, such as a snail

mooring a fixture attached to the seabed to which boats can tie up

native title a legal term used in Australia to describe land or waterways that have always been owned by First Nations Australians according to their traditions, laws and customs

photosynthesis the ability in plants to convert solar energy into a food source

polyp a primitive organism consisting of a digestive sac and a skeleton of calcium carbonate (limestone)

salinity the level of salt dissolved in water

sea pilot a skilled sailor with extensive local knowledge, who guides ships through dangerous waters

sea surface temperature the temperature of the ocean at or very near to the surface

symbiotic relating to a biological relationship between two organisms from which both benefit

trampling damage done to an ecosystem by people walking over its surfaces

upwelling an ocean current that rises from the ocean floor towards the surface, bringing large amounts of nutrients with it

zooxanthellae symbiotic algae that live with coral polyps and create the colours of the coral

UNIT 12.1

The characteristics of the Great Barrier Reef

The Great Barrier Reef's vast complex of more than 2000 reefs comprises 10 per cent of the world's **coral** reefs. This ecosystem encompasses a myriad of environments, including **coral cays**, islands, sandbanks and, of course, different types of coral reefs. Overall, the Great Barrier Reef system covers an enormous area of 348 000 square kilometres. This makes the reef system larger than the UK, Switzerland and the Netherlands combined.

12.1.1 Spatial pattern of the Great Barrier Reef

Spatial patterns

Located off the east coast of northern Queensland, the Great Barrier Reef stretches approximately 2300 kilometres from Papua New Guinea's Fly River in the north (8°S) to K'gari in the south (24°S) (see Figure 12.1.1). Almost all the reef system lies in the tropics, with only the very southern portion lying south of the Tropic of Capricorn. The reef sits within the Coral Sea, an arm of the South Pacific Ocean.

To appreciate the sheer size of the Great Barrier Reef, it is useful to compare it to other large reef systems. The Belize Barrier Reef (off the Caribbean Sea coast of Belize in Central America) stretches for 290 kilometres, while Ningaloo Reef off the Western Australian coast, is approximately 280 kilometres long.

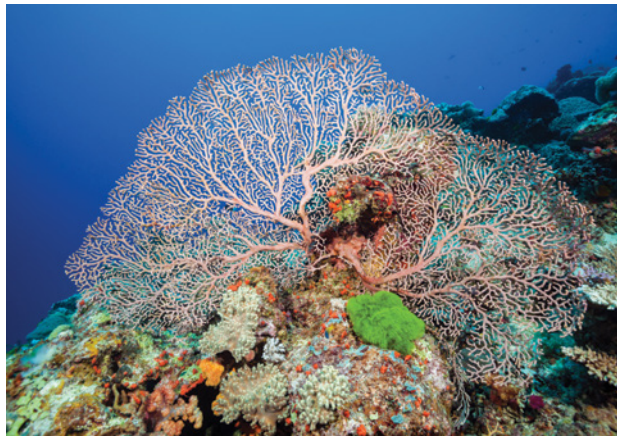
As shown in Figure 12.1.1, there are different ways to consider the extent of the Great Barrier Reef system. The Great Barrier Reef World Heritage Area covers the full 348 000 square kilometres. It extends from the low-water mark of the Queensland mainland and encompasses all the islands within the area. The Great Barrier Marine Park, which is around 344 000 square kilometres, also begins at the low-water mark of the mainland but excludes islands that are owned by the Queensland Government and some port areas.

Climate is the single most important factor in determining the location of coral reefs globally, and the Great Barrier Reef is no exception (see Figure 12.1.2). The warm waters of the Coral Sea are one of the most significant factors that allowed the reef system to develop. Lying north of the Coral Sea is the Solomon Sea and to its north-west is the Bismarck Sea. These two small seas form the Western Pacific Warm Pool, one of the world's warmest maritime areas. Currents from these seas flow both north and southward, spreading warm waters across the Pacific. Along with the Coral

Sea, these warm seas are major sources of tropical cyclones. In fact, research has shown that more than 10 per cent of all the world's tropical storms originate in the waters of the Coral Sea.

Three elements are vital to the formation and survival of coral reef systems.

1 **Temperature:** corals are limited to areas of the sea where the water temperature does not fall below 17–18°C, but rarely exceeds 33–34°C.
2 **Light:** corals contain organisms called **zooxanthellae**. These organisms need **photosynthesis** (the conversion of solar energy into a food source) to survive. Consequently, sunlight is a prerequisite for coral formation and survival.
3 **Salinity:** salinity refers to the amount of salt dissolved in the water. Corals thrive in relatively stable, saline conditions. Elevated salinity stunts coral growth and low salinity will result in the zooxanthellae dying.



12.1.2 Corals only grow in areas with very specific climatic conditions.

Types of reefs

An important characteristic of the Great Barrier Reef is that the system contains examples of the different types of reefs.

Fringing reefs

Forming in shallow waters close to the shoreline, **fringing reefs** are common along the shores of the many islands within the Great Barrier Reef (see Figure 12.1.3). There are also patches of these reefs in the northern parts of the mainland coastline. Globally, these are very vulnerable reefs as they are the most accessible to humans. The high rainfall along the coastline has limited the development of fringing reefs, as the outflow of fresh water from the numerous rivers on the mainland reduces salinity in the nearshore coastal waters, which limits the development of the corals there.

12.1.3 Fringing reefs at Lizard Island, north-east of Cooktown

Barrier reefs

Often referred to as offshore reefs, these reefs are located well away from the coast, sometimes as far as 100 kilometres or more. They tend to run parallel to the coastline and are sometimes called ribbon reefs as they tend to be long and narrow in extent (see Figure 12.1.4). These reefs are by far the most common within the Great Barrier Reef system, located across its extent. These reefs are very different in structure and support different biodiversity to the fringing reefs. They are far less fragile, as they are constantly assaulted by the power of ocean waves.

12.1.4 Barrier reefs form offshore and tend to run parallel to the shoreline. They are the most common type of reef found within the Great Barrier Reef system.

Patch reefs

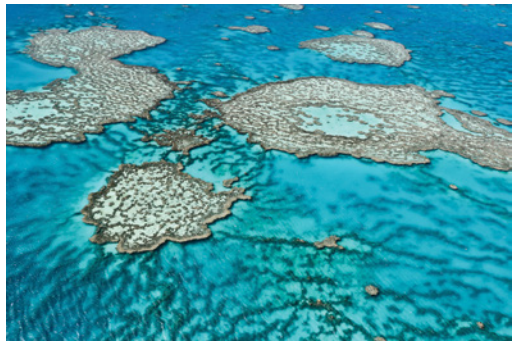
Patch reefs form in shallow waters and are usually circular in shape. They sometimes have a lagoon in the centre (see Figure 12.1.5).

Atolls

Atolls are reefs that built up to the sea surface level. They are usually circular or oval and have a lagoon surrounded by coral (see Figure 12.1.6). Some atolls, especially those in the Pacific Islands, are associated with volcanic activity.

Coral Cay

These are low-lying islands formed when material eroded from the reef system accumulates. Initially, little more than a sandbank, the cay eventually stabilises over time as more material builds up (see Figure 12.1.7). Gradually birds bring seeds, and a soil structure develops. The cay stabilises further as vegetation takes hold.



12.1.5 Patch reefs are often circular and can have a lagoon in the centre.

12.1.6 Lady Musgrave Island is an atoll located in the southern part of the Great Barrier Reef.

12.1.7 Heron Island is a coral cay located in the central part of the Great Barrier Reef.

Did you know?

The University of Queensland maintains an internationally renowned scientific research station on Heron Island, where up to 20 scientists conduct different types of research. The island is also home to a resort for tourists wanting a nature-inspired holiday.

Biodiversity of the Great Barrier Reef

Coral reefs are among the most biodiverse of all ecosystems. They support a great variety of both flora and fauna, and this is reflected in the complex food webs that exist within them. As the most extensive of all reef systems, the Great Barrier Reef's biodiversity is staggering, making it one of the most biodiverse places on the planet. Part of the World Heritage status conferred on the Great Barrier Reef was in recognition of this extraordinary biodiversity.

Species diversity

Apart from coral, the Great Barrier Reef is a highly diverse system made up of thousands of individual species. The mass of nutrients created by the plants and algae of the reef system is several times that of the open ocean. The main reason for this very high rate of production is the constant recycling of nutrients that takes place within the reef system. Algae within the reef play much the same role as trees do in rainforests, another highly productive ecosystem, which is constantly recycling decaying plant material into nutrients for further plant growth.

12.1.8 There are more than 400 species of hard corals, such as these, in the Great Barrier Reef.

CORALS

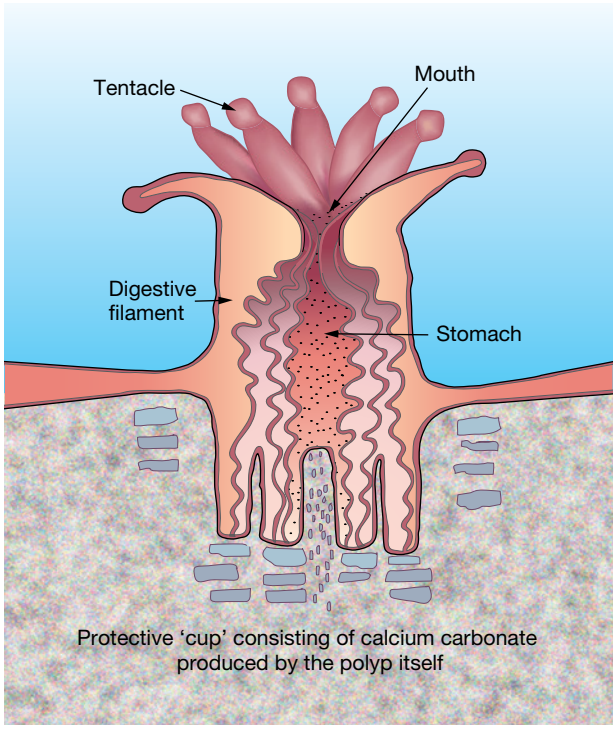
There are around 600 species of coral found within the Great Barrier Reef, the greatest diversity being in the northern section of the reef. Corals are broadly characterised into hard and soft corals, with hard corals being more dominant in the Great Barrier Reef system, with over 400 species (see Figure 12.1.8). The rarer soft corals tend to be more famous due to their often beautiful forms and colours (see Figure 12.1.9). The key difference between hard and soft corals is that hard corals have a hard outer skeleton made of calcium carbonate, which soft corals lack.

12.1.9 Soft corals, such as this knotted fan coral, as less common than hard corals on the Great Barrier Reef.

Although predominantly a rock structure, the living reef itself has been built by animals, known as **polyps** (see Figure 12.1.10). These primitive organisms consist of little more than a digestive sac or stomach and an outer skeleton of limestone (calcium carbonate). The polyp pulls food into its mouth through a ring of tentacles.

Within the polyp lives a **symbiotic** alga called zooxanthellae. The zooxanthellae and polyp mutually benefit from each other. The zooxanthellae produce sugars and oxygen through photosynthesis, while the polyp provides nutrients. It is the zooxanthellae algae that give the corals their brilliant colours.

Each coral reef begins as a single coral polyp, which then reproduces itself to create a colony. The colony gradually expands the reef upwards and outwards. As the individual polyps die, their limestone skeletons remain to create a structure on which the new corals will form. Coral reproduction is unique. In late spring or early summer every year the corals release their eggs into the warming water. Simultaneously, the corals also release sperm in a single massive spawning. The fertilised eggs form into larvae and settle onto the skeletal remains of the dead coral to continue the reef-building process.



12.1.10 Cross-section of a coral polyp

FISH SPECIES

There are at least 1625 species of fish living on the Great Barrier Reef. Some feed on material washed in from the open ocean, while others, such as the parrot fish, graze on the coral itself, eating the algae and polyps. The abundance of fish attracts a range of predatory animals to the reef. At the top of the food chain are predators such as sharks, with white-tip and black-tip sharks being the most common (see Figure 12.3.11). Grey whaler, leopard and epaulette sharks are also key species.

Did you know?

A huge coral that is more than 10 metres wide and 5 metres high is believed to be the biggest and oldest coral on the reef. It is called Muga dhambi by the traditional owners, meaning 'big coral'. It is thought that this coral is at least 420 years old and may be as old as 440!

CNIDARIANS

Large numbers of **cnidarians**—animals without backbones (invertebrates)—are also found throughout the Great Barrier Reef. Cnidarians are divided into two broad categories:

- sedentary cnidarians, which are unable to move; for example, corals and sea anemones
- mobile cnidarians; for example, jellyfish.

Regardless of their type, all cnidarians have stinging cells, which they use to catch prey and for self-defence.

MOLLUSCS

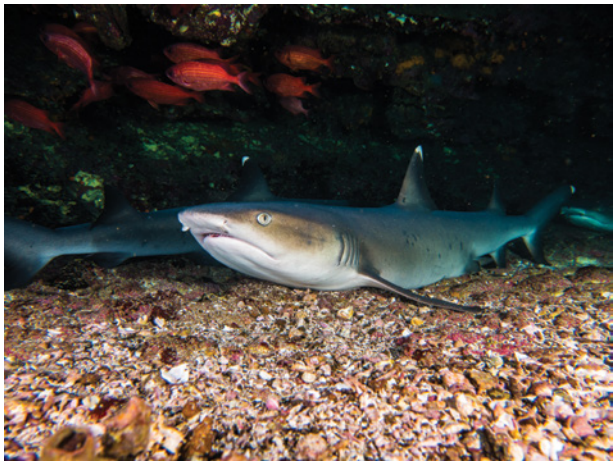
Molluscs are also found in large numbers. These are soft-bodied animals, such as sea slugs, clams and octopuses.

ECHINODERMS

Another common animal group is the **echinoderms**. These strange creatures have tubed feet, an armour-like skeleton and a body divided into several parts. Starfish and sea urchins are of this genus. The crown-of-thorns starfish is one of the best-known echinoderms on the reef. This species attaches itself to coral and gradually feeds off the coral, eventually killing it. At times, it reaches plague proportions. This leaves large areas of the reef degraded.

CRUSTACEANS

Crustaceans (invertebrates with an exoskeleton and jointed legs) perform an important role in recycling nutrients within the reef system. Including prawns, crabs and lobsters, these animals live on the sea floor and eat a range of food, including the dead fish that have settled to the seabed.



12.1.11 White-tip sharks are common on the reef system, sitting with other shark species at the top of the reef's food chain.

12.1.12 The Great Barrier Reef has a globally important population of dugongs.

12.1.13 More than 10 000 humpback whales migrate to the Great Barrier Reef annually to calve.

MAMMALS AND REPTILES

At the upper end of the food chain is found a range of mammals and reptiles. Turtles and sea snakes are found across the extent of the reef system. Large saltwater crocodiles are found in the northern parts of the system, generally closer to the mainland shoreline.

Mammals, such as dolphins and dugongs, live on the reef all year round. Dugongs, one of the most iconic animals of the reef (see Figure 12.1.12), graze on the vast seagrass beds that are found in the sheltered waters behind the reefs. They can grow as large as 400 kilograms and play a key role in the ecology of the extensive seagrass beds of the Great Barrier Reef. The reef's population of around 2800 dugongs is one of the most significant in the world and was another important reason for the system being declared a World Heritage Site. Their grazing nature means they are sometimes referred to as sea cows.

The reef system is home to several dolphin species. Two of these species, the Australian snubfin dolphin and the Indo-Pacific humpback dolphin, are both vulnerable species with their numbers in decline.

Although not living permanently on the Great Barrier Reef, migratory whales, including humpbacks, are regular visitors. They inhabit the reef for breeding and calving in the winter months before returning to Antarctic waters to feed in summer. The Great Barrier Reef Marine Park Authority (GBRMPA) estimates that more than 10 000 humpback whales (see Figure 12.1.13) migrate to the reef region each year. This is around half the number that once travelled to the reef, before large-scale industrialised whaling in the first half of the twentieth century, when numbers fell as low as 500 before whaling ceased. Smaller minke whales also migrate to the more northerly parts of the system.

Did you know?

Humpback whales are among the loudest animals on earth. Scientists believe that some of their calls can travel up to 10 000 kilometres if the ocean conditions are right.

SEABIRDS

Seabirds are another important part of the Great Barrier Reef ecosystem. The schools of fish found in the sheltered lagoons and shallow waters of the reef attract a large number and variety of seabirds. Around 175 species of birds are found across the reef system. Some of these live permanently in the region, while others use the reef's islands, cays and lagoons as resting stops on their migrations.

Most birds found in the region have large, webbed feet for swimming. Examples of seabirds include noddies, boobies, swallows (see Figure 12.1.14) and terns, which are found on most islands in the reef system. Birds play an important role in transporting seeds from the mainland to islands and from island to island.

12.1.14 Brooding swallows on Michaelmass Cay

Activities

Acquiring and processing geographical information

1 Describe the location and extent of the Great Barrier Reef.
2 Describe the environmental conditions necessary for coral reefs to form.
3 Describe how fringing reefs differ from barrier reefs.
4 Account for the limited development of fringing reefs along Queensland's coastline.
5 Differentiate between hard and soft corals.
6 What is a coral polyp?
7 Explain the symbiotic relationship between coral polyps and zooxanthellae.
8 Describe the nature of cnidarians.
9 Explain why crustaceans play an important role in the functioning of the Great Barrier Reef food web.
10 Describe the importance of the Great Barrier Reef to mammal species.

Applying and communicating geographical understanding

11 Using a simple flow chart, explain the formation of a coral cay.
12 Write one paragraph explaining the formation of a coral reef from a single polyp.
13 Study Figure 12.1.10. Complete the following activities.
   a List the major components of a coral polyp.
   b Explain the role of a coral's tentacle.
14 Write an extended response on the topic, 'Examine the biodiversity of the Great Barrier Reef'.

UNIT 12.2

The dynamics of the Great Barrier Reef's ecosystem functioning

Like all ecosystems, the Great Barrier Reef is the result of a complex set of interactions between the four spheres of the biophysical environment. Each sphere plays a crucial role in the functioning of the reef as a system, allowing it to have the resilience to overcome factors that make it vulnerable.

Vulnerability and resilience

The Great Barrier Reef is highly dynamic, meaning that it is subject to constant change. Naturally occurring stresses, such as wave action, storm events, and climate variability due to natural cycles such as El Niño, increase the vulnerability of the Great Barrier Reef. However, through the processes of dynamic equilibrium, the reef system has evolved and adapted to these stresses, developing resilience to them. Human-induced modifications, such as **climate change**, are far more challenging for the reef to develop resilience to, and this is discussed in this unit.

As outlined in Chapter 11 (see page 320), there are three main factors that cause ecosystem vulnerability: location, extent and biodiversity. Each of these factors must be considered in a discussion of the reef's vulnerability and resilience.

For example, the location of the Great Barrier Reef in the warm waters of the Coral Sea increases its vulnerability to tropical cyclones. The extensive size of the reef system enhances its resilience and reduces its vulnerability by minimising opportunities for impact across the whole of the system. Similarly, the extensive biodiversity of the reef is a protective factor, reducing its vulnerability.

The role of the atmosphere

The Great Barrier Reef lies within Australia's cyclone zone. For thousands of years, tropical cyclones (intense storms) have shaped the reef ecosystem. The summers of 2021–22 and 2022–23 saw four major tropical cyclones form in the Coral Sea that impacted the Great Barrier Reef zone. Another major cylcone, Cyclone Kirrily, also struck the region in late January 2024.

The impact of a tropical cyclone is dependent on the intensity and duration of the storm. In general, tropical cyclones cause damage to the corals themselves. The damage results from the large storm waves generated by the strong winds that are caused by intense low-pressure systems. These waves rip apart the softer corals, while the hard corals are chipped and damaged. In some cases, the cyclone may result in the reef system being buried by sediment.

Large amounts of rain are also associated with tropical cyclones. As large volumes of freshwater flood onto the reef from coastal river systems, the salinity of the reef waters is altered. The turbidity of the water can also be increased.

12.2.1 Waves breaking on Hastings Reef, around 55 km offshore from Cairns

The role of the lithosphere

The lithosphere plays an important role in forming and transforming reef ecosystems. The reefs themselves produce solid limestone (the dead skeletal remains of coral polyps). At the same time, the limestone is weathered and redistributed to other parts of the ecosystem to create a range of new landforms, including coral cays.

Through the production of limestone, coral reef systems can withstand the erosive power of waves (see Figure 12.2.1). Over time, individual corals die. However, in a sign of the resilience of the reef, their death enables new corals to grow on the limestone structures that they created. In this way, current reefs are growing on top of long-dead reefs.

● SPOTLIGHT

Tropical cyclones Yasi and Debbie

The most destructive cyclone ever recorded in Queensland was Cyclone Yasi, which struck in 2011. This was a category five storm (the highest rating). At its peak, wind gusts reached up to 295 kilometres per hour as the cyclone crossed the coast at Mission Beach, around 100 kilometres south of Cairns. The cyclone, which raged for four days, caused an estimated $3.5 billion in damages. The storm caused extensive damage to both the human and natural environment. For example, the famous Dunk Island resort was destroyed by the storm and remained a ruin for more than a decade, before it was finally bought by a developer in 2022.

Researchers examining the reef after the cyclone found extensive damage over a huge area (see Figure 12.2.2). The intensity of the storm meant that parts of the reef quite distant from the cyclone's path still suffered a significant impact. It was estimated that around 15 per cent of the entire reef system was impacted adversely by the storm. However, the resilience of the reef was also demonstrated by the storm. A study conducted by environmental scientists from Australia and the United States showed that the affected reefs were gradually recovering in the years following the storm. Their research found that by late 2013, coral in the affected areas had increased by around 4 per cent annually.

From 28 March to 1 April 2017, Tropical Cyclone Debbie—a large Category 4 tropical cyclone—struck the southern part of the Great Barrier Reef. The heavy rains associated with the cyclone initiated widespread erosion across inland parts of Central Queensland. River systems, including the Burdekin, Fitzroy and Gregory rivers, bringing huge quantities of sediment down from the inland areas out onto the reef, dramatically increasing turbidity (see Figure 12.2.3).

Tropical Cyclone Debbie also saw a dramatic increase in physical damage to the Great Barrier Reef, especially around the Whitsunday Islands. At the height of the storm, wind gusts were fast as 260 kilometres per hour and these winds created a huge sea swell and storm waves. In the wake of the storm, research by the Australian Institute of Marine Science (AIMS) found that more than 95 per cent of corals were destroyed on some reefs in the Whitsundays. Even corals found in deeper waters, which are usually less impacted by storm damage, had been affected by the ferocity of Tropical Cyclone Debbie.

12.2.2 Agincourt Reef, near Port Douglas. The damage caused to the reef by Cyclone Yasi is still evident in this photo taken in 2013.

12.2.3 Aerial photographs showing the mouth of the Fitzroy River in Queensland. The photograph on the left shows the river in the days prior to Cyclone Debbie and the one on the right shows the extent of the sediment plume following the cyclone.

Sediment is also an important influence on the reef. Sediments, such as sand and mud, can cloud the water, creating turbidity. Turbidity refers to the cloudiness of water. It can result in less light penetrating the water to reach the reef, which can affect the processes of photosynthesis. As discussed in the box, Spotlight: Tropical Cyclones Yasi and Debbie, coral reefs can also be smothered in sediment, especially where there are high levels of continental sediment run-off (that is, sediment run-off from land). For example, there are few reefs close to the shore (known as fringing reefs) within the Great Barrier Reef system. This is due to the high rainfall along this part of the Queensland coast, which creates considerable sediment run-off. In the Ningaloo Reef system, off the north-west coast of Australia, there are numerous fringing reefs. Here, the climate is dry and there are few rivers to transport sediment onto the reefs.

The role of the hydrosphere

Coral reefs tend to grow best where there is high wave energy. Wave energy is generated by ocean swells or by locally generated waves associated with the movement of air (wind). Reefs are very effective at interfering with wave energy. The structure of the reef is such that the seaward (or front) part of the reef absorbs much of the energy, creating an area of relatively calm water behind it.

The amount of water flowing across the Great Barrier Reef is so enormous that it is measured in thousands of cubic kilometres. Powerful currents, such as the East Australian Current, which flows southward along the Queensland coast, move vast quantities of water and nutrients across the reef. This inflow of nutrients is vital in providing energy into the food chain and helps to support the enormous biodiversity of the reef. Countercurrents flowing northward also draw in cooler waters at different times of the year.

The hydrosphere also plays a key role in the supply of fresh water to the reef. Lying in a tropical zone, coastal North Queensland receives extensive rainfall. This is further enhanced by the influence of mountains along the eastern seaboard creating orographic rainfall (an interaction between the atmosphere, lithosphere and hydrosphere). Cairns, for example, has an average annual rainfall of 2000 millimetres. This water flows across the relatively narrow coastal plain into coastal rivers and estuaries, making its way into the sea and onto the reef system (see Figure 12.2.4). The effect of freshwater entering the system is to alter the salinity levels, which in turn impacts coral formation that relies on saline waters. This is another reason fringing reefs are relatively rare along the Queensland coast.

12.2.4 The mouth of the Daintree River, north of Cairns

The role of the biosphere

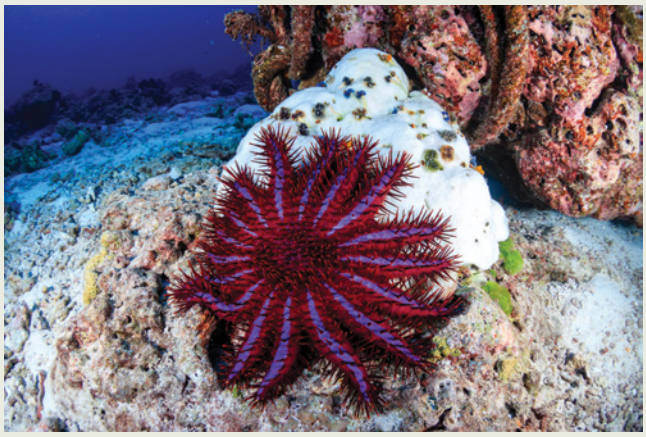
As outlined in Unit 12.1, the Great Barrier Reef is rich in biodiversity. This is a key factor in reducing vulnerability and enhancing the resilience of the reef system to stresses. Biodiversity creates more complex food webs by increasing the number of connections within the webs and this, in turn, creates a more resilient system. However, this careful balance can be impacted by both natural and human-induced stresses on the biodiversity of the reef. This is not an issue found on the Great Barrier Reef. However, natural stresses like the crown-of-thorns starfish can have significant impacts.

SPOTLIGHT

Crown-of-thorns starfish

The crown-of-thorns starfish is a large marine invertebrate, native throughout the coral reefs of the Indo-Pacific region, including the Great Barrier Reef (see Figure 12.2.5). The starfish grow up to 80 centimetres in diameter and have a voracious appetite for hard corals, consuming as much as 10 square meteres per year. The crown-of-thorns feeds by extracting their stomach through their mouths and covering the prey coral in digestive enzymes that break down the coral tissue into a soup-like liquid, which is then ingested. Once finished, the starfish simply retracts its stomach back into its body and moves on.

The starfish has a high capacity to reproduce. They reach sexual maturity at two years of age and the female can release up to 200 million eggs annually, which are fertilised by the male releasing sperm into the water at the same time as the release of eggs. By around six months of age, the juvenile begins to eat corals as their sole source of food.



12.2.5 A crown-of-thorns starfish feeding on hard corals

Although the crown-of-thorns starfish is a naturally occurring species across the reef, it has the potential to do significant damage. Large infestations of starfish, known as outbreaks, are common on the reefs. They were first identified in the early 1960s, although research indicates that outbreaks have always occurred. Four major outbreaks have taken place over the last 60 years.

Outbreaks of the starfish are one of the major sources of coral loss on the Great Barrier Reef. The outbreaks usually start in the north with the starfish migrating southward in huge numbers. Individual reefs can lose up to 90 per cent of their corals during an outbreak. While reefs will typically recover, other impacts, typically those associated with human activity, will increase coral stress and limit their capacity to recover from the outbreaks.

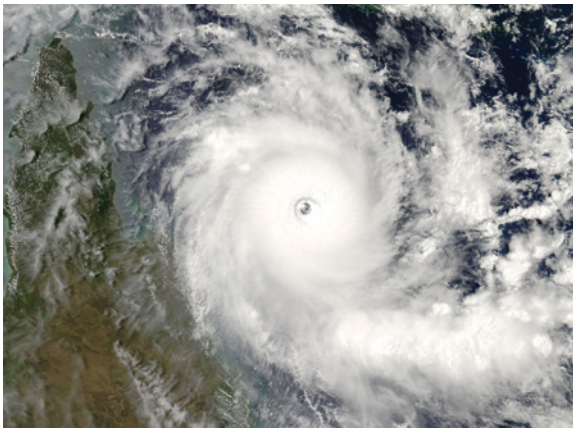
Sources of outbreaks are complex and marine scientists have been studying them since the 1960s. AIMS and the GBRMPA believe that there may be some link between human activities and more intense outbreaks of the starfish. Two major hypotheses have emerged as possible links to human activities.

1. An increase in nutrients entering the reef zone from onshore human activities may be increasing phytoplankton levels, as phytoplankton are the main food source of crown-of-thorns larvae, meaning that many more starfish survive to breeding age.
2. A reduction in the starfish predators allows numbers to swell. For example, coral trout, rock cod and tropical snapper are predators of the starfish and are also popular species caught by commercial and recreational fishers. Therefore, the reduction in their numbers may be a factor in starfish outbreaks.

Ecological disturbances

Ecological disturbances are events or forces that cause the death of organisms within an ecosystem. They can be biological—for example, a disease—or nonbiological—for example, a natural disaster. Ecological disturbances change the spatial patterns of populations of organisms within an ecosystem, and therefore can change the nature and character of the whole ecosystem.

Ecological disturbances are well researched in many terrestrial ecosystems, but less so in marine environments like the Great Barrier Reef. However, stresses such as tropical cyclones can clearly cause significant damage to individual reefs, damaging and killing corals, which can displace populations of animals that feed on and inhabit the corals, and, in turn, displace the animals that feed on these. Therefore, this non-biological event can be a major source of ecological disturbance (see Figure 12.2.6). Tropical cyclones can have equally damaging effects on seagrass beds. A large-scale study of the impacts of Tropical Cyclone Sandy in the Gulf of Carpentaria found that over 185 square kilometres of seagrass beds were damaged or destroyed by this 1985 storm event. While this event did not take place in the Great Barrier Reef area, it highlights the vulnerability of the extensive seagrass beds within the reef zone.



12.2.6 Tropical cyclones are a major non-biological cause of ecological disturbance across the Great Barrier Reef.

Biological factors, such as crown-of-thorns starfish outbreaks have a similar capacity to create significant ecological disturbances. With the potential to kill off up to 90 per cent of hard corals within an individual reef, the starfish can dramatically alter the functioning of the reef system.

When disturbances take place frequently, or occur multiple times during the recovery phase of an ecosystem, there is potential for an alternative community of species to invade and take over the ecosystem and transform its character altogether. The threat of climate change clearly has the greatest potential to do this. This is discussed in considerable detail in Unit 12.3. Warmer sea temperatures over sustained periods could result in the total collapse of coral communities, leading to their replacement with a different community, which in turn will flow through the entire biosphere of the reef system.

Activities

Acquiring and processing geographical information

1 Explain how the size of the Great Barrier Reef may help to reduce its vulnerability.
2 Summarise the impacts of tropical cyclones on the reef.
3 Explain the importance of limestone to the reef.
4 What is turbidity?
5 Describe the impact of increasing turbidity on the reef.
6 Outline the roles of wave energy in the structure of reef systems.
7 Describe the importance of ocean currents in supporting life on the reef.
8 Why is biodiversity important in making the reef more resilient?
9 Explain the concept of ecological disturbance.

Applying and communicating geographical understanding

10 Study the box, Spotlight: Tropical cyclones Yasi and Debbie. Complete the following activities.
   a Describe the scale of Tropical Cyclone Yasi.
   b How did Yasi affect the reef's biophysical environment?
   c Describe the impacts of the heavy rains brought about by Tropical Cyclone Debbie.
11 Study the box, Spotlight: Crown-of-thorns starfish. Complete the following activities.
   a Describe the life cycle of the crown-of-thorns starfish.
   b Explain why the crown-of-thorns starfish is such a stress on the reef system.
   c Describe the possible links between outbreaks of the starfish and human activities.
12 Write a paragraph describing one example of a stress that may lead to ecological disturbance on the Great Barrier Reef.
13 Write a response on how the functioning of the Great Barrier Reef is a response to interactions between the four spheres of the biophysical environment. Include examples that illustrate the interactions.

UNIT 12.3

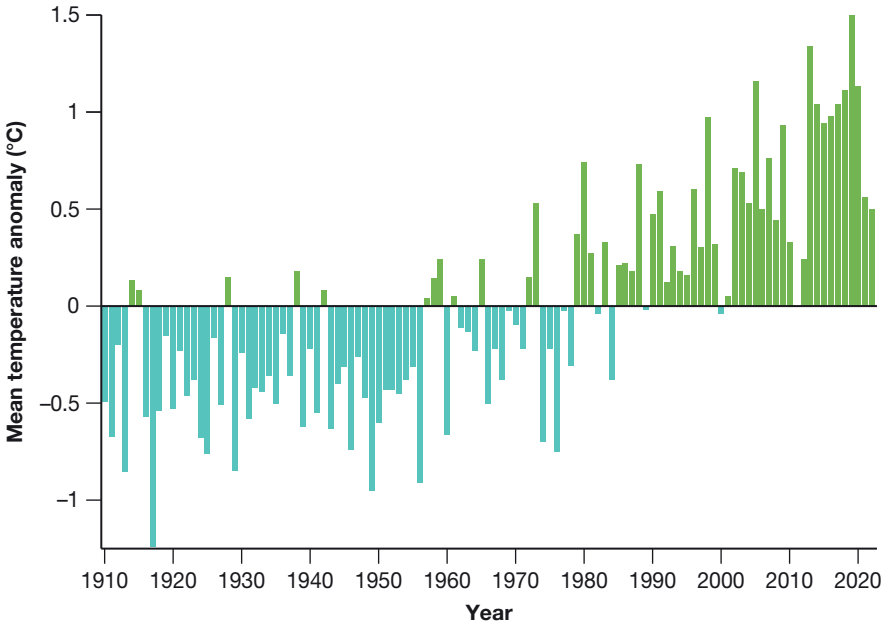
Human-induced modifications to the Great Barrier Reef

There is a long history of human activity on the Great Barrier Reef. Aboriginal and Torres Strait Islander peoples have fished and hunted on the reefs for thousands of years. Their cultural and spiritual connections with the reef, its animals and the surrounding lands and waterways remain very strong.

Since the European colonisation of North Queensland, which resulted in a bloody frontier war between First Nations peoples and Europeans in the mid-nineteenth century, human-induced modifications to the reef began to emerge. In contemporary times, climate change poses by far the greatest threat to the reef. Other activities, including tourism, agriculture and mining, all pose threats to the reef, unless very carefully managed.

Climate change

Climate scientists have shown, using many different sources of evidence, that Earth's climate is warming and that this warming is the result of human actions. The burning of fossil fuels releases greenhouse gas emissions, which have created the warming trends that are increasingly evident in the world's climate data. Figure 12.3.1 shows the annual mean temperature anomaly in Northern Australia for the month of February between 1910 and 2022. This anomaly measures how far below or above average the February monthly temperature is. Since the second half of the twentieth century, there has been a clear pattern of above-average temperatures. Similar patterns of anomalies are evident in climate data from around the world.

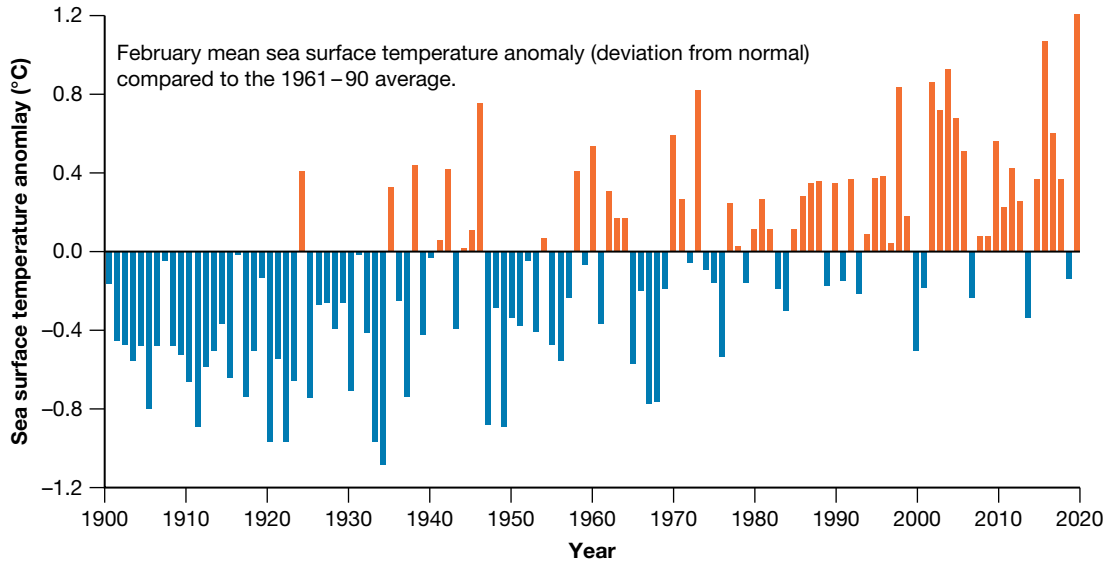


Source: Bureau of Meteorology

12.3.1 Annual mean February temperature anomaly for Northern Australia, 1910–2022.

This warming is already having an impact on Earth's climate. Much of this additional heat is being absorbed by the world's oceans. Scientists measure **sea surface temperature** by taking the temperature of the top millimetre of the ocean's surface. There is a considerable amount of data going back to the mid-1880s that give scientists the ability to develop a long-term understanding of the average temperatures. Sea surface temperature varies due to many factors. For example, large-scale changes in temperatures in the Pacific Ocean are associated with a cyclical change to ocean currents, known as the El Niño and La Niña climate cycles. However, data confirms an overall pattern of warming oceans. Figure

12.3.2 shows the annual mean temperature anomaly in the waters of the Great Barrier Reef for the month of February between 1900 and 2022. This measures how far above or below the February average the temperature is each year from the long-term average. What is clear from the data is that the overall trend in the Coral Sea is one of warming temperatures, especially since the 1960s. This correlates with the warming of terrestrial temperatures in Northern Australia, shown in Figure 12.3.1.



Source: Bureau of Meteorology

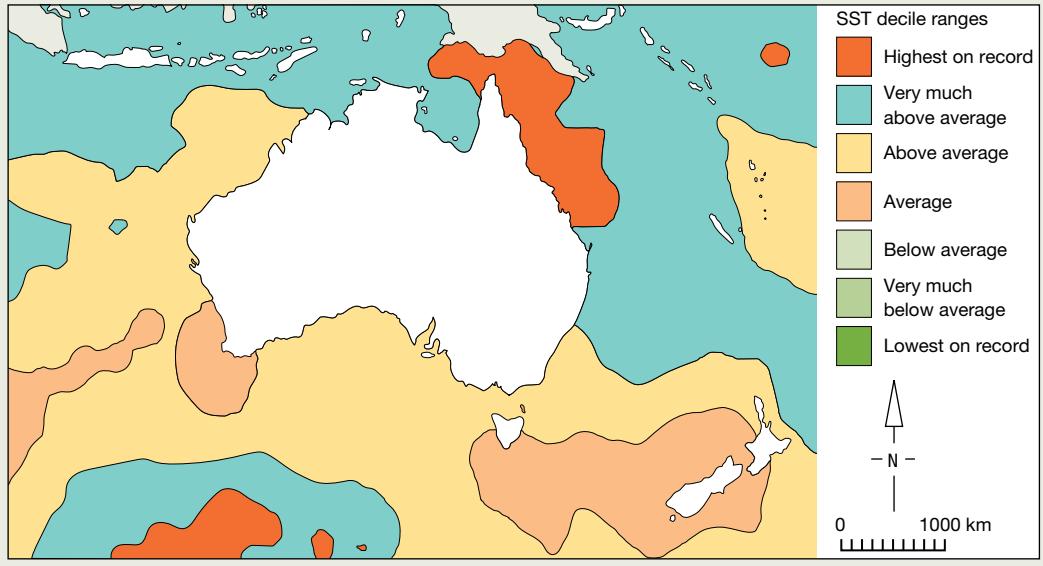
12.3.2 February temperature anomaly for sea surface temperatures across the Great Barrier Reef 1900 to 2022.

● **SPOTLIGHT**

Marine heatwave 2020

There were record-breaking temperatures across the Great Barrier Reef in 2020. Several factors combined to cause this. One factor was a delay in the wet season over Northern Australia, associated with sea temperatures in the Indian Ocean. This resulted in less cloud cover over the reef, and weaker winds across the reef. This, combined with already warming sea temperatures in the Coral Sea, associated with climate change, led to the GBRMPA to describe the conditions of summer 2019–20 as a marine heatwave.

The average summer sea surface temperature across the reef was 28.6°C, with January's average measured at an extremely high 29.2°C. This is an average, meaning that temperatures on individual days and at specific times were much higher. This led to sea surface temperatures well above average, including the highest on record over much of the reef (see Figure 12.3.3).



Source: Bureau of Meteorology

12.3.3 Sea surface temperature (SST) ranges for summer 2019–20.

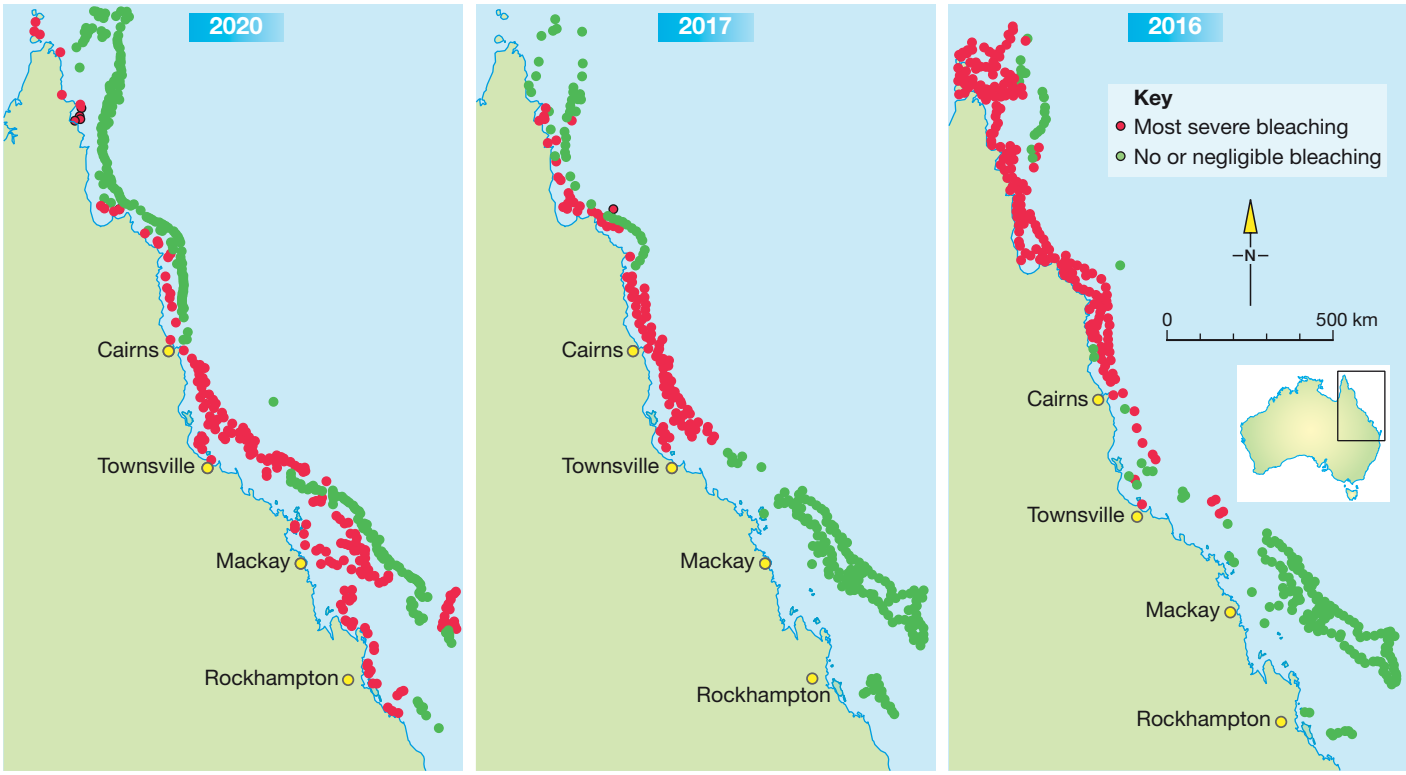
Coral bleaching

Coral has specific climatic requirements. These include a water temperature that does not fall below 17–18°C and rarely exceeds 33–34°C. Increasingly, temperatures exceed this level, which places stress on the corals. When the corals become stressed, the symbiotic relationship between the coral polyp and the zooxanthellae breaks down, causing the coral to expel the algae. As a result, the coral loses the colour that was provided by the zooxanthellae. This process is known as bleaching, as the reef turns white (see Figure 12.3.4). Not all bleached coral will die, but there is a significant risk of this, and it is a strong indication of severe stress on the reef.

12.3.4 Coral bleaching on the Great Barrier Reef

Studies conducted across the globe by environmental scientists with expertise in coral reefs have consistently shown the stresses that reefs are under. Since the 1980s, there has been five-fold increase in the frequency of severe **coral bleaching** events across reefs around the world. This coincides with the significant increases in average sea surface temperatures recorded.

Coral bleaching events can be associated with natural changes in climatic conditions. For example, during naturally occurring El Niño events, the sea temperatures in the western Pacific Ocean and the Coral Sea rise. However, it has become clear that human-induced climate change is causing more frequent and more extreme bleaching events. In 2016, a massive event saw a 29 per cent loss of the shallow reefs across the Great Barrier Reef due to bleaching. The same year also saw the hottest sea surface temperatures ever recorded in March and April, and, until 2020, the hottest February. Scientists estimate that up to 93 per cent of the reef had some bleaching in 2016. Some of this was quite mild bleaching, especially in the southern parts, where the coral recovered well. However, the northern parts, where waters were warmer, saw significant coral death. The 2016 event was followed by a further mass bleaching event in 2017, which recorded the third hottest January sea surface temperature since 1900 (see Figure 12.3.5).



12.3.5 Effects of Great Barrier Reef coral bleaching events 2020, 2017 and 2016

12.3.6 A storm surge hitting the coastline of Far North Queensland. Storms are becoming more intense in the tropics due to climate change.

Increased storm activity

Climate change increases the intensity of tropical cyclones. The formation of tropical cyclones is the result of complex interactions between the atmosphere and hydrosphere. Their formation is associated with temperature differences between warm ocean waters and a cooler atmosphere. Some climate scientists predict a decrease in the number of major storm events due to warmer atmospheric conditions. However, there is almost universal agreement that the storms that do form will be stronger, longer lasting and more intense, due to energy derived from the warming ocean waters (see Figure 12.3.6).

Tropical cyclones are a major source of damage across the Great Barrier Reef, and an increase in their intensity and length of storm events will have a profound effect on the reef system.

Ocean acidification

Ocean acidification is a major consequence of climate change and has a significant impact on marine ecosystems like the Great Barrier Reef. The oceans are an enormous 'carbon sink', absorbing huge amounts of carbon dioxide from the atmosphere. As the carbon dioxide is absorbed by the salt water, a chemical reaction takes place that results in hydrogen ions becoming concentrated and reduces the carbonate ions. This makes the salt water more acidic.

Ocean scientists have estimated that acidity levels in the world's oceans have increased by around 26 per cent since global industrialisation and the widespread use of fossil fuels began in the eighteenth century. This is in contrast to studies showing that long-term acidity levels were steady for millions of years previously.

Corals are greatly affected by ocean acidification, especially the hard corals, that are by far the most dominant on the Great Barrier Reef. These corals make skeletons in a process known as calcification. As acidification increases, calcification slows, resulting in less growth and weaker coral structures. Acidification also impacts plankton, which form the base of the food chain, reducing their capacity to build shells, plates and skeletons. Some studies have also found that the reproduction of many fish species is affected by acidification, as their eggs are very sensitive to acid level changes.

Species decline

The effects of climate change are not just confined to coral, but impact the broader ecosystem of the Great Barrier Reef.

Sea birds

Several seabird species are already in decline across parts of the reef. Mass mortalities and a failure of eggs to hatch have occurred in several large rookeries of seabirds. Scientists believe that this is the result of 'provisioning failure', meaning that the adult birds are having to travel too far to find food as the availability of fish decreases due to changed ocean circulation patterns.

Food chain functioning

Climate change is altering the location, frequency and timing of nutrient **upwellings**. These upwellings are ocean currents that bring nutrients upwards from the sea floor. Such upwellings attract fish, which, in turn, attract predator fish and mammals, such as sharks and dolphins. Changes in these nutrient upwellings have a significant impact on the functioning of the food chain. Humans are also noticing impacts because of these changes, with fewer fish being caught by commercial fishers in the region.

Larger animals

Climate change is also beginning to affect the largest animals on the reef. Scientists have concerns for the habitat of the humpback whales that breed in the warm northern waters in the winter months. Turtles are another species under threat because of climate change (see Figure 12.3.7). The gender of a turtle is determined by temperature: higher temperatures result in more female turtles being hatched. As the region warms, more female turtles are being born and a gender imbalance is emerging. Other threats to turtles include sea level rise, reducing nesting sites. Turtles nest on beaches, which are gradually being inundated by the sea level rise.

12.3.7 Hawkesbill turtles are one of many species impacted by climate change.

Recreational and commercial sea vessels

Recreational boating is a common pastime on the reef. On any day of the year, thousands of small craft can be observed fishing, sightseeing and sailing up and down the length of the reef. While those waters represent a relatively safe boating environment for humans, the boats have the potential to damage the reef ecosystem.

The boats' heavy metal anchors damage the reef's coral formations and dredge up the seagrass beds. Boats are also a source of pollution, through oil and fuel spills, rubbish and sewage. When boat owners vent their onboard sewerage systems while at sea, raw sewage is released into the water. Sewage from a single boat is not damaging. However, the impact is considerable when hundreds of boats do this.

Thousands of large ships, including bulk carriers, tankers and cruise ships transit through the Great Barrier Reef each year. There are an estimated 11 000 large ship movements in and around the Great Barrier Reef annually, and this number is expected to continue to grow over the coming decade. These ships carry everything from grain, minerals, bulk cargo (such as cars) and oil. Fortunately, there has not yet been a major oil spill on the reef. However, with many ships travelling through the area the potential for a major spill is very real.

There have been significant accidents in the past. In April 2010, the MV *Shen Neng 1* ran aground on Douglas Shoal (see Figure 12.3.8), leaving a 400 000 square metre scar over the reef. When the matter went to court in 2016, it was revealed that the reef was still degraded from the incident. One major impact was toxic paint residues that were still evident on the reef where the hull of the ship had contacted it. However, the area is carefully managed, and the International Maritime Organisation has judged that because of the careful management it is 'unlikely' that a major incident will occur on the reef.

Ships also bring with them rubbish and can produce small oil slicks associated with leaks. They also have the potential to introduce feral aquatic species by releasing ballast water. This is water that is used to balance the ship: water is pumped into the ship, often in an overseas port, and released when it is no longer needed.

12.3.8 The MV *Shen Neng 1* after it ran aground on Douglas Shoal in the Great Barrier Reef

Small animals and plant species can be transported across the oceans in this way. It is estimated that as many as 250 species have been introduced to Australian waters by ballast discharges, and 15 of these species have been found in parts of Queensland.

● SPOTLIGHT

Impacts of port expansions

Several ports across northern Queensland are undergoing expansion or have plans to do so in coming years. Port expansion involves dredging the sea floor to increase the depth of ports and the channels that link them to the open ocean. Dredging is carried out by either using large scoops or high-pressure suction to remove sediments and place them elsewhere. This has an obvious impact to the immediate sea floor, but the process also stirs up fine sediment, causing clouds of very fine particles to drift long distances. Some research indicates that these sediment plumes can drift for up to 100 kilometres and increase turbidity in the water, reducing sunlight and impacting coral growth.

There are five major dredging projects planned across Queensland. One massive project is planned for Trinity Inlet in Cairns, where more than 1 million cubic metres of material will be dredged and removed to allow access for larger cruise ships. The inlet has extensive seagrass beds. A massive expansion of the Abbot Point coal port facilities north of Bowen in the southern parts of the Great Barrier Reef will also see more than 1 million cubic metres of material removed (see Figure 12.3.9). This is also home to very sensitive seagrass beds, which are an important dugong habitat and turtle breeding area.

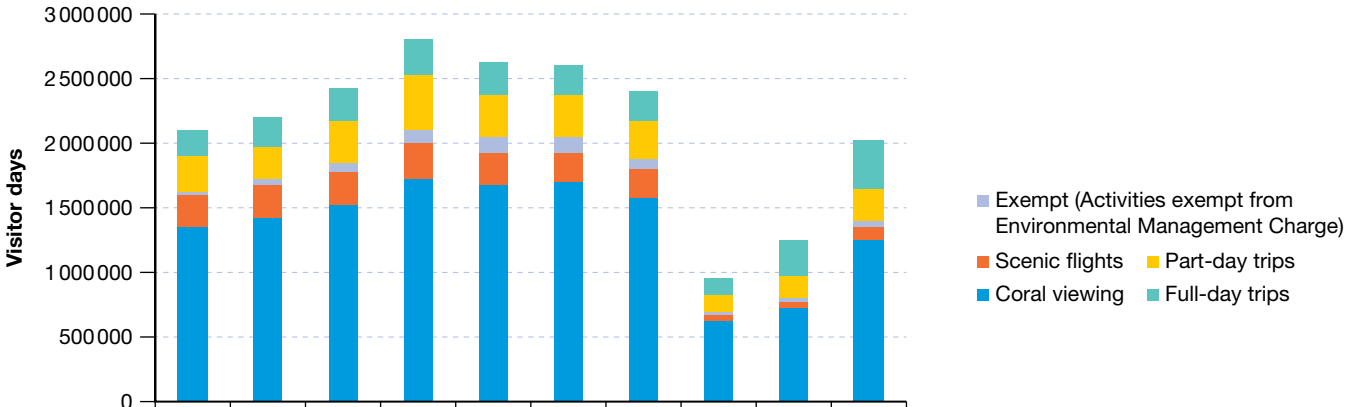
12.3.9 Point Abbot coal terminal north of Bowen in the southern Great Barrier Reef region

Tourism

Tourism is one of the most important industries in Far North Queensland and the Great Barrier Reef is a tourist attraction of international importance. Research by Deloitte Economics, released in July 2017, placed the value of the Great Barrier Reef to the Australian economy as $56 billion. Although the research has not been updated, the figure is arguably considerably higher today. To place this into context, this is twelve times the value calculated for the Sydney Opera House. Of the total value, $29 billion was associated with tourism. The reef generates around $6.4 billion of economic activity annually, mostly associated with tourism. An estimated 64 000 jobs are associated with the Great Barrier Reef, mostly in tourism and industries associated with supporting the tourism sector.

In 2022, there were just over 2 million visitor days (this measures the total time visitors spent there) to the Great Barrier Reef, with around 1.25 million individual visitors. While this represents a number lower than pre-COVID-19 pandemic figures, which exceeded more than 2.4 million visitor days, the overall trend has been one of very high visitor numbers. Future planning predicts visitor numbers to continue to grow well beyond the pre-pandemic levels towards 2030.

Figure 12.3.10 provides a summary of the visitor numbers and activities undertaken by visitors across the Great Barrier Reef Marine Park. The impact of the COVID-19 pandemic on numbers is clear, but so too is the strength of the rebound in visitors since travel restrictions were eased in late 2021, showing the resilience and popularity of tourism across the reef. Figure 12.3.11 describes the impacts of various tourist activities.



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Coral viewing	230 768	260 076	252 323	276 873	265 312	236 518	215 768	50 042	59 314	118 320
Scenic flights	40 105	47 200	80 063	109 031	115 933	110 969	92 751	33 053	25 134	45 546
Exempt	273 716	259 101	319 970	404 519	339 319	340 805	286 753	127 699	189 033	246 515
Part-day trips	189 449	210 701	256 591	276 764	234 384	222 686	226 861	125 152	263 699	366 628
Full-day trips	1 359 100	1 417 630	1 529 985	1 725 446	1 667 324	1 697 971	1 579 254	619 923	714 133	1 243 564

12.3.10 Activities undertaken by visitors to the Great Barrier Reef Marine Park, 2013–22

Only around 7 per cent of the reef is allocated for tourism, so despite the vast size of the reef, key tourist activities are concentrated around the Whitsunday Islands, Cairns and Townsville. The northern parts of the reef have the lowest levels of tourism activity.

Activities	Impacts
Coastal tourism development	Most tourists to the region stay in hotels and resorts on the mainland. This development places a strain on coastal environments, including estuarine river systems.
Island-based tourism	The growth of tourism on islands can create problems associated with sewage and rubbish discharges, as well as disruption to turtle and sea bird breeding sites.
Marine-based tourism	Tourist boats make thousands of journeys out to the reef each year. These boats bring rubbish and have the potential for oil spills. These boats also require **moorings** on the outer reef. Moorings destroy coral, as do anchors and the anchor chains of boats.
Water-based activities	Diving and snorkelling are popular tourist activities. Most divers are careful and cause no damage to the corals. However, studies show that a small proportion of divers swim too close to the corals, breaking them. The fragile branching corals are particularly susceptible to this. The chemicals in sunscreen worn by divers and snorkellers can also have a damaging effect on corals.
Wildlife interactions	Most tourism operators are very careful to ensure that tourists do not come too close to the marine animals that live on the reef. However, again, studies show that a small proportion of careless operators and tourists disrupt wildlife, which can impact breeding cycles and natural interactions.
Trampling and souveniring of coral	Trampling occurs when people walk on reefs that become exposed at low tide. This practice was once a common form of reef tourism, especially on inner reefs close to the shoreline, but it has now been made illegal. Souveniring of coral, shells and other elements of the reef ecosystem was also a major problem. In the past, tourists and some commercial traders took large amounts of material, mostly from the inner reefs. Such souveniring disrupted natural processes and is now illegal unless the collector is correctly licensed.

12.3.11 Impacts of tourism activities on the Great Barrier Reef

Did you know?

There are 26 fully licensed tourist diving companies operating on the Great Barrier Reef.

Did you know?

Research by marine biologists has found that some chemicals used in sunscreens are harmful to many marine species. For example, if found in high enough levels in corals, sunscreen can create bleaching effects.

12.3.12 The population of Cairns more than doubled between 2001 and 2021, resulting in many new housing developments.

Urbanisation and land clearing

There are 26 major river systems that flow from mainland Queensland out onto the Great Barrier Reef. Approximately 25 per cent of the land area of Queensland drains out onto the reef. This run-off represents a major impact on the reef. Agriculture, urban development and **aquaculture** (fish farming) all affect the quality of the water that runs into the Coral Sea.

The coastal areas adjacent to the reef continue to expand rapidly. The 2001 Census recorded the population of Cairns at 115 301. By the 2021 Census, it had grown by 55 per cent to 253 748 (see Figure 12.3.12). Townsville grew by 43 per cent in the same period, from 133 003 people in 2001 to 234 283 in 2021. This rate of growth is evident in coastal communities across North Queensland. Such growth requires increased housing, resulting in land clearing. This increases surface run-off, which brings more nutrients and sediments to the reef. These developments also increase the run-off of sewage and other pollutants. Developments associated with the tourism industry also have similar impacts.

The GBRMPA notes that the clearing of wetlands is another major issue impacting the sustainability of the reef. Estuarine and intertidal wetlands provide important habitats and nurseries for many of the species that form part of the reef ecology. These species include wading birds and small crustaceans. The wetlands also retain large volumes of freshwater during heavy rainfall. As wetlands are diminished, more freshwater flows out onto the reef, affecting salinity levels.

Agriculture and aquaculture

Aquaculture is becoming an increasingly popular form of commercial farming. Prawns, several fish species, and pearl and edible oysters are commercially farmed in large ponds within and next to the Great Barrier Reef Marine Park. These farms can release chemicals and diseases that impact on wild species and may also be a source of pollutants.

Conventional agriculture (see Figure 12.3.13) on the coastal plain adjacent to the reef has long been a source of concern for reef ecologists and marine biologists. The use of chemical fertilisers in the farming process can increase nutrients that promote algal growth. The algae smother the reef and reduce light penetration. Unsustainable agriculture is also a major source of soil erosion. As seen in 2017 with Cyclone Debbie, heavy tropical rains can dramatically increase erosion with the river systems, leading to this sediment being deposited onto the reef.

12.3.13 Sugar cane farming in North Queensland

Mining

The Great Barrier Reef is protected through state and federal laws, and internationally because of its World Heritage status. This prohibits mining within the marine park itself. However, the areas adjacent to the reef, such as around Mackay, are major coal mining areas. In 2022, more than 186 million tonnes of coal were mined in Queensland, with the vast majority of this sent overseas as exports.

These mines have impacts on the reef in several indirect ways. The most significant is the need for very large ships to transit through the reef to carry away the coal that has been mined inland. Huge ports have already been established in the region (see Figure 12.3.14). Each year there has been an increase of nearly 5 per cent in the number of ships calling at ports within the reef area.

The mines in Central Queensland are coal mines and the burning of this coal releases large quantities of carbon dioxide, the main greenhouse gas that leads to climate change. With climate change posing the greatest threat to the reef, climate change activists argue that coal mining must be stopped to give the reef a chance at survival.

12.3.14 Hay Point Coal loading facility near Mackay

Plastics and marine debris

The extent of the pollution of the marine environment by plastics has become a major focus in recent years. Images of the so-called Great Pacific Garbage Patch in the central Pacific Ocean have highlighted the extent and longevity of plastic pollution. Research and surveys across the Great Barrier Reef show that pollution from debris is a major concern. Ocean current debris can travel vast distances and the nature of the currents means that the northern and more isolated parts of the reef are more impacted than the southern parts. Oceanographers believe that much of the rubbish accumulating on and around the reef originates from the megacities of South-East Asia, with ocean currents transporting it.

Around 80 per cent of debris is plastics. Microplastics (plastic particles smaller than 5 mm) are a major concern as they can easily enter the food chain when they are ingested by animals. Plastics are toxic and bioaccumulation of these toxins in the food chain can have lasting effects. Ingestion by seabirds, fish and other marine animals can also lead to gastrointestinal blockages causing death.

Plastic and other debris, such as fishing nets, lines and equipment, can also cause entanglement that can lead to death, especially in animals that need to rise to the surface to breathe, such as dugongs, dolphins and turtles. Soft plastics, such as bags and wrappers, can smother corals, increasing the threat of disease due to stress.

● SPOTLIGHT

Marine debris in the most isolated areas

Volunteers regularly take trips to remote beaches along Australia's northern coastlines, including on Cape York Peninsula. The volunteer groups, known as 'trash tribes', work to clear stretches of beaches that are among the most isolated and least visited in all of Australia. Despite the locations' isolation, the volunteers consistently remove tonnes of plastic rubbish and other debris that has been washed ashore (see Figure 12.3.15).

A 2017 expedition by the volunteer group Clean Coast Collective to Chilli Beach in the Kutini-Payamu National Park, more than 750 kilometres north of Cairns, removed over 7 tonnes of debris from just one 7-kilometre stretch of the beach. More than 60 per cent of the material removed was plastic. Among the items collected were 6500 plastic bottles and containers, nearly 2300 toothbrushes and 1000 cigarette lighters.

More recent expeditions, including one in 2022 supported by Sea Shepard and Indigenous rangers, have focused on beaches in the Northern Territory's Arnhem Land region and found very similar patterns to the 2017 collection.

12.3.15 Marine debris pollution, much of it plastic, is a common sight along isolated beaches on the northern Great Barrier Reef.

Activities

Acquiring and processing geographical information

1 Summarise the main cause of climate change.
2 Explain the link between coral bleaching and climate change.
3 What is the link between climate change and tropical cyclone activity?
4 Explain how changes in tropical cyclones could impact the reef.
5 Describe ocean acidification. How is it linked to climate change?
6 Explain how climate change can cause species to decline.
7 Summarise the impacts that recreational boating can have on the reef ecosystem.
8 Describe the threats to the reef posed by large commercial ships.
9 Summarise the main impacts on the reef by tourism.
10 Describe the impacts on the reef by land clearing for urban development.
11 Explain how agricultural and aquacultural activities impact the reef.
12 Describe the effects on the reef of mining on the mainland.
13 Summarise the extent and impact on the reef of pollution by marine debris.

Applying and communicating geographical understanding

14 Study Figure 12.3.1. Describe the overall patterns shown on the graph.
15 Study Figure 12.3.2. Complete the following activities.
   a Describe the trends shown on the graph.
   b Compare this trend to that observed in Figure 12.3.1.
16 Write a paragraph explaining the link between climate change and oceans.
17 Using the maps in Figure 12.3.5, write a short report describing the extent of coral bleaching in each year shown.
18 Study the box, Spotlight: Impacts of port expansions. Complete the following activities.
   a Summarise the process and impacts of dredging associated with port expansions.
   b Using the internet, research one of the ports currently being expanded or that has plans to be expanded. Prepare a brief report on the port. Name and locate the port, summarise the nature of the expansion and what the impacts of the expansion may be on the environment, including the reef.
19 Using the data in Figure 12.3.10, briefly outline the main activities and trends in tourist numbers to the Great Barrier Reef.
20 As a class, discuss whether tourism plays a positive role in protecting the Great Barrier Reef. Record your ideas in a table, listing the positive and negative impacts of tourism.
21 Write an extended response to the following, 'Analyse the extent of human modifications to the Great Barrier Reef.'

UNIT 12.4

Responses and strategies to maintain ecosystem and actions for sustainability

The Great Barrier Reef was declared a World Heritage Site in 1981. The protection and management of ecosystems that are assigned World Heritage status fall to the Commonwealth (federal) Government. Therefore, even though the Great Barrier Reef is part of the state of Queensland, the Commonwealth Government is the primary manager of most of the reef. Many Queensland government agencies also assist.

In 2015, the Commonwealth and Queensland governments signed the *Great Barrier Reef Intergovernmental Agreement 2015*. This agreement provides an important framework for how the governments will work together to support research, investment and protection of the Great Barrier Reef.

The GBRMPA is the main agency that advises the Commonwealth Government on the management of the reef (see Figure 12.4.1). Other agencies assist in the management of the reef through various specialised roles, such as research, marine transport safety, fisheries and quarantine. Local councils manage areas along the coast adjacent to the reef. They have an indirect role in its management through their power to veto (reject) development applications and manage land use.

The Great Barrier Reef Marine Park covers an area of approximately 345 000 square kilometres. The park consists of all the waters below the average low-water mark, which is the water level at low tide. It also includes any islands in the park area that are owned by the Crown, that is, the Commonwealth Government. In addition, the park contains the seabed and below the seabed to a depth of 1000 metres and the airspace above the park to a height of 915 metres. These defined boundaries offer an important way to control mining, including oil exploration, and low-flying aircraft, such as helicopter joy flights.

Islands that are within the park but not owned by the Commonwealth are designated as Island National Parks and are protected by the Queensland Parks and Wildlife Service (QPWS). Around one-third of all the islands in the area are protected in this way. Only a handful of islands are privately owned.

Zoning

In 2004, the GBRMPA announced the creation of the Great Barrier Reef Marine Park Zoning Plan. This plan was developed to allow select human activities to take place within the park, while not degrading the overall ecosystem. For example, commercial fishing is permitted in only some parts of the reef, and tourist developments (such as pontoons) on the outer reef are permitted only in certain areas.

Nineteen detailed zoning maps have been created, covering all areas of the marine park. Each map outlines the types of activities permitted in the zone. The maps are available for free online, on an app and through local bait and fishing shops, as well as marinas and other tourist locations across the reef region. This zoning plan ensures that the reef will survive for future generations, while also allowing the present generation access to the resources of the reef in the most sustainable ways possible.

12.4.1 GBRMPA and Queensland rangers jointly manage the reef.

Strategies to manage shipping and boating impacts

The waters of the Great Barrier Reef Marine Park are part of a major shipping route along the east coast of Australia. Several major ports lie on the coast adjacent to the reef and these attract many cargo and cruise ships. The reef is also a major boating destination, with many recreational boats found within its waters at any given time. Therefore, careful management is required to minimise the risks associated with so many ships and boats operating within the waters of the reef.

12.4.2 A pilot arriving by helicopter to guide a huge bulk carrier through the Great Barrier Reef area.

Shipping regulations

Ships entering and travelling through the Great Barrier Reef are subject to very strict regulations. Specific shipping zones have been created to minimise the risk of ships striking parts of the reef and to keep them away from highly vulnerable areas.

Since 1991, ships that are 70 metres or longer and any ships carrying cargo of oil, chemicals or liquefied natural gas, must have a pilot to guide them through various parts of the reef that are considered high risk. A pilot (often known as a **sea pilot**) is a highly skilled mariner who has a deep knowledge of the areas that they guide the ships through, including currents, underwater obstacles and other risks that may cause ships to have accidents. The pilots use small boats or helicopters to arrive at and depart from the ships that they pilot through the reef (see Figure 12.4.2). Threats to the reef from shipping accidents are greatly reduced by the use of these pilots.

12.4.3 Public moorings are found throughout the reef, allowing boats to avoid using anchors.

Anchoring and mooring

Boat anchors can have a major impact on the reef. Numerous strategies have been adopted to reduce the impact of the thousands of boats that sail through the reef every year.

Zoning maps clearly indicate 'no anchor' zones in many locations across the reef. Floating markers are also installed in many of these areas and marine park rangers patrol and enforce the rules. The sheer scale of the park makes it impossible for all areas to be patrolled constantly, but education campaigns, maps and markers all help to maximise compliance.

Public moorings have been installed at many of these locations by the GBRMPA (see Figure 12.4.3). These moorings are permanently fixed to the seabed and allow boat skippers to secure their boats without the use of their anchors. Using the mooring prevents the damage caused by anchors and anchor chains dragging across the seabed.

12.4.4 Hamilton Island, within the Whitsundays region, has a very high concentration of tourists.

Strategies to manage tourism impacts

Tourism is the most intensive human activity carried out on the reef and can have many negative impacts on the ecosystem. However, tourism also plays an important role in educating people about this fragile ecosystem and why it needs to be protected. If carefully managed and regulated, tourism can be carried out in more sustainable ways that reduce its impacts.

A major issue in relation to the management of tourism on the reef is that it is very concentrated geographically. For example, about 85 per cent of all visitors to the reef visit the reefs around Cairns or the Whitsunday Islands (see Figure 12.4.4). These two regions represent just 7 per cent of the overall reef area. This means that hundreds of thousands of people visit these tiny areas of the Great Barrier Reef each year. This concentration places significant stress from tourism on these

parts of the reef. However, the strategy of concentrating tourism enables the marine park managers to regulate and monitor the industry by enabling them to concentrate resources in these high-tourist areas more easily.

12.4.5 The Eye on the Reef app

Tourist education

One of the aims of the World Heritage Convention is to promote education about the importance of environmental protection and the impact of human activities on ecosystems. This is a vital step in addressing global environmental issues. Every visitor to the reef pays a small fee, which is used by the GBRMPA to undertake education programs and to manage the ecosystem.

The GBRMPA also has an extensive citizen scientists program called Eye on the Reef. Visitors are encouraged to collect information about the health of the reef ecosystem and report this information back to the authority via an app. For example, the sightings program allows people to upload in real time sightings of species of interest to researchers and environmental managers. This provides extensive up-to-date data on the movements of many different species, such as dugongs, whales and turtles (see Figure 12.4.5). The app also contains educational material to help people understand the intrinsic, biodiversity, utility and heritage values of the reef. The app also contains the extensive zone maps, making them very accessible.

Management of tourism pontoons

Research also shows that most visitors to the reef are daytrippers, and most of these will spend some of their day on the reef on a floating pontoon (see Figure 12.4.6). These are large platforms that are usually anchored to the sea floor and act as a base for various activities, such as snorkelling and diving. Many pontoons are located on the outer reefs and tourists transit to them in large fast ferries. There have been several accidents involving pontoons, including the sinking of the Fantasy Island pontoon in 1988. In response, the GBRMPA will not approve a pontoon until the operator has completed a detailed environmental impact assessment.

Tourist boats and recreational fishing

12.4.6 Pontoons linked by ferries, such as this one, is how most tourists visit the reef

With thousands of recreational boats sailing through the Great Barrier Reef every week, management of tourist boats is a key issue for the GBRMPA (see Figure 12.4.7). Speed limits have been imposed and are enforced in many parts of the reef, to reduce the damage caused by the wake of boats. This is particularly important where boats travel close to shore. Other initiatives include an education program about the need to minimise pollution from boating. Television, radio and newspaper advertisements are used, along with information signs at boat ramps.

Strict rules around fishing are enforced across the reef. The zoning system clearly outlines where fishing is allowed and where it is prohibited. Rangers enforce these rules and penalties for fishing in prohibited areas include fines of more than $220 000.

Impacts on wildlife

Another concern with tourism relates to the disturbance of wildlife. Studies conducted in the 1990s found that breeding cycles in some seabird colonies were being disturbed by tourist activity. For example, seabirds on Michaelmas Cay, near Cairns, had stopped breeding due to the large number of tourists visiting the tiny island. The islands on which most birds breed are controlled by the QPWS. The service regularly assesses colonies and if one is found to be in danger, access to the island is reduced or stopped altogether. Many islands are now permanently closed to humans during the breeding season. The QPWS is working closely with tourist operators to limit access while ensuring tourists can visit the islands.

12.4.7 Rangers and park managers enforce boating and fishing rules throughout the marine park.

12.4.8 Strict rules regulate the popular tourist activity of whale and dolphin watching.

Whale and dolphin watching has become a popular tourist-related activity on the reef (see Figure 12.4.8). Both Commonwealth and Queensland laws have been enacted to ensure that whale-watching operators stay well clear of whales. Vessels must not approach a whale within 100 metres or 50 metres for a dolphin. If a whale or dolphin approaches the vessel, the captain must disengage the engine and not chase or follow the whale closely. A small but growing number of operators allow people to swim near the whales. A code of conduct has been established to ensure that this activity does not adversely affect the whales. This includes fully briefing swimmers on what they can and cannot do, and ensuring that swimmers do not swim towards whales.

Turtles are another major tourist attraction. The most common interaction between humans and turtles is on the small number of beaches where the turtles lay eggs. Nesting turtles can easily be disturbed by humans and a code of conduct has also been established for operators who specialise in turtle watching. The Commonwealth Government has protected turtles on the reef through the *Environment Protection and Biodiversity Conservation Act 1999*.

Improving water quality

The reef ecosystem is susceptible to degraded water quality from inland river systems. Water from inland rivers can be polluted by fertilisers, pesticides and animal waste from farms far away from the reef. Research consistently shows that the inshore fringing reefs are most at risk, but increasingly reefs further away from the shore are also impacted.

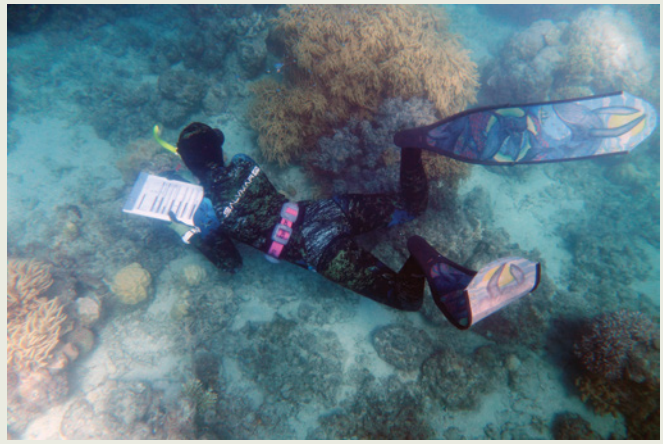
The Reef 2050 Water Quality Improvement Plan was drafted in 2017 to provide long-term management of water quality across the reef ecosystem. It covers not just the water on the reef itself, but also importantly deals with the land that makes up the river catchments that eventually flow out onto the reef. Among the plan's goals is an 80 per cent reduction in dissolved inorganic nitrogen, which is mostly derived from fertilisers used on agricultural land. The plan has also set a 50 per cent reduction target for sediment derived from soil erosion in the catchments.

SPOTLIGHT

The tourism industry as environmental managers

Tourist operators can play a key role in helping to manage the Great Barrier Reef. For the operators, a healthy reef is essential to their business and so there is a strong financial incentive for them to help protect the reef. The Tourism and Recreational Reef Advisory Committee (TRRAC) was formed by the GBRMPA to act as a liaison between the authority and the tourism industry. The TRRAC was established in its current form in 2014, but the GBRMPA has been seeking advice from the industry since 1999. The committee meets several times throughout the year and members represent a broad cross-section of the Great Barrier Reef tourism industry, scientists and government officials. Through the TRRAC, the tourism industry plays an important role in the management of the reef. It is in the best interests of the industry to protect the reef, as a degraded Great Barrier Reef would not attract tourists and therefore the industry would suffer.

Tourism Reef Protection Initiative was a $15.1 million program that ran through to mid-2024. Under this project, 26 different tourism operators were contracted to conduct observations and data collection activities across 95 reefs throughout the marine park (see Figure 12.4.9).



12.4.9 The Tourism Reef Protection Initiative involved tourist operators in collecting important scientific data about the reef.

The first water quality report card for 2020 was released in 2022. This report found that although water quality was still only considered moderate, there was an improvement across overall water quality. Pesticide risk was now rated as good across many of the river catchments of the reef.

Project Catalyst

There are many other community-based projects across North Queensland communities that aim to improve water quality across the reef. One such project is underway around the town of Tully, where sugar cane is the major crop. The WWF is working with 80 cane growers on a special program called Project Catalyst. The project aims to reduce the number of chemical pollutants coming off farms (see Figure 12.4.10). One initiative is to use organic cow manure as a fertiliser, replacing inorganic chemical fertilisers that release large amounts of nitrogen. The project, which has been in operation since 2010, is estimated to have improved 150 billion litres of water annually that flow out onto the reef.

12.4.10 Project Catalyst aims to reduce agricultural chemical run-off

Strategies for reducing the impacts of climate change

While climate change is by far the greatest risk to the longevity and biodiversity of the Great Barrier Reef, it is not a human-induced modification that can be addressed solely by actions from the managers of the Great Barrier Reef Marine Park. It is a truly global environmental issue that requires global actions.

At a local level, providing information and education about the risks associated with climate change and the actions that individuals can take, including applying political pressure and making more informed decisions as consumers, is one of the key strategies used by park managers. Government initiatives, prompted by increasing public pressure to reduce greenhouse gas emissions; for example, through net zero initiatives, are essential for reducing the impacts of climate change on the reef. (This is discussed in greater detail in Chapter 13 of *Global Interactions 11 Fourth Edition*.)

Strategies that involve First Nations Australians

There are more than 35 distinct Aboriginal and Torres Strait Islander nations which have important traditional links or connections to various parts of the Great Barrier Reef and its surrounds. Each of these groups has its own distinctive cultures and traditions.

Aboriginal people have lived along the Queensland coast and adjacent islands for thousands of years. Their traditional lifestyle is that of hunters and gatherers and they harvested both plants and animals from the region.

Torres Strait Islanders are seafaring peoples who occupy the islands of the Torres Strait. These islands separate mainland Australia from Papua New Guinea. Torres Strait Islander peoples have traditionally relied on fish and other marine resources for their survival.

Aboriginal and Torres Strait Islander peoples have, over thousands of years, developed management strategies that are sustainable. They only took enough resources from the ecosystem to satisfy their needs and, in doing so, did not disturb the dynamic equilibrium. There is much for contemporary managers to learn from these sustainable techniques as they strive to manage the reef today.

Today, the role of First Nations Australians in the management of the Great Barrier Reef continues. In 1992, the High Court of Australia ruled that First Nations Australians had rights over many of their traditional lands. The famous Mabo Case, in which Eddie Mabo, three other Meriam men and one Meriam woman, won rights over the Murray (Mir) Islands Group in the Torres Strait, established the concept of **native title**. Today, there are more than 70 Indigenous owner groups that have long and enduring relationships with the Great Barrier Reef. These groups have traditional lands along the Queensland coast adjacent to the reef and on the islands of the reef and the Torres Strait.

SPOTLIGHT

Indigenous women rangers win international environment prize

In 2020, The Earthshot Prize was founded by William, Prince of Wales, and a number of donors to support environmental projects that use innovative approaches to solving complex environmental problems. In December 2022, it was announced that one of the winners of the annual awards was the Queensland Indigenous Women's Ranger Network, receiving a $1.8 million prize.

The network was described by the Earthshot judges as an 'inspiring women-led program'. It aims to combine the deep and complex knowledge that First Nations peoples have, to protect the land and sea, with digital technologies. Female rangers working on the Great Barrier Reef are key members of the network.

The network creates a forum for First Nations female rangers to share their knowledge, experience and ideas with each other through digital platforms, as well as in more traditional meetings. This enables rangers who often work in very isolated and remote regions to connect with and support each other.

In awarding the prize to the Network, the judges hoped that it would enable more female rangers to be trained. Sixty female rangers, many whom work as reef rangers, have been trained, but this only represents 20 per cent of all Indigenous rangers working in Queensland. The judges also hoped that the Network would inspire similar initiatives to develop in other countries, especially in the developing world, using the knowledge and skills of Indigenous women to enhance the protection and sustainable management of the environment.

Traditional Use of Marine Resource Agreements

First Nations communities have special rights to use the reef and its resources to practise their cultures, which includes educating their children in customary laws and practices, and providing traditional foods for their families. These rights are established through special agreements between the traditional owners, the GBRMPA and the Australian and Queensland governments. Called Traditional Use of Marine Resource Agreements (TUMRA), the agreements aim to strike a balance between the customs and cultures of First Nations Australians and the protection of the reef environment. The TUMRA also aim to incorporate First Nations communities into the management of the reef. As of 2023, there were 10 agreements in place, covering 18 traditional owner groups, spanning large areas of the Great Barrier Reef Marine Park area.

12.4.11 First Nations Rangers play a key role in the management of the Great Barrier Reef.

Indigenous Reef Advisory Committee

The GBRMPA has also formed the Indigenous Reef Advisory Committee (IRAC). The committee meets regularly and has representatives from traditional owner groups and senior officials from government agencies. The role of the committee is to provide expert advice to the authority on conservation and ecologically sustainable use of the reef and its resources. The committee draws heavily on the knowledge of the environment that traditional owners have gained over thousands of years and blends this with contemporary science (see Figure 12.4.11).

Activities

Acquiring and processing geographical information

1 Summarise the role of governments in the protection and management of the reef.
2 Describe the size and location of the Great Barrier Reef Marine Park.
3 Describe the concept of zoning.
4 Explain how zoning assists in the management of the Great Barrier Reef.
5 Describe the importance of tourist education.
6 Summarise the purpose of the Eye on the Reef app.
7 How are tourist boats managed on the reef?
8 Describe how water quality is managed on the reef.
9 Describe the traditional relationship that Indigenous communities had with the Great Barrier Reef.
10 Outline the purpose of TUMRAs and Indigenous land use agreements.

Applying and communicating geographical understanding

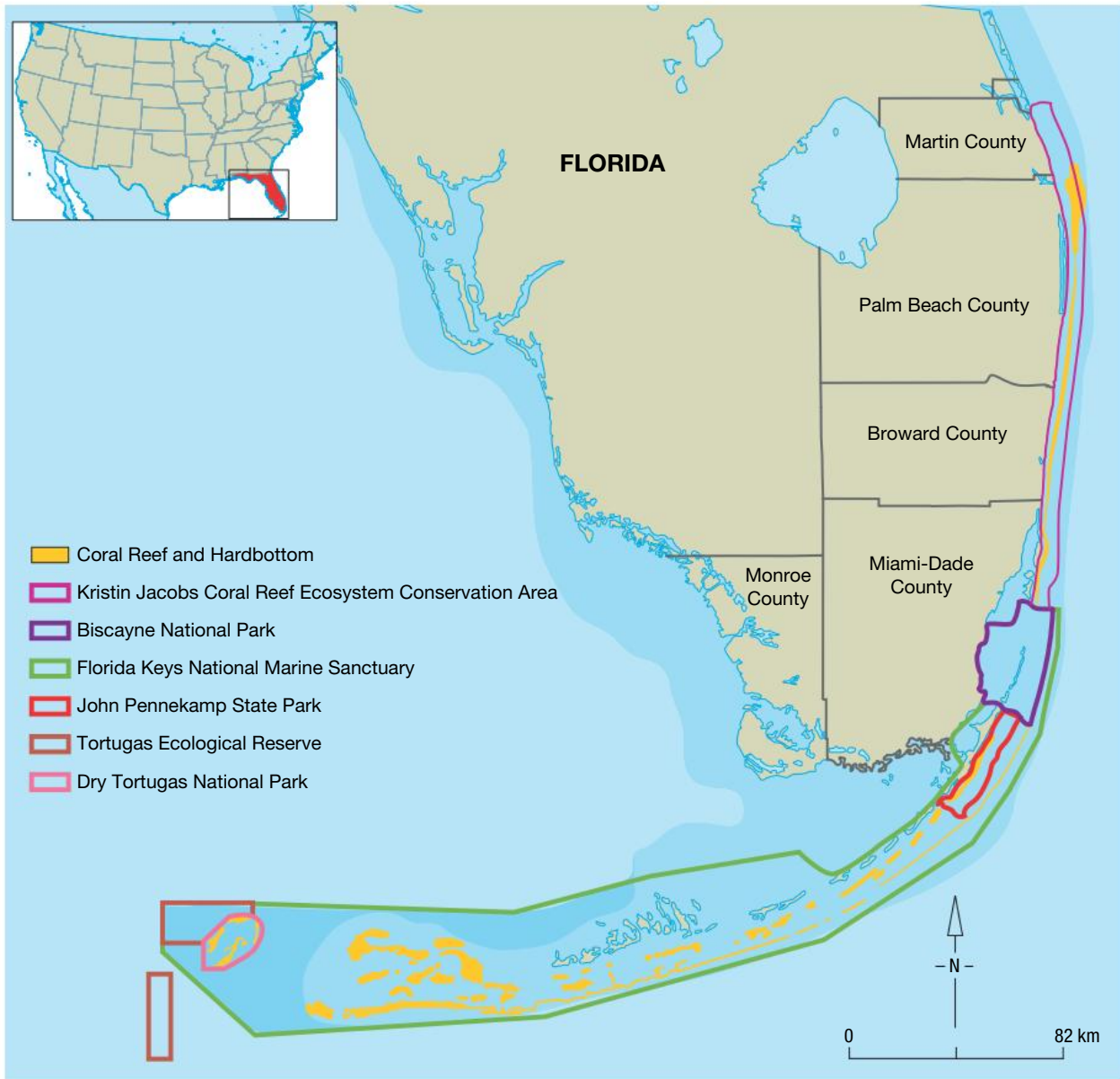
11 Write a brief report on the strategies used to manage shipping and boating across the reef.
12 As a class, discuss whether concentrating tourism activities into a small area of the Great Barrier Reef is a good idea. Write a paragraph response on your assessment of the strategy.
13 Write a short report on the strategies used to manage tourism operators across the reef.
14 Write a paragraph describing the reasons why the Queensland Indigenous Women Rangers Network was awarded an Earthshot Prize.

UNIT: 12.5

Differences in ecosystem management: Great Barrier Reef and the coral reefs of Florida

Florida is only place in the continental United States that has coral reef systems close to the coastline. The reefs in Florida are a special type of barrier reef. They are called barrier bank reefs, as they do not have the sheltered lagoons commonly associated with barrier reefs.

The reef has a large extent, stretching around 560 kilometres along the eastern and southern coasts of Florida, within the Atlantic Ocean (see Figure 12.5.1). The reef system is mostly contained within several different national parks, state parks and marine reserves. Florida's reefs have much in common with the reefs of the Carribean Sea, which lie further south.



12.5.1 Florida's coral reefs

Approximately two-thirds of the reef lies within the Florida Keys National Marine Sanctuary (FKNMS), which was declared in 1990. The sanctuary is administered by the National Oceanic and Atmospheric Agency (NOAA) and is jointly managed by NOAA and staff from Florida state agencies. The sanctuary covers an area of almost 10 000 square kilometres.

There are several similarities and differences between the strategies used in the management of the Great Barrier Reef and the reefs of Florida. These are due to economic, political and sociocultural factors.

Political factors

Like the Great Barrier Reef, Florida's reefs face many challenges due to human-induced modification. The greatest of these is climate change, and, as with the Great Barrier Reef, there is little that can be done to deal with this challenge at a local level by the reef managers. The political situation in the United States, which is the second biggest emitter of greenhouse gas emissions in the world, is very complex and divided on this issue. In late 2021, President Biden announced net zero emissions targets, but the political structure in the United States means that such commitments can be undone in the future.

One of the key differences between the management strategies used at the Great Barrier Reef and Florida's reefs is the structure of the managing agencies. As discussed throughout this chapter, the GBRMPA is the key coordinating agency for the management of the Great Barrier Reef. In Florida, the reef system is not managed as a single integrated ecosystem, but instead is managed in smaller fragmented sections by different agencies. Even within the FKNMS, which looks after the largest part of the reef, there are multiple agencies involved, although NOAA does have overall control. This fragmentation of the reef and its management reflects the political structures used within the United States. This means that there is a lack of overall management of the reef system and no coordinated approach. For example, human activities on land that impact the reefs are managed with only limited regard to the reef system. This is very different from the much more coordinated approach adopted by the GBRMPA.

Population pressures

A geographical feature of the Florida reefs is their proximity to densely populated areas. The Greater Miami metropolitan area had a population of almost 2.7 million at the last census, in July 2022. Florida is a key growth state within the United States (see Figure 12.5.2) and southern Florida has a rapidly expanding population and urban area. The environmental pressures on the reefs created by the urban population are significant. This is further complicated by the fact that most of the reefs are close to shore. This is quite different to the situation on the Great Barrier Reef and means that management of urban run-off is a key focus of much of the reef management in Florida.

12.5.2 Biscayne Bay and the skyline of Miami

Economic factors

It is estimated that as much as half of Florida's corals have been lost over the last four decades. Over-tourism has played a key role in this decline. Key West, at the very southern extent of Florida, is a good example of this. The city of Key West has a permanent population of only 23 000 people, yet more than 1 million people visit the city each year as tourists, most via cruise ships (see Figure 12.5.3). Florida is home to one of the largest cruise ship fleets in the world. There are six major cruise ship terminals in the state, and it is common for more than 40 cruise ships to be in Florida's waters at any one time. Many of these are the largest cruise ships in the world, with thousands of guests and crew on board.

The size and number of the ships take a toll on the reefs. Not only are there risks associated with accidents, but the plumes of sediment created by the ships' propellors in the shallow waters smother corals and disrupt breeding cycles for many reef species. The economic priorities of the industry have created challenges for reef managers to enforce greater regulations. While the Great Barrier Reef is also a major tourist destination and is a major shipping route, there is far greater regulation on the way ships transit through the reef than in Florida.

12.5.3 Cruise ships at the Port of Miami, one of six major cruise terminals in Florida

The economic value of tourism to Florida in 2023 was estimated at close to US$100 billion per year. It is one of the state's key sources of income and one of its major employers. The political and economic priorities are often in tension with the environmental protection of Florida's reefs.

A key strategy difference between the Great Barrier Reef and the reef in Florida is around access. While zoning controls are used in both locations, the purposeful concentration of all tourist activities on the Great Barrier Reef to just 7 per cent of its extent is not an approach used in Florida, where access is far greater. Obviously, the GBRMPA does have the advantage of a much larger area to use, as the reef is many times bigger than the reefs in Florida. However, there is far more open access to the reefs in Florida and this certainly complicates the management of the reef when it comes to compliance. The fragmentation of the reefs' management agencies also adds to this complication.

There is an economic imperative from each of the densely population communities along Florida's shoreline to exploit its reefs for tourism. A 2020 report found the reefs have an estimated annual tourism value of US$8 billion. Overfishing and souveniring of coral are two major human-induced modifications to Florida's reefs which are less significant on the Great Barrier Reef. This is partly due to the complexities of compliance and the easier access people have to Florida's reefs.

Activities

Acquiring and processing geographical information

1 Summarise the role of governments in the protection and management of Florida's reef.

2 Describe the location and extent of Florida's reefs.

3 Compare the management structures used on the Great Barrier Reef with those for Florida reefs.

4 Summarise how population growth impacts Florida's reefs.

5 Describe the nature and value of Florida's tourism industry.

Applying and communicating geographical understanding

6 Write a short report outlining the tensions between economic and environmental priorities in relation to Florida's reefs.

7 Select one management strategy used on the Great Barrier Reef. Using the internet, conduct research into whether this strategy is used in Florida. Compare and assess the two approaches used.

UNIT 12.6

Research and innovation in the sustainable management of the Great Barrier Reef

As discussed throughout this chapter, there are many challenges facing the Great Barrier Reef. Environmental managers and scientists from many agencies and universities, both locally and internationally, are engaged in extensive research and innovation to decrease the vulnerability of the reef system and enhance its resilience.

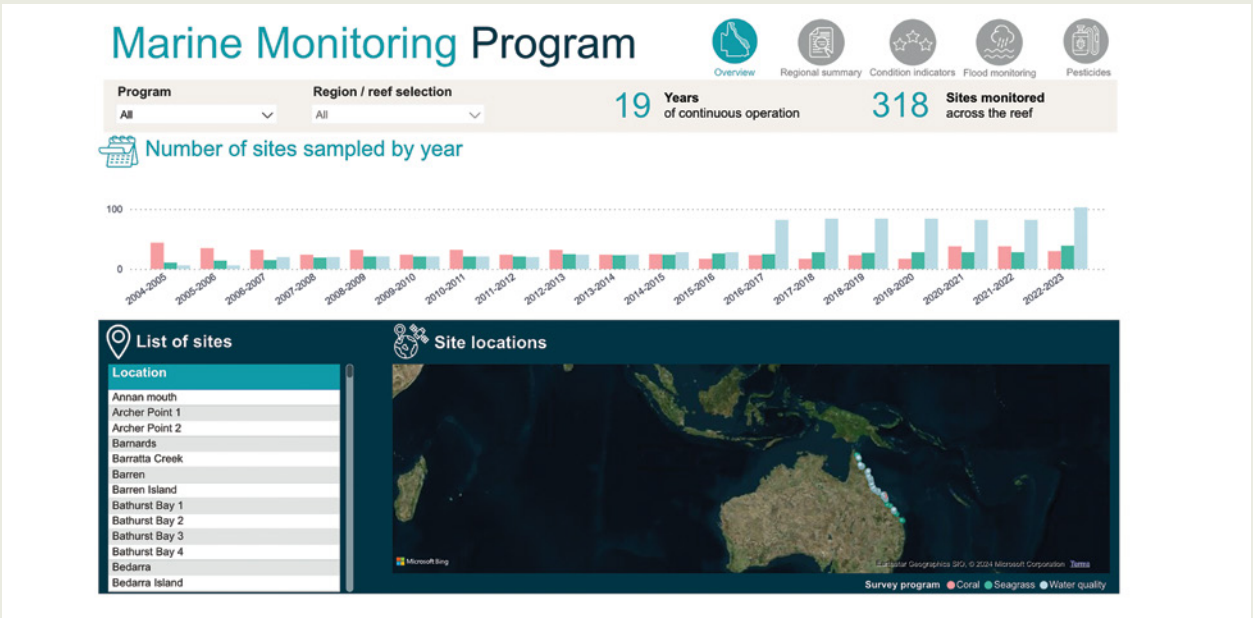
The Marine Monitoring Program

A key aspect of scientific research is to establish baseline data from which to assess impacts and the effectiveness of any management strategies adopted. Since 2005, the GBRMPA has been collecting, analysing and synthesising comprehensive data from across the reef. The Marine Monitoring Program examines data on water quality, coral health and the status of seagrasses. Across these three areas, information on freshwater inflows and the pollutants they carry is regularly measured. Extensive research is also carried out after extreme weather events, such as tropical cyclones. Research into habitat recovery from extreme events and from human-induced modifications gives researchers guidance on future management strategies.

SPOTLIGHT

The Marine Monitoring Dashboard

Launched in late 2022, the Marine Monitoring Dashboard (see Figure 12.6.1) is maintained by the GBRMPA and provides easily accessible data on the status and health of the inshore part of the reef. The dashboard draws on data from Marine Monitoring Program. The dashboard provides easy access to the reef's data from 2005 onwards, allowing researchers to study aspects of the reef in longitudinal ways. The dashboard records data across 318 sites and is searchable.



12.6.1 The Marine Monitoring Dashboard

12.6.2 Scientists monitoring coral seeding sites around the Keppel Bay Islands

Coral seeding programs

One of the key innovations in coral reef resilience is coral seeding. This is a relatively new innovation and Australia is a leader in its research and development. Coral seeding has great potential to assist in coral recovery after significant disturbance; for example, mass coral bleaching events and cyclone-induced damage (see Figure 12.6.2).

The process of coral seeding begins with scientists collecting wild corals from the reefs that are full of eggs and sperm. In the laboratory, the corals are monitored, waiting for them to spawn. Once spawning begins, the egg and sperm bundles are collected. The fertilised eggs are then reared until they reach the larval stage. They are then placed into specially designed plugs and allowed to grow into individual polyps. Once well-established on the plugs, the infant corals and plugs are attached to various coral seeding devices and returned to their home reef (see Figure 12.6.3).

12.6.3 Examples of coral seeding devices

SPOTLIGHT

National seas simulator

The National Sea Simulator, often referred to as SeaSim, is a special laboratory operated by the Australian Institute of Marine Science (see Figure 12.6.4). It opened in 2013, and in 2021 a significant investment of more than $36 million was announced to significantly increase the size and capacity of the simulator.

The simulator has large seawater tanks that enable scientists to manipulate key environmental factors; for example, adjusting temperature, salinity, turbidity and pollutants. Importantly, the simulator has facilities that are used for coral seeding projects. The simulator boosts scientists' capacity to better understand how the reef responds to various modifications and various strategies.

12.6.4 The National Sea Simulator, operated by the Australian Institute of Marine Science

International Coral Reef Initiative

The International Coral Reef Initiative was founded in 1994 with eight founding members, including Australia. Today there are now 90 members of the initiative representing 75 per cent of the world's coral reefs. While every reef is different and faces unique challenges, there are many that are common to all. For example, climate change and its impacts, such as coral bleaching, are common to virtually all reef systems globally.

The GBRMPA is a key contributor to the initiative. Through collaboration with environment agencies and scientists around the world, the initiative provides the managers of the Great Barrier Reef with greater resources to draw on. Similarly, as the managers of the largest and most complex coral reef system in the world, there is much that can be learnt from the diversity of management strategies used on the Great Barrier Reef, for reef managers elsewhere.

Activities

Acquiring and processing geographical information

1 Summarise the purpose of the Marine Monitoring Program.

2 Describe the process of coral seeding.

3 Under what circumstances is coral seeding thought to be a useful strategy?

4 Describe the benefits of the International Coral Reef Initiative.

Applying and communicating geographical understanding

5 Study the box, Spotlight: The Marine Monitoring Dashboard. Complete the following activities.

- **a** Explain the value of the dashboard to scientists and reef managers.
- **b** Access the dashboard at the link https://reefknowledgesystem.gbrmpa.gov.au/dashboards/marine-monitoring-program. Write a paragraph assessing the useability of the site and its value.

6 As a class, consider coral seeding. Discuss whether you think that seeding may provide a long-term solution to the major challenges facing coral reefs. Record the thoughts of the class using a graphic organiser.

CHAPTER

13 Ecosystem study: Fiordland of New Zealand

The Fiordland National Park of New Zealand is a spectacular ecosystem encompassing a wide variety of environments, both terrestrial and marine. Fiords are complex geological formations caused by the movement of glaciers. Fiords are not unique to New Zealand, and are also found in regions as diverse as Argentina, Canada, Greenland Norway, Scotland and the United States. Despite this dispersed geography, all these locations share a common heritage of being areas of considerable glacial and tectonic activity.

Fiordland is an area of global significance as it is one the best intact representations of the flora and fauna of the ancient supercontinent of Gondwanaland. New Zealand broke away from Gondwanaland long before the emergence of marsupials and mammals, which are absent from the endemic fauna of New Zealand. This has created a unique natural environment and Fiordland is one of the best-preserved examples of it in the country.

This chapter investigates the ecosystem of New Zealand's Fiordland region, its spatial patterns, its biodiversity, the dynamics of its functioning, and its vulnerability and resilience to natural and human-induced modifications. Human responses to and strategies for maintaining the Fiordland ecosystem functioning are examined, including a comparison of the management of the Great Barrier Reef and West Norwegian Fjords, and an exploration of the role of research and innovation in the sustainable management of New Zealand's Fiordland.

> **Fiordland, a vast tract of mountainous terrain that occupies the south-west corner of South Island New Zealand, is one of the most astounding pieces of land anywhere on God's earth and one's first impulse, standing on a cliff top surveying it all, is simply to burst into spontaneous applause.**
>
> **Douglas Adams, British author, humourist, screenwriter and travel writer**

13.0.1 Milford Sound, Fiordland, New Zealand

Chapter glossary

biosecurity measures that aim to prevent the introduction or spread of invasive species or diseases

carbon sink an accumulation or store of carbon

commercial fishing the catching of wild fish to sell

customary harvesting hunting and gathering by the traditional owners of an ecosystem

fiord underwater valleys that have been carved out by glaciers and then flooded by the sea

fjord the Norwegian spelling of fiord

glacier a massive body of slow-moving ice

Gondwanaland an ancient supercontinent that incorporated present-day Australia, New Zealand, South America, Africa, India and Antarctica

introduced species a species that has been introduced to an ecosystem either intentionally or inadvertently by humans

invasive species a species that is not endemic to an area, that invades and establishes itself there

iwi a Māori term that roughly translates to nation

landslide the movement downslope of material, such as rock and dirt

podocarp a type of broadleaved forest

recreational fishing catching of wild fish for sport or personal consumption

sedimentary rock rocks that are formed by the accumulation of materials which are then compressed under intense pressure

transform plate boundary a boundary between two tectonic plates where the plates are sliding past each other

tree avalanche a landslide caused the falling of a large tree on a steep slope

tree line the altitude above which endemic trees will not grow

UNIT 13.1

The characteristics of Fiordland National Park

13.1.1 Doubtful Sound, one of the fiords within Fiordland National Park

Fiordland National Park lies in the southwest corner of New Zealand's South Island. Its rugged, steep terrain, coupled with the incredible amount of rainfall the area receives, make it a challenging environment for humans to inhabit. No significant human occupation has ever taken hold across the region. The Indigenous peoples of New Zealand, the Māori, named this region Te Rua-o-te-moko, which translates into English as shadowlands, no doubt reflecting the shadows cast by the enormous cliffs of the **fiords**. Few Māori ever lived permanently within Te Rua-o-te-moko. Instead, it tended to be a place of seasonal visitation for food gathering. The Fiordlands National Park contains diverse landscapes, including alpine, lake, fiord and cool temperate rainforest.

The most dominant feature of Fiordland is its namesake, the fiords (see Figure 13.1.1). These are underwater valleys that have been carved out by **glaciers**—vast moving bodies of ice. Fiords are typically narrow and have steep-sided mountains alongside them. When sea levels rose after the last ice age, the valleys flooded with seawater, creating the fiords.

● SPOTLIGHT

Fiord, fjord, sound or loch?

It is common to see the spelling **fjord**. This is the Norwegian spelling of the word and widely used around the world as Norway's fjords are among the most famous. Fiord is the English spelling and is used throughout the chapter, except when specifically referencing the Norwegian fjords.

A confusing element of the fiords of New Zealand is that many of them are called sounds, for example, Milford Sound and Doubtful Sound. Is a sound another name for fiord? Technically no; while a fiord is a geological feature created by glacial action, a sound is a flooded river valley. Hence a fiord is a valley that was created by a glacier that floods, whereas a sound is a valley that is created by a river that floods—these are also sometimes called a ria. Sydney Harbour is in fact a ria. New Zealand's sounds are therefore misnamed; they should technically have the name fiord not sound. The term sound also has its origins in Norway, coming from the Old Norse word sund, which means swimming.

Even more confusingly, two of the fiords in Fiordland are called inlets, Chalky Inlet (see Figure 13.1.2) and Preservation Inlet. These are also incorrectly named as they were also created by glaciers and are therefore fiords.

To make this even more confusing, there is also the term loch, which is used in Scotland to describe a fiord. The most famous of the Scottish fiords is Loch Ness—said to be home to the mythical Loch Ness Monster. Lochs are the same as fiords, in that they are a creation of glaciers.

13.1.2 Chalky Inlet, despite its name, is a fiord.

Spatial patterns

Fiordland National Park is located in the south-west corner of the South Island of New Zealand (see Figure 13.1.3), known as Te Wahipounamu in the Māori language. Covering an area of more than 12 000 square kilometres, Fiordland is the largest national park in New Zealand. The park lies within and makes up the most significant portion of the Te Wahipounamu World Heritage Site, which extends beyond the park's northern boundary to include three other national parks.

13.1.3 Fiordland National Park

13.1.4 Dusky Sound, the largest of the fiords in Fiordland

13.1.5 Forests cling to the steep slopes of Doubtful Sound.

13.1.6 Temperate rainforests with a complex understorey grow in the wetter areas of Fiordland.

The park stretches in a north-to-south direction down the western coastline for around 200 kilometres and contains 15 fiords that flow out into the Tasman Sea. Dusky Sound, located on the southerly portion of the coastline, is the most complex of the fiords (see Figure 13.1.4). It stretches inland from the coast for around 40 kilometres and is 8 kilometres at its widest. Sutherland Sound in the north is the smallest of the fiords. A large sandbar across its mouth makes it the only fiord along the coast that does not have easy access to the sea.

Biodiversity of Fiordland

Fiordland National Park is rich in biodiversity and is one of the most intact natural environments in New Zealand, and indeed the world. The biodiversity of Fiordland reflects the wide variety of natural environments found within the park. This diversity includes forest, marine, lake and alpine environments.

The climatic conditions in Fiordland are extreme. The average annual rainfall across the park is an astonishing 7 metres (7000 millimetres) per year. By way of contrast, Dunedin, which lies on the east coast of the South Island at a similar latitude to Fiordland, receives less than 700 millimetres per year. This very high rainfall is one of the key factors in the creation of the unique environment of Fiordland.

The park's biodiversity extends across the habitat areas of forest, alpine and marine zones, including its birdlife.

Forest areas

The dominant forests of Fiordland are the beech and **podocarp** forests. The podocarp family of trees, including rimu, miro and Hall's totara, often grow on the steep mountainsides that lie adjacent to the fiords (see Figure 13.1.5). They have only a thin layer of soil in which to anchor themselves and so-called **tree avalanches** are common in high winds and rainstorms.

Beech trees are among the most common tree species within Fiordland. Red and mountain beech are found growing in large stands around the lakes that dominate the eastern part of the park in the Eglinton Valley. In wetter areas, a complex understorey of smaller trees, shrubs and tree ferns are found, along with mosses and lichens (see Figure 13.1.6). These ancient forests are globally significant as remnants of the types of forests that once dominated the supercontinent of Gondwana.

Alpine areas

A large portion of Fiordland's terrestrial area is dominated by alpine areas. In New Zealand, an alpine area is defined as the area between the upper limits of trees and the lower limit of permanent snow. In most parts of Fiordland, the **tree line** is at around 900 metres. The tree line is the altitude above which endemic trees can no longer grow. In New Zealand the tree line is often referred to as the bush line.

The highest mountains within Fiordland are found in the Darran Mountain range, which is in the northern part of Fiordland (see Figure 13.1.7). At 2723 metres,

13.1.7 The Darran Mountains are the highest of the alpine zone in Fiordland.

Mount Tūtoko is the tallest mountain in the range. Another important alpine region lies in the south of Fiordland—the Murchison Mountains. These are smaller, with the highest being Mount Lyall at 1892 metres in altitude. These mountains are rugged and isolated.

At altitudes above 900 metres, forests give way to alpine vegetation, which are slow-growing, ground-hugging plants that typically grow up to altitudes of 1500 to 1600 metres in Fiordland's alpine zone. Alpine herb fields, alpine daisies and buttercups are found here (see Figure 13.1.8). Alpine vegetation is highly adapted to live in the harsh conditions above the tree line. It must cope with extreme cold and high winds. In summer, temperatures can be high and there are extended dry periods. Additionally, alpine vegetation often grows in poor soil conditions. These hardy plants have short growing seasons and typically have well-developed root and/or rhizome systems, where they store energy to survive once they are snow-covered in winter. Alpine plants are typically small, in response to the limited resources available to them. They also grow low to the ground to protect themselves from the wind.

13.1.8 Alpine daisies and other alpine herbs grow above the 900-metre tree line.

In the alpine zone, small birds, such as the pīwauwau, and insects, are the dominant fauna. Several **introduced species** also inhabit these regions, including stoats and tahr, which have significant negative impacts on the zone's ecology.

Marine areas

Fiordland's marine environment is complex and unique. Here again, the high rainfall of the region plays an important role. There is extensive run-off from the forest regions that feeds into the streams that make their way into the fiords and lakes. This run-off is stained by the tannin produced by the vegetation, creating a water colour similar to that of strong black tea.

As the tannin-stained freshwater enters the fiords, it does not mix well with the saltwater, creating a dark layer on the surface. This darkened surface layer reduces sunlight penetration to the lower depths. This means that light-sensitive species, which normally live at considerable depths, are typically confined to within the top 40 metres of the fiords. The deepest fiord is Doubtful Sound, which plunges to depths of more than 400 metres at its deepest point.

Within the 40-metre depth range, the water is calm and relatively warm, and is home to cool water corals, sponges and numerous fish species, including some that are more often associated with sub-tropical regions. Significant colonies of Fiordland black coral, about 7 million colonies, are found throughout the fiords (see Figure 13.1.9). These corals are white while alive, but turn black once dead and are commonly found washed up on the shoreline in their black state. Some colonies of black coral are thought to be more than 200 years old, and the Fiordland colonies are unusual in that they grow as close as 15 metres to the surface, whereas they are typically deep-sea growing corals elsewhere. Another soft coral, known as yellow zoanthid, is also found in the fiords and often grows in banks together forming walls. Sponges, sea dragons, crayfish, molluscs and tubeworms are all common across the waters of the fiords.

13.1.9 Fiordland black coral

The waters of Fiordland are also home to brachiopods. These are primitive clam-like animals. Like the ancient forests of Fiordland that date back to **Gondwanaland**, the brachiopods are also ancient, having remained unchanged by evolution for more than 300 million years.

There are several larger marine animals that inhabit the fiords. These include bottlenose dolphins, which are attracted by the rich feeding grounds provided by the fiords. Similarly, sizeable populations of New Zealand fur seals live on the rocky shores of the fiords. Recent research estimates that as many as 24 000 individual fur seals inhabit the fiords. Colonies of Fiordland crested penguins (see Figure 13.1.10), an endemic species to Fiordland, are found within the fiords, along with colonies of the more common little penguin.

13.1.10 The Fiordland crested penguin

The Fiordland crested penguin, or tawaki, is one of the rarest penguins in the world, and is only found in the south-west of the South Island and some of

the outer islands. It is considered vulnerable, with only 2500–3000 nesting pairs left in the world. The number has stabilised, and intensive research has indicated that the population may be slowly growing, but careful management is essential for their survival.

Birds of Fiordland

New Zealand broke away from Gondwanaland more than 60 million years ago and became isolated, allowing a unique process of evolution to take hold. No terrestrial mammals or other ground predators exist in New Zealand (other than introduced species), and birds have become the dominant fauna (see Figure 13.1.11). Free from predators on the ground, many of New Zealand's birds, including the iconic kiwi, have lost the ability to fly. With the arrival of humans and their animals in New Zealand, believed to be during the thirteenth century, many of the bird species went into decline. The isolation and limited human modification of Fiordland has made it a haven for many endangered native bird species.

Did you know?

Proportionate to body weight, Kiwis lay one of the largest eggs in the bird world. Kiwi eggs often weigh up to one-third of the female's body weight.

Kākāpō
The kākāpō is the world's only flightless parrot. It is also the world's rarest and heaviest parrot. This incredibly endangered species is now only found in small populations on islands of Fiordland, such as Anchor Island, located within Dusky Sound, and in some captive breeding sanctuary and zoo programs. Sometimes confused for owls, the kākāpō can weigh up to 3 kg and is nocturnal. Although now displaced, the kākāpō's preferred habitat is in the beech and podocarp forests, but they are highly adaptable and were once found in the alpine regions as well. They are an entirely herbivorous species, living mostly on leaves, seeds and rhizomes.

Kiwi
The most iconic of all New Zealand's native animals, the kiwi is a flightless, ground-dwelling species. It is mostly nocturnal, and is generally found in podocarp and beech forests, where they use their highly sensitive, long beak to hunt out worms, grubs and seeds. They will also consume eels, small frogs and even crayfish. While there is no active management of kiwis within Fiordland, steps are underway to reduce feral species that compete with the kiwi.

Takahē
The takahē is one of the rarest birds in New Zealand and was in fact thought to be extinct until a small population was discovered in Fiordland. It is a sizeable flightless bird typically weighing around 2 kg. Its preferred habitat is the swampy regions. The common name for the species is swamp hen. Active management and captive breeding programs have assisted in the partial recovery of the population to around 420. The most significant populations are found in the rugged Murchison Mountains in the southern part of Fiordland.

	Mōhua Often referred to as the yellowhead due to its vibrant yellow plumage, this once common bird is now confined to small populations in Fiordland and some islands. They are small, about the size of a sparrow, and hunt insects. They are known for their musical songs. Today they are found in the beech forests, often in more isolated areas where there is less competition from introduced species.
	Pīwauwau Sometimes called the rock wren, this is a rare species of small bird that inhabits the alpine region of Fiordland. They inhabit rocky areas above 900 m but below 2500 m, where they feed mostly on insects.

13.1.11 Key bird species of Fiordland

Activities

Acquiring and processing geographical information

1 Describe the location of Fiordland National Park.
2 Describe the spatial patterns of Fiordland.
3 Describe the nature of the podocarp forests of Fiordland.
4 Define the term tree line.
5 Describe the growing conditions for plants above the tree line.
6 Explain how alpine vegetation has adapted to the living conditions where it is found.
7 What is the source of tannin in the waters of Fiordland?
8 Explain the role of tannin in the marine environment of Fiordland.
9 Briefly describe the main aspects of the biodiversity of Fiordland's marine environment.
10 Explain why many birds in New Zealand have become flightless.

Applying and communicating geographical understanding

11 Study the box, Spotlight: Fiord, fjord, sound or loch? Write a short paragraph explaining the difference between a sound and fiord. How are the sounds of Fiordland misnamed?
12 Write a short report on how the high rates of rainfall impact on the character and biodiversity of Fiordland.
13 Hold a class discussion on the topic, 'Why has Fiordland become a refuge for many endangered and vulnerable species?'

UNIT 13.2

The dynamics of ecosystem functioning in Fiordland

13.2.1 The Southern Alps of New Zealand

A complex set of interactions between the four spheres of the biophysical environment have resulted in the unique ecosystem of Fiordland. As in every ecosystem, each sphere plays a crucial role in the functioning of the Fiordland ecosystem, allowing it to develop the resilience needed to overcome the factors that make it vulnerable.

Geological processes

Fiordland National Park is the result of complex geological forces that stretch back millions of years. Around 400 million years ago, the whole of Fiordland, including its alpine regions, was a flat sea floor. Layer upon layer of sediment was deposited over the sea floor, compressing it into **sedimentary rock**. So much sediment built up that geologists estimate parts of the Eglinton Valley found in the eastern part of Fiordland had sedimentary rock over 12 000 metres thick before erosive forces began to wear it down.

Massive tectonic forces, resulting from the collision of the Indo-Australian and Pacific tectonic plates, have played a major role in the formation of New Zealand and Fiordland. Over millennia, the sea floor was subject to uplift, bringing it above the water line, and then to periods of submergence, when it sunk back down again. The extensive mountain ranges of New Zealand and, in particular, the Southern Alps (see Figure 13.2.1) are the result of these tectonic forces. Today, the Alps effectively divide the western part of the South Island, including Fiordland, from the flatter and drier eastern portion.

Glaciation

Around 100 million years ago, the process of glaciation began to shape the landscape of Fiordland. Glaciers are enormous bodies of very slow-moving ice over centuries. They are made up of fallen snow that gets compressed into ice over centuries. As the weight of the compressed snow grows, the force of gravity takes hold and the glacier begins to move outwards and downwards. As the glacier moves, its sheer weight and size makes it a powerful erosive force, carving out deep valleys.

In the last ice age, glaciers covered much of Earth's surface. Today, they are confined to some alpine regions and the polar and sub-polar regions. There are still around 3000 glaciers in New Zealand, including the significant Fox (see Figure 13.2.2) and Franz Joseph glaciers, which lie around 200 kilometres north of Fiordland. Most of the glaciers in New Zealand are small, and most of them are in retreat, meaning they are shrinking in size due to melt.

A moving glacier can eventually make its way to the sea, leaving an extremely steep-sided valley that can be hundreds or even thousands of metres deep (see Figure 13.3.3). As the glacier gradually melts into the ocean, water can inundate the valley, creating a fiord. All fiords worldwide are created in this way. Where water now sits, was there once a huge body of moving ice.

13.2.2 Fox Glacier on the west coast of New Zealand's South Island

13.2.3 Milford Sound is typical of many fiords, with extremely steep sides.

It is common for a fiord to have a sill, or a step, near the mouth that leads into the ocean. The sill marks the terminal moraine—this is furthest point of advance of a glacier and is marked by a build-up of debris. Imagine the glacier is like a bulldozer that has stopped, and the terminal moraine is the material that is being pushed by the blade of the dozer. At Milford Sound the sill lies at a depth of around 27 metres, but the ocean and the fiord on either side of the sill plunges to more than 300 metres in depth. The sill plays an important role in the movement of water into and around the fiord. The sill effectively blocks much of the ocean swell from entering the fiords, creating calming waters within the fiord. This helps to encourage more fragile species, such as the soft corals and sponge beds, which are found in many fiords.

Vulnerability and resilience

Fiordland is a complex ecosystem encompassing a number of different environments, each of which is unique. It is a highly dynamic ecosystem, especially its marine environment and in the way that tectonic forces affect the region.

Vulnerability relates to how easily an ecosystem can be altered by naturally occurring or human-induced stresses. Resilience, on the other hand, is the ability of the ecosystem to cope with these changes, or stresses, and recover. Fiordland faces both natural and human-induced stresses. Like most ecosystems, it has evolved over hundreds of thousands of years to deal with most natural stresses, giving Fiordland high levels of resilience. However, Fiordland is less resilient to human-induced stress.

As outlined in Chapter 11 (see page 320), there are three main factors that cause ecosystem vulnerability: location, extent and biodiversity. Each of these factors must be considered in a discussion of Fiordland's vulnerability and resilience.

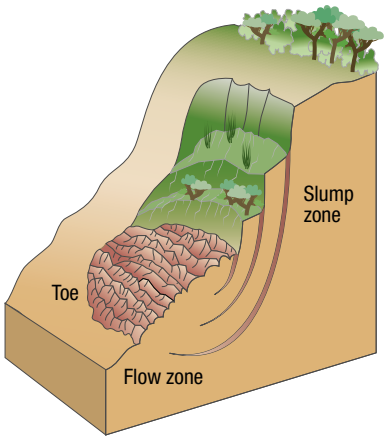
For example, the location of Fiordland in a tectonically active area means that it is vulnerable to earthquakes, and the **landslides** they can create. However, the relative isolation of Fiordland has played a key role in minimising human development across the national park and this has allowed the ecosystem to retain much of its ecological integrity, enhancing its overall resilience.

Atmospheric and hydrospheric processes

As already noted, Fiordland is one of the wettest places in the world. Westerly onshore winds gather moisture in the Tasman Sea and the Southern Ocean. As these winds strike the Southern Alps, they deposit a huge volume of rainfall across the west coast of New Zealand's South Island and in particular, Fiordland.

The high rates of rainfall and steepness of the topography of Fiordland make landslides a significant threat throughout Fiordland. A landslide is defined as the movement of rock, soil, vegetation and debris down a sloped section of land. Areas of great steepness are at greater risk of a landslide than flatter topography. Landslides occur due to a lack of stability in the slope itself. This can be caused by tectonic forces, such as an earthquake, a loss of vegetation, particularly roots that would otherwise bind the soil together, or, the most common cause, water.

Excess water mobilises the layers of soil, weakening the bonds that hold the soil together to the point that eventually the erosive power of the water combines with the forces of gravity and the soil begins to slide down the slope. This type of landslide is often referred to as a slump or landslip (see Figure 13.2.4). As the matter slumps, the vegetation that was growing in the slump zone and in the flow zone is destroyed by the movement. Such landslides are common throughout Fiordland and have an impact, especially on the podocarp forests that favour the steeper slopes in and around the fiords.



13.2.4 Dynamics of a slump landslide

An intense period of rainfall in the winter of 2015 saw a series of landslides occur across Fiordland. One of the most significant occurred near Deep Cove, part of the Doubtful Sound fiord. The landslide damaged the only road, trapping a group of primary school children and teachers who were on a school camp. The landslide resulted in significant damage to human infrastructure and a significant loss of forest.

Similarly, in 2020 heavy rains led to a significant landslide in the Eglington Valley, east of Milford Sound. This landslide destroyed several buildings at Gunn's Camp, a historic holiday camp.

Although north of Fiordland, a series of massive landslides in 2018 and 2019 near Fox Glacier are indicative of the potential impact of landslides. More than 90 million cubic metres of material was moved in these landslides following periods of heavy rain. The Alpine Gardens landslide accounted for 50 million cubic metres of materials moved at the time of the landslide and over the next 12 months, due to erosion.

TREE AVALANCHES

A feature of Fiordland is the prevalence of tree avalanches. This is where a falling tree causes a cascading effect of other trees and soil to become mobilised in a special type of landslide. On the steep sides of the fiords, the podocarp forests cling to the rocky surfaces with shallow root systems in the sparse soil.

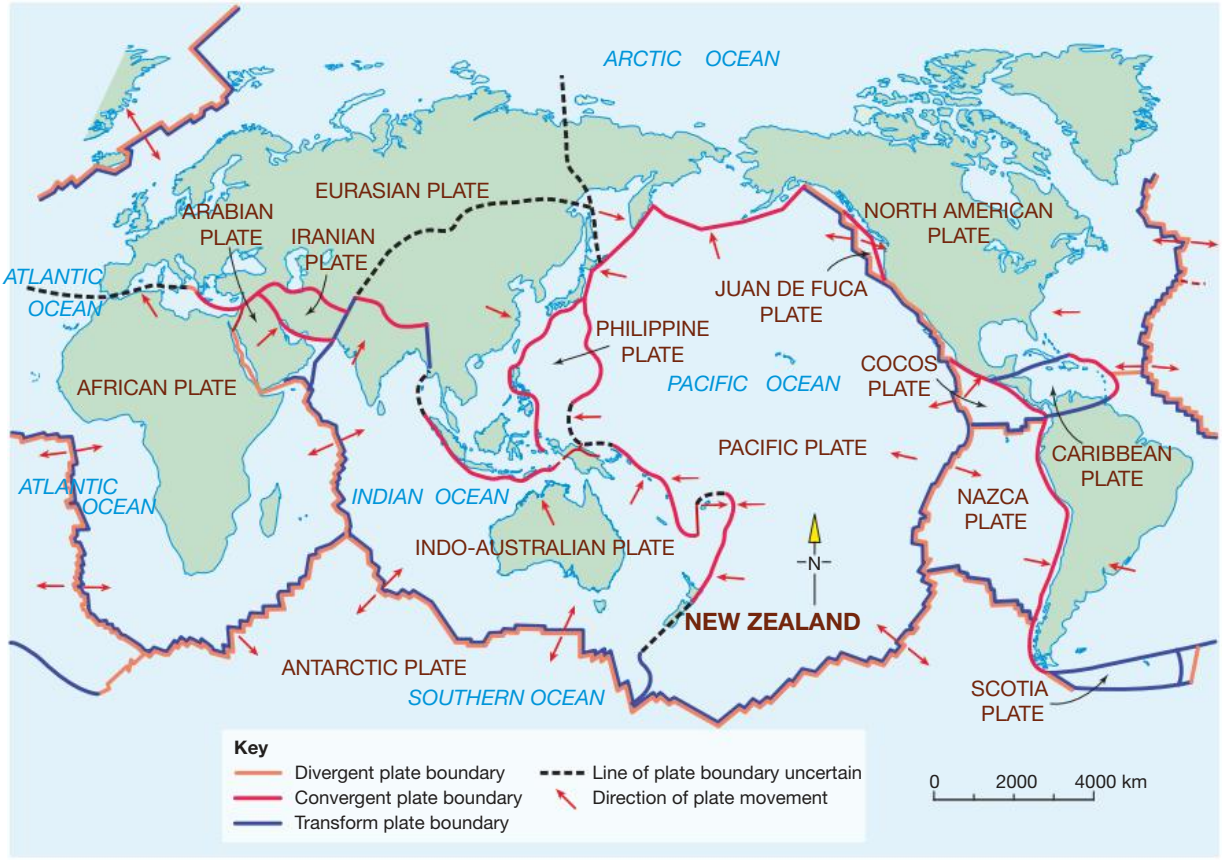
During periods of heavy rain, as the soil becomes saturated it is not uncommon for a tree to topple, triggering a whole series of tree falls. These tree avalanches leave deep scars in the podocarp forests and are visible throughout Fiordland (see Figure 3.2.5).

13.2.5 Scar from a tree avalanche, Doubtful Sound

While the high rates of rainfall and steep topography make Fiordland vulnerable to landslides and tree avalanches, the forests are generally resilient to these stresses. However, research does show that the nature of the forest as it regenerates from a slide is different. For example, ribbonwood trees, which are more commonly associated with lowland areas, are often found growing in the debris fields (or landslide toes) left from landslides. There is also an increase in lower-growing shrubs, such as the tree fuchsia and carpodetus serratus, within the landslide zone. These are able to grow due to the increased light available after the loss of the dense forest canopy. This creates opportunities for other endemic species to gain a foothold.

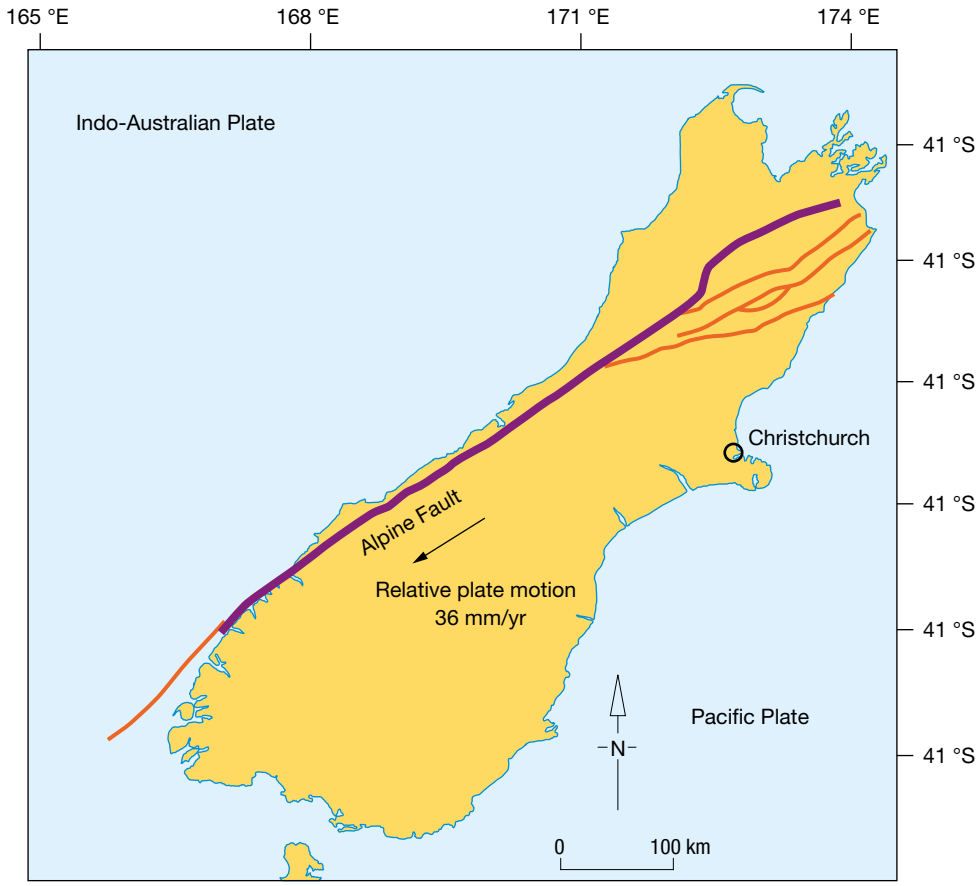
Geomorphic processes

New Zealand is sometimes called the Shaky Isles due to the frequency and intensity of earthquakes and other tectonic forces, such as volcanoes. New Zealand lies on the boundary of the Pacific and the Indo-Australian plates (see Figure 3.2.6). A **transform plate boundary** lies across most of the country. This type of boundary is where the two plates slide past each other, and is often associated with earthquakes.



13.2.6 New Zealand lies on the boundary of the Pacific and Indo-Australian tectonic plates.

A major fault line, called the Alpine Fault, extends around 600 kilometres in a north–south direction down the South Island (see Figure 3.2.7). This fault meets the coast at Milford Sound in northern Fiordland and is responsible for the mighty Southern Alps range. The fault is highly active; over its history, the earthquakes generated along the fault line have had magnitudes of around 8 on the Richter scale.



13.2.7 The Alpine Fault runs through New Zealand's South Island for around 600 kilometres and is highly active.

Although only identified in the 1940s, the Alpine Fault is now extensively studied as it represents such a significant threat. There is evidence indicating that over the last 900 years the fault has ruptured four times, producing earthquakes of around magnitude 8 each time. The last significant rapture of the fault took place in 1717. Prior to this there were large quakes in 1620, 1450 and 1100. New Zealand's Institute of Geological and Nuclear Science (GNS Science) predicts that there is a high probability of a rupture of the fault by the 2070s. Such an earthquake would likely be one of the most significant earthquakes in New Zealand since European settlement in the eighteenth century. Researchers from Victoria University of Wellington estimate that there is more than an 80 per cent chance that an earthquake along the Alpine Fault would have a magnitude of at least 8.

An earthquake along the southern section of the Alpine Fault near Milford Sound would be less damaging to human infrastructure, due to the lack of human development there compared to other areas of the South Island. However, a quake along the fault would have significant effects on the biophysical environment of Fiordland.

A magnitude 7.1 earthquake in 2003 in Fiordland provided an indication of the impact that a stronger earthquake would cause. The earthquake's epicentre was near Doubtful Sound and geologists estimate that at least 200 major landslides were triggered by the quake. This included seven major landslides that extended from the summit to the valley floor, each covering a vertical distance of around 1500 metres.

● SPOTLIGHT

The Green Lake landslide

The Green Lake landslide was an ancient landslide that occurred between 12 000 and 13 000 years ago. It provides an example of the potential impact of a large earthquake along the Alpine Fault. The landslide is believed to have been the biggest in New Zealand and is possibly the largest ever on Earth.

The size of the landslide is a staggering 45 square kilometres, with a volume of around 27 cubic kilometres (see Figure 13.2.8). The landslide was trigged by an earthquake, which resulted in the collapse of a 9-kilometre segment of the Hunter Mountains to the east of Dusky Sound in southern Fiordland. It is estimated that the landslide moved material over 700 metres vertically and the toe of the landslide measured more than 800 metres in height, creating a dam that caused water to build up behind it, leaving behind Green Lake.

A landslide of this scale has catastrophic consequences for the biophysical environment, radically altering the landscape and destroying huge swathes of forest, riverine and other ecosystems. Researchers believe that there is at least a 50 per cent chance that a large landslide associated with a major earthquake will occur by 2070.

13.2.8 The Green Lake landslide zone

The risk of landslides associated with major earthquakes along the Alpine Fault represents the greatest threat to the natural environment of Fiordland. However, there are also some risks associated with the potential for a tsunami to occur along the coastline. There is limited resilience that any ecosystem can develop that would allow it to cope with such a sudden and severe impact. However, Fiordland has a long history of violent geomorphic activity and yet the ecosystem continues to thrive and survive, indicating its overall resilience.

It is important to note that although there has not been a major rupture of the Alpine Fault since European settlement of New Zealand, the extent and biodiversity of the ecosystem is now quite different from the pre-European era. For example, there are several species for whom Fiordland now represents their final wild refuge and they are of course incredibly vulnerable to any significant events that would dramatically alter the functioning of the ecosystem.

Biological factors

There are several vulnerabilities within the Fiordland ecosystem that stem from the biosphere. Naturally occurring diseases are one such threat. Several fungal diseases occur in the podocarp and beech forests. While these are not widespread within Fiordland, they have been a serious concern in other parts of New Zealand and pose a risk to Fiordland.

Phytophthora agathidicida, commonly known as kauri dieback disease, is one such threat. The kauri trees within the podocarp forests are susceptible to this disease, which is transferred through soil. At present, due to good control measures, such as education

campaigns to ensure people clean their boots of dirt from other locations, there has been limited spread of the disease within Fiordland. Similarly, the relative inaccessibility of much of Fiordland has helped to keep other diseases and pests, such as beech buprestid, largely at bay. The larvae of this insect species which is native to New Zealand, can attack already stressed trees; for example, those damaged in storms, and affect the health of the trees.

The alpine vegetation of Fiordland is highly adapted to the challenging and inhospitable alpine environment. The vegetation here is highly adapted to occupy the niche environment that exists above the tree line. Like all specialised species, this increases the vulnerability of the alpine vegetation. Its slow-growing rates and susceptibility to even small changes in climate make this part of Fiordland's ecosystem one of the most vulnerable (see Figure 13.2.9). For example, studies from around the world show that even relatively minor damage caused by hikers trampling alpine vegetation can have significant impacts on the vegetation due to its slow growth rates. A study conducted in the Australian Alps found that species diversity was greatly affected by trampling and this reduced the resilience of large areas. This study also found that soil compaction was a major threat to alpine vegetation. Similar outcomes are found in the alpine regions of Fiordland.

13.2.9 Fiordland's alpine vegetation is vulnerable to even small impacts.

Ecological disturbance

Ecological disturbances are events or forces that cause the death of organisms within an ecosystem. They can be biological, such as, a disease, or nonbiological, such as a natural disaster. Ecological disturbances change the spatial patterns of populations of organisms within an ecosystem and therefore can change the nature and character of the whole ecosystem.

Fiordland faces ecological disturbances from both biological and non-biological factors. While there are some naturally occurring threats to specific species, such as Kauri dieback disease, the most significant biological threat stems from introduced species which can radically alter the landscape, deny endemic species of habitat and disrupt food webs. These are species that have been introduced by humans and are one of the main modifications of humans on the functioning of Fiordland as an ecosystem. This is discussed in greater detail in Unit 13.3.

The greatest risk of widespread ecological disturbance stems from geomorphic events. Landslides associated with earthquakes along the Alpine Fault constitute a major risk to the ecosystem. As evidenced by the ancient Green Lake landslide, such events can occur over a large scale and have ecosystem-changing consequences that can cause significant ecological disturbance.

Activities

Acquiring and processing geographical information

1 Describe what a glacier is.
2 Explain how a glacier creates a fiord.
3 What is a terminal moraine?
4 Define the terms vulnerability and resilience as they relate to ecosystems.
5 Explain the impact of high levels of rainfall on the geomorphology of Fiordland.
6 Define the term tree avalanche.
7 Outline the causes of a tree avalanche.
8 Explain how earthquakes increase the vulnerability of Fiordland.
9 Describe the nature of the Alpine Fault.
10 Summarise the biological factors that create vulnerabilities for Fiordland.
11 Define the meaning of ecological disturbance.
12 Summarise the main ecological disturbances in Fiordland.

Applying and communicating geographical understanding

13 Write a short report explaining the long-term geological processes that created Fiordland.
14 Study Figure 13.2.4. Using the figure and the associated text, write a paragraph describing the dynamics of a landslip.
15 Study Figure 13.2.7. Use the map and associated text to explain why New Zealand is vulnerable to earthquakes.
16 Study the box, Spotlight: The Green Lake landslide. Complete the following activities.
   a Describe the extent of the landslide area.
   b Describe the factors that caused the landslide.
   c Explain why a study of the Green Lake landslide site is useful for understanding the vulnerability of Fiordland today.
17 Write an extended response on the following topic. Analyse the vulnerability and resilience of Fiordland.

UNIT 13.3

Human-induced modifications to Fiordland

The relative isolation and rugged topography of Fiordland has helped to minimise the impacts of human activity. UNESCO's 2020 Conservation Outlook Assessment on Fiordland, released in early 2023, noted that the outlook for Fiordland was good, with some concerns. As this rating shows, Fiordland is not entirely immune from the impacts of humans. Fiordland's increasing international profile as a tourist destination places significant pressure on parts of the ecosystem. Introduced species and the broader impacts of human-induced climate change, also represent major ways in which humans have modified and are impacting the ecosystem of Fiordland.

Introduced species

In UNESCO's most recent World Heritage report on Fiordland, it reported **invasive species** as having the biggest impact on the ecosystem. For more than 60 million years, New Zealand was isolated from the rest of the world. Due to this isolation, New Zealand evolved unique flora and fauna. Most significantly, there was an absence of mammals and ground-dwelling predators in the natural environment of the country. Instead, birds, including a number of flightless species, and reptiles dominate the biosphere.

However, European invasion and colonisation of New Zealand saw the introduction of many non-native species to New Zealand, including predatory animals that hunt native species and browsing animals that disrupt natural vegetation patterns, reducing habitat. This impact is evident across New Zealand, including Fiordland, and it represents a significant challenge for the ecosystem managers of Fiordland. Introduced species have emerged as one of the major sources of vulnerability for the ecosystem, in both its terrestrial and marine environments.

Invasive marine species

An invasive species of seaweed called undaria is a significant threat to the marine environment of Fiordland. It is a large, brown-coloured seaweed native to waters of the north Pacific Ocean (see Figure 13.3.1). It has been in New Zealand waters for some decades. It was not until 2010 that evidence of undaria was found in Fiordland, when a single specimen of the seaweed was found attached to the mooring line of a barge in Breaksea Sound. It is likely that the seaweed reached Fiordland on a boat or ship that had been in other parts of the country. Soon afterwards, more specimens were found on the sea floor. Undaria can rapidly overrun native seaweeds and other aquatic plants, reducing biodiversity.

13.3.1 Undaria, an invasive species of seaweed common in New Zealand waters, is now also found in parts of Fiordland.

While undaria remains the most significant population of an invasive species in Fiordland's waters, there are risks of other species entering the ecosystem's waters. The biggest threat is from boats and ships bringing in non-endemic species in their ballast tanks, on anchor and mooring lines, and on fishing gear. Careful management of the movement of vessels into Fiordland is needed to mitigate this risk.

Introduced terrestrial species

European colonisers introduced many species of animals to New Zealand throughout the eighteenth and nineteenth centuries. These introductions were largely intentional, with the goal of providing animals for hunting and/or for agriculture. In a land where mammals and large land-based predators were absent, these introduced animals have had a significant impact on the country's native ecology. Fiordland has not been immune to these introduced species, with several species proving to be problematic throughout the region. Some of the most significant terrestrial invasive species in Fiordland are outlined here.

TAHR

Originating from the mountainous regions of India and Nepal, the Himalayan tahr was introduced to New Zealand in the late nineteenth century. It is estimated that close to 35 000 tahr now live in alpine regions of New Zealand. They are a goat-like animal that favours rugged terrain. They are fast and agile, easily navigating steep rocky slopes (see Figure 13.3.2).

13.3.2 Himalayan tahr are found in the alpine zone of Fiordland.

The tahr's favoured habitat is the alpine grassland, where they feed on alpine herbs. Although the tahr is considered to be near-threatened in its native habitat, in New Zealand it has no natural predators and its population has the potential to grow quickly if not controlled. Hunting is the only control method available, and the species is popular with hunters. Ironically, it was for this hunting that it was originally introduced.

There are two main impacts associated with the tahr. Living in grazing herds, the tahrs can eat large amounts of native vegetation, which has not evolved to cope with grazing. This has a significant effect on the slow-growing alpine plants in Fiordland. Secondly, the hard hoofs of the tahr trample vegetation and compact the soil, causing further damage to the fragile and vulnerable alpine zones. These effects also impact the native species that live in the region, significantly reducing habitat and food sources.

DEER

First introduced in 1851, significant populations of wild deer are found in many parts of New Zealand. Red deer is the most common, but in Fiordland a North American species, wapiti, dominates. This is one of the largest species of deer and is famed for its large antlers (see Figure 13.3.3).

13.3.3 Wapiti, a deer native to North America, is a dominant species in Fiordland.

The impact of deer is largely evident in the forests of Fiordland. They eat the ferns of the understorey, changing the structure of the forest, which is an important habitat for native species, including ground-dwelling birds and reptiles. In the alpine zones, deer consume the tussock grasses, wildflowers and alpine herbs, reducing food stocks for native species. In a similar fashion to tahr, deer also impact vegetation through soil compaction.

POSSUMS

A native animal of Australia, brushtail possums are a major invasive species throughout New Zealand. They were originally introduced for the fur trade in 1837, but have become a major pest (see Figure 13.3.4). It is estimated that combined, all the possums in New Zealand consume around 21 000 tonnes of vegetation every night. This radically changes the composition of forests and impacts greatly on native species.

13.3.4 Brushtail possums were introduced to New Zealand in 1837 for the fur trade.

Did you know?

The number of feral possums in New Zealand is thought have peaked in the 1980s, when there were 50–70 million across the country.

Although possums have a broad diet, they have favoured species and will eat selectively when given the opportunity. They tend to prefer the leaves of the larger canopy trees, and studies in Fiordland have shown that when significant possum populations are found in a patch of forest, they can kill up to 50 per cent of these larger trees within two decades of arrival. This radically changes the forest, increasing the growth of shrubs that are not favoured by the possums.

Possums also compete with several native bird species for the same food sources. Some studies have shown that possums raid birds' nests for eggs and attack young native bats. There are also risks associated with diseases carried by possums, especially tuberculosis, which can be passed on to native species.

13.3.5 Stoats have a major impact on native birds.

STOATS

Members of the mustelid family, stoats, and their close relatives weasels and ferrets, were all introduced to New Zealand in 1879 as part of a program to help control rabbits, another introduced species. Adult stoats grow to between 30 and 40 centimetres in length and are highly adaptable, living in many different types of ecosystems (see Figure 13.3.5). In New Zealand, they can found in coastal areas right up to and above the tree line.

In Fiordland, and indeed across much of New Zealand, stoats have had a devastating impact on native birds. They are skilled hunters with a voracious appetite. The nests of ground-dwelling birds, such as the kiwi, are particularly vulnerable to raids from stoats, who take the eggs and young hatchlings. Even large adult birds can become prey for the stoats. Adult takahē weighing up to 3 kilograms have fallen prey

to the determined stoats, who store the carcass to eat later. Stoats are associated with the extinction of at least three native bird species on the South Island.

FERAL CATS

Sometimes referred to as ships' cats, European sailors introduced cats to New Zealand in the mid-eighteenth century. Feral cats are different from stray domestic cats, as they are born wild and tend to grow much larger than their domesticated cousins. Feral cats have a similar impact in Fiordland as stoats. They too prey on native birds, lizards and larger insects. Hence their impacts are both direct in the form of eating native species, and indirect as competition with native species for the same food.

RATS

There are three major species of rat in New Zealand. These include ship rats, Norway rats and the Polynesian rat, or kiore. All three species are found in Fiordland. To some Māori, the kiore has cultural significance as they are associated with the migration of the Polynesians to New Zealand in the fourteenth century. The only significant populations of kiore are found in Fiordland and nearby areas of the south-west. The main impact of the kiore is by preying on the large insect invertebrates that are also an important food source for native species.

Ship rats, also called black rats or house rats, are common in podocarp forests. They are good climbers and attack birds' nests, taking eggs and even young hatchlings. The larger Norway rats, or brown rats, which are more commonly found on the islands surrounding Fiordland, can kill burrow-nesting sea birds and take eggs from the nest.

SPOTLIGHT

Eradicating rats on Breaksea Sound's islands

Located in the central coast of Fiordland, Breaksea Sound has many islands (see Figure 13.3.6). In 1986, a successful conservation project eradicated Norway rats from the small 9-hectare island of Hawea. Soon afterwards, in 1988, the much larger Breaksea Island was also declared rat-free.

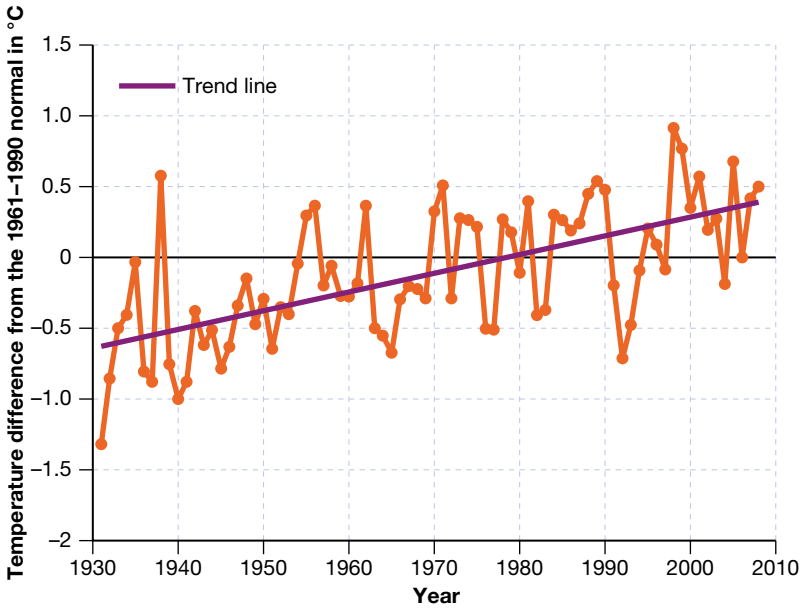
13.3.6 Breaksea Sound

A major study undertaken in 2020 assessed how the ecology of these islands, and several others in Breaksea Sound and other parts of Fiordland, were faring since the eradication of the rats. Some of the scientists involved in the 2020 research had been involved in the original work in the late 1980s. They recalled the islands infested with rats and an ecosystem on the verge of collapse.

The eradication of rats had a dramatic impact on the islands. The islands now form a major bird sanctuary with a number of species, such as mōhua and tīeke, having been translocated to the island; their populations now thriving.

Populations of kakaruwai, often called South Island robins (see Figure 13.3.7), recovered to such an extent after the rat eradication that small groups have been translocated to repopulate islands where rats had killed the bird's population. The 2020 research also noted there was an abundant population of the large flightless weevil, a type of beetle that was a major food source of the rats. Populations of burrowing seabirds were also growing, especially populations of the broad-billed prion.

13.3.7 Kakaruwai, also known as the South Island robin



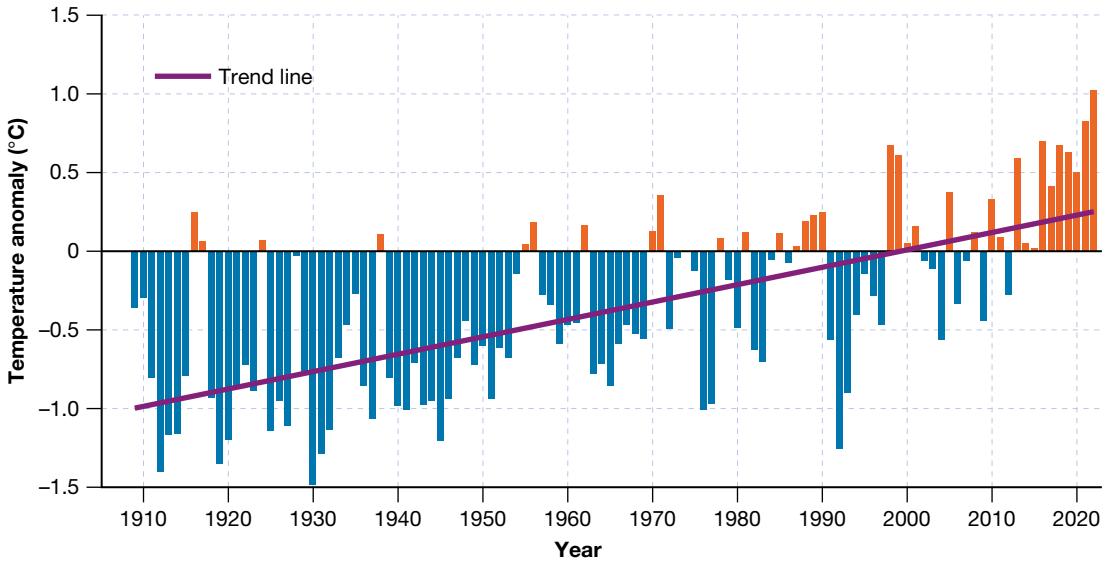
13.3.8 Average annual temperature anomalies across 11 locations in New Zealand, 1930–2008, known as the eleven-station series.

Climate change

Earth's climate is changing. Overwhelmingly, climate scientists agree that this is the result of human actions. They have come to this conclusion using evidence from many different sources. The burning of fossil fuels, combined with other unsustainable activities that emit greenhouse gases, is gradually warming the Earth. This is moving many ecosystems towards a tipping point. Unlike many other human modifications, where factors such as remoteness, World Heritage status protections and rugged topography serve to minimise the impacts on ecosystems such as Fiordland, climate change's impacts are felt everywhere, as it is a truly global issue.

Figure 13.3.8 shows data on temperature anomalies from 1930 to 2008 in 11 weather stations across New Zealand. An anomaly shows the difference (above or below) from the long-term average. The data were analysed by the National Institute of Water and Atmospheric Research (NIWA), an official New Zealand government agency. Although this data set is quite dated, it is very useful in that the 11 stations used did not move at all in the 78 years shown in the data set. This helps to create a reliable set of data, where variables such as taking the temperature at a different altitudes do not affect the results.

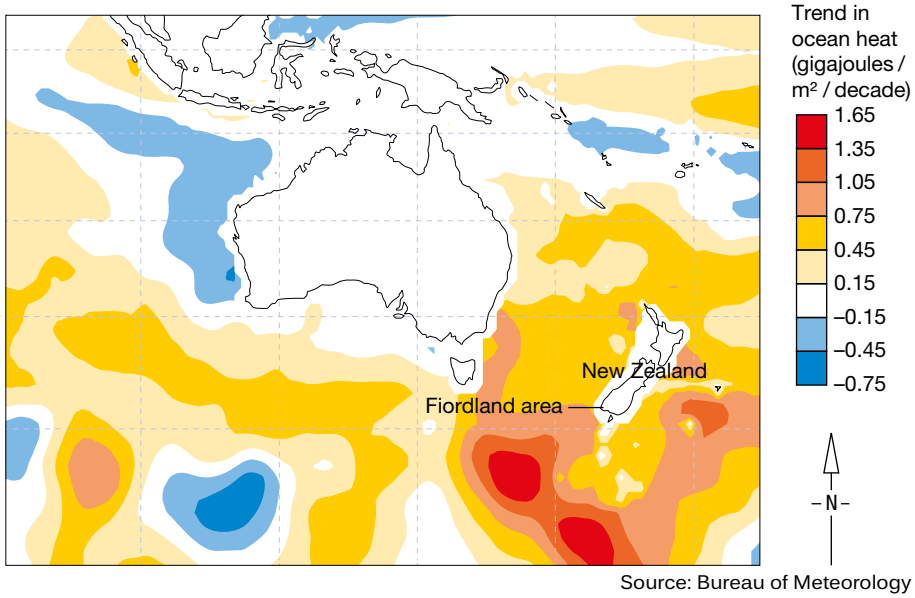
NIWA also uses another data set, which is known as the seven-station series. This collates data over an even longer period. Its data collection began in 1910. Figure 13.3.9 shows the temperature anomalies up to 2020. The seven-station series has had some locational changes over time, so it is different to the eleven-station series. Nonetheless, the key point of comparison is the similarity between the changes shown in the two data sets. Both demonstrate a warming pattern at around the same intensity.



13.3.9 The seven-station data series, showing temperature anomalies from the average 1910– 2020.

Data such as those shown in the eleven-station and seven-station series demonstrate that temperatures in New Zealand are becoming warmer. Research compiled from many sources by the Australian Bureau of Meteorology has found that the seas and oceans of the Southern Hemisphere have absorbed the majority of the extra heat created by global warming. In fact, the Tasman Sea, which lies between Australia's east coast and New Zealand, has warmed the most compared to all of the waters surrounding the entire Australian continent.

Figure 13.3.10 shows the trend in ocean warming between 2005 and 2021, and shows the significant warming that is taking place in the waters of southern New Zealand, close to Fiordland. These measurements show temperatures taken from the top 2000 metres of water depth.



13.3.10 Trends in ocean temperature in waters around Australia and New Zealand, 2005–21.

Effects of climate change on the functioning of the ecosystem

As in all ecosystems, climate plays a key role in the functioning of Fiordland. Many aspects of the ecosystem are vulnerable to changes in climate. This is particularly the case in the alpine zone, which has become highly adapted to the cold climate. The marine zone is also susceptible to changes brought about by the warming of the waters around Fiordland.

For example, in 2022 marine biologists discovered a mass bleaching event of sea sponges in Doubtful Sound, and in populations of sponges in Breaksea Sound and Dusky Sound. The bleaching is seen in sponges as white spots and is a sign of stress. Scientists attributed this stress to a marine heatwave in the waters of the sounds, where sea temperatures were well above normal (see Figure 13.3.11). Interestingly, the bleaching does not kill the sponges, but makes them far more susceptible to being attacked by fish. This is most likely because the white spots make them much more visible to fish. Many of the bleached sponges showed signs of fish bite marks, which eventually caused the sponges to die. Scientists estimate that in Doubtful Sound the 2022 bleaching event resulted in a 5 to 10 per cent death rate in the sponge population.

13.3.11 A sea sponge in Fiordland showing white spots indicating bleaching.

The loss of sponges influences the whole marine food chain in Fiordland. Sponges obtain their food from a symbiotic relationship with diatoms, tiny single-cell algae. The sponges release excess carbon produced by these diatoms, which is a food source for other organisms in the seawater, especially microbes. These microbes form the base of the marine food chain in the fiords. Hence, a reduction in sponges has a flow-on effect across the whole food chain.

13.3.12 Milford Sound is one of the wettest places in the world and climate change will make it even wetter.

Another key impact of climate change is extreme weather events. A key consequence of a warming climate is more intense storms, and there is already evidence of this in Fiordland (see Figure 13.3.12). Damaging storms that bring flooding rains have become more common in Fiordland. In February 2020, Fiordland experienced extreme weather. On a single day, 3 February, Milford Sound recorded a staggering 566 millimetres of rainfall. The average monthly rainfall for all of February is 455 millimetres. In the first four days of February in 2020, Milford Sound received 1124 millimetres of rainfall.

Scientists from NIWA and the New Zealand Department of Conservation (DOC) predict that Fiordland will receive more heavy rain days (greater than 25 mm in a day), more hot days (greater than 25°C) and significantly fewer frost nights (where temperatures fall below 0°C). Modelling showed that the 3 February 2020 event was a once-in-86-year event. However, on current trends it will be a once-in-55-year event by 2040 and once-in-27-year event by 2090. Hence, Fiordland will become even wetter and also warmer. This will have an impact on many species and functions within the ecosystem.

More rain will bring about increased risks of landslides and tree avalanches. There may also be changes in the chemistry of Fiordland waters. For example, the brackish waters may become diluted by even more rainfall.

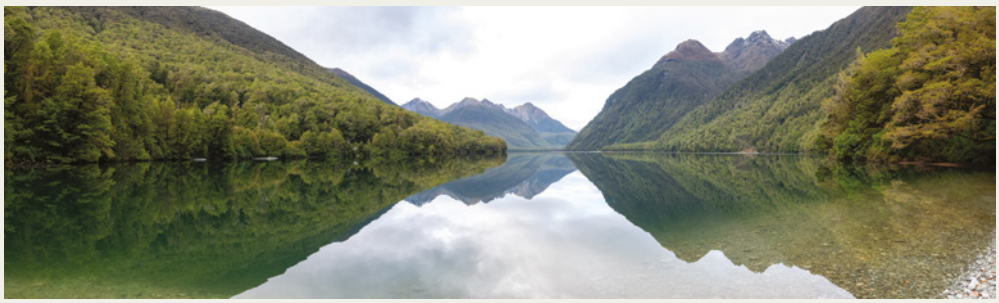
● **SPOTLIGHT**

Fiords as 'carbon sinks'

'Carbon sinks' are places that store carbon dioxide from the atmosphere and effectively lock it away in long-term storage, helping to restore the balance in the carbon cycle that humans have disrupted. The oceans are among the main carbon sinks and the stored carbon is sometimes referred to as blue carbon. Climate researchers have found that fiords in temperate areas, such as New Zealand and Scotland, are among the greatest potential carbon sinks available.

Organic carbon—carbon stored in plant material that settles on the seafloor and is quickly buried—is one of the best carbon stores available. The fiords of Fiordland do a wonderful job at this, as they are surrounded by forests and have large inflows of sediment to bury the plant material (see Figure 13.3.13).

Globally, fiords occupy less than 0.1 per cent of Earth's surface, yet it is estimated that they account for around 11 per cent of marine organic carbon burial. Fiordland is a hotspot because its waters are deep and oxygen is very low on the seabed, meaning the organic material is well preserved, locking in the carbon. Climate scientists in New Zealand estimate that Fiordland's fiords could potentially store 10–20 per cent of the country's greenhouse gas emissions, based on current emissions.



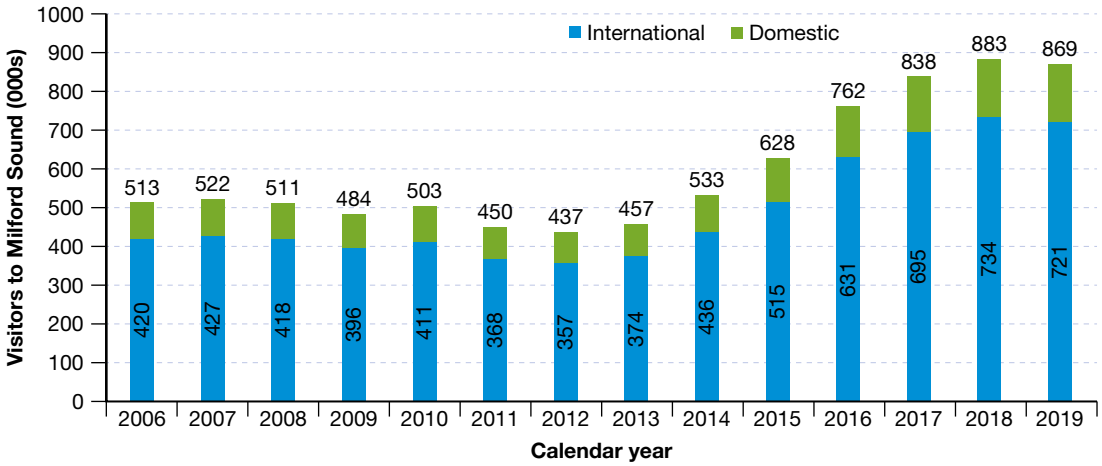
13.3.13 Fiordland's forests absorb carbon and convert it into organic material, which is then deposited and buried in the deep fiords in a low-oxygen environment, locking the carbon away.

Fiordland, as an ecosystem, plays an important ecosystem service role in sequestering carbon from the atmosphere and creating a long-term carbon sink.

Tourism

Fiordland is one of New Zealand's key tourist destinations. Milford Sound is the main tourist location within Fiordland, due to it accessibility by road. The COVID-19 pandemic had an enormous impact on visitor numbers, but in the year prior, 2019, there were around 870 000 visitors to Milford Sound (see Figure 13.3.14). This figure does not include the thousands more tourists that visited Milford Sound on cruise ships. In the 12 months between June 2018 and June 2019, approximately 222 000 people visited Milford Sound on 140 cruise ships. For comparison, just 13 cruise ships visited Milford Sound in 2006.

More than 20 per cent of all international visitors to New Zealand include a visit to Milford Sound in their plans. This is over 5 per cent more than for any other single destination in the country, highlighting the significance of Fiordland to the New Zealand tourism industry and the broader economy. Based on the long-term data, it is estimated that visitors to Milford Sound will increase by 70 per cent to more than 1.4 million visitors by 2050.



13.3.14 Visitor numbers to Milford Sound (excluding cruise ship passengers) 2006–2019

As far back as 2007 when the Fiordland National Park Management Plan was released, there have been calls to cap visitor numbers to no more than 4000 people per day in Milford Sound. The plan also called for caps on cruise ships. Part of this cap would be to reduce traffic into Milford Sound by significantly reducing parking to encourage people to use buses to come to the site. However, these plans have not been implemented, largely due to tensions over the economic benefits of tourism.

13.3.15 Traffic in the busy summer season en route to Milford Sound

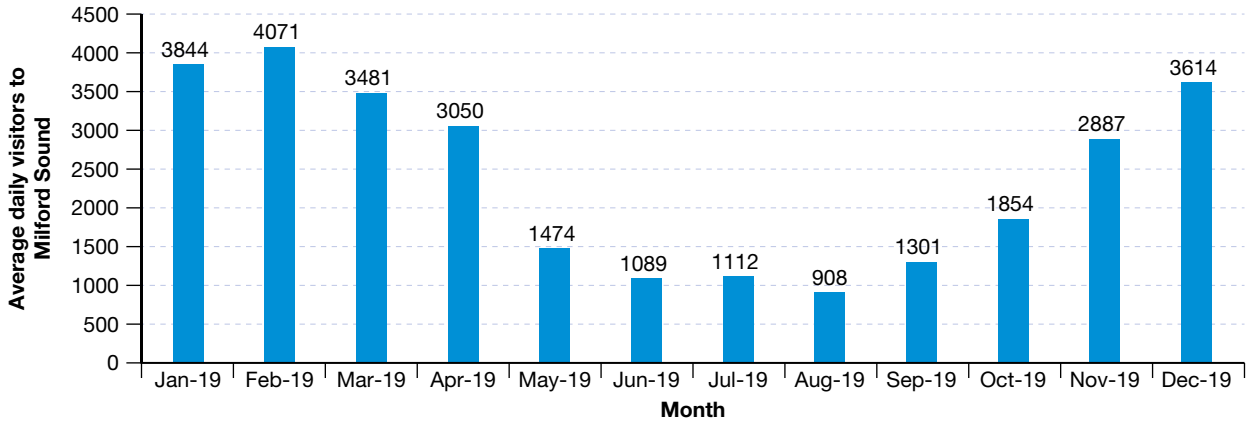
Concentration of visitors

While Fiordland covers an area of around 12 000 square kilometres, most of the tourist activity is confined to Milford Sound. This is because Milford Sound is by far the most accessible part of Fiordland, being linked by road and an airport, although only 5 per cent of visitors arrive by plane. The famous Homer tunnel was once one of the longest road tunnels in the world. It allows traffic to pass into the sound, but is a one-way road, so traffic jams are common in the tourist season. The tunnel is single-lane, so traffic can only travel in one direction at a time (see Figure 13.3.15).

A feature of Fiordland tourism is the seasonality of visitors. There is a peak in visitor numbers starting in late spring, through the summer and into early autumn (see Figure 13.3.16). This concentration of visitors increases the potential impact of tourism. With the concentration also being centred on Milford Sound, this impact is quite considerable.

Did you know?

Work on the Homer Tunnel began in 1935, but was not completed until 1953 due to a combination of challenging working conditions and a pause in construction due to World War II.



13.3.16 Average daily visitors to Milford Sound in 2019, prior to the COVID-19 lockdowns

Most people visiting Milford Sound do so as a daytrip, often from Queenstown. This further concentrates visits, with the period between 11 a.m. and 3 p.m. seeing peak visitor numbers. Other areas of Fiordland have fewer visitors. Doubtful Sound, the second most popular site, has a fraction of the visitors and is only accessible via boat or on foot.

13.3.17 In 2023, 104 cruise ship visits were made to Milford Sound.

Cruise ships

Cruising is now one of the most significant sectors of tourism. Cruise ships are now among some of the largest ships in the world and the sector is rapidly growing. Cruising is a popular way for tourists to visit and see New Zealand, and the fiords of Fiordland are a key destination. In 2023, 104 cruise ships visited Milford Sound (see Figure 13.3.17). These cruise ships can carry up to 5000 people, including crew. This adds considerably to the pressure created by the daytrip visitors coming by road.

Apart from the obvious environmental impacts these massive ships create, such as carbon emissions, one of their main impacts is around their potential to bring introduced species into the fiords in ballast water and attached to their hulls. There are also risks associated with accidents that could release toxic oil and other chemicals into the fiords. In a bid to minimise the impact of cruise ships there are many restrictions, with only selected areas allowed to be accessed by the ships.

Commercial and recreational fishing

No **commercial fishing** is permitted in the waters of Fiordland. However, outside of the fiords themselves, commercial fishing does take place, although it is heavily regulated. Commercial fishers are allowed to store lobster pots, including those containing live lobsters caught outside the fiords, in designated areas. This has attracted some criticism, as the pots themselves can damage the aquatic plants.

A major study commenced in 2023 into the impact of fisheries on the marine environment. It reported that lobster pots were found in numerous locations outside the designated areas. Many of these pots were loose, meaning that they had broken free from their moorings. The pots have the potential to do damage to sea floor communities, including black corals, and indiscriminately capture and kill animals.

Discarded fishing equipment, including nets, lines and tackle brought into the Fiordland waters, also pose a threat to seals and other mammals such as dolphins. This equipment can cause entanglement and drowning.

SPOTLIGHT

Tourism impacts at Milford Sound

The concentration of tourism in Fiordland in Milford Sound helps minimise the impact of visitors on the overall ecosystem. However, it does intensify the pressure on Milford Sound. In July 2021, New Zealand Minister of Conservation, Stuart Nash, noted:

> Tourism at Milford Sound Piopiotahi cannot return to its pre-COVID state. Significant pressure from the 870 000 visitors in 2019 undermines cultural and environmental values and infrastructure. As a tourist experience, it was crowded, rushed, noisy and unsafe.

Tourism generates a range of issues in Milford Sound. Notable is the disposal of waste, including sewage. Wildlife disturbance includes direct impacts, such as road kills by the large volume of traffic. There are also indirect impacts, such as increased carbon dioxide emissions from the large numbers of vehicles and the tourist boats that are the main activity on the sound (see Figure 13.3.18).

13.3.18 Tourist cruises are the most popular activity for daytrippers to Milford Sound.

The large number of cruise boats on Milford Sound leads to one of the key impacts of tourism. Typically, these boats host around 200 tourists at a time on sightseeing trips around the fiord that last for 2–3 hours. Combined, the boats have a capacity of 10 000 people, with a temporary ban on any additional boats.

There have been suggestions that the presence of so many boats is impacting the population of New Zealand fur seals by disrupting their breeding and feeding cycles. The seals breed along the rocky shorelines and raise their pups there, sheltering in the rock crevices or in the nearby undergrowth in the forests. Boatfuls of people moving close to the seals is a source of concern. Fur seals are also at risk from plastic pollution. The seals can become entangled in plastics and mistake them for food. Tourism activities are a major source of plastic pollution in Fiordland waters.

Other research has suggested that the population of bottlenose dolphins living in Doubtful Sound may have been badly impacted by the increase in boat traffic there. The population is one of the most southerly in the world and has declined considerably in recent years. Little research has been carried out in recent years, but a major study in 2008 found that the population had declined by around 30 per cent since the last major study in 1994. This decline coincided with an increase in tourism in Doubtful Sound, including dolphin watching.

While many people visit Fiordland for just a few hours, typically taking a cruise around the fiord, there are other ways in which tourists access the national park. Hiking is another key tourist activity across Fiordland. The 53.5-kilometre-long Milford Track is a 4-day walk and is one of the most popular hikes in New Zealand. Around 5500 people use the track annually. Numbers are strictly controlled on the walking tracks, and this has limited the impact. However, tramping (as hiking is called in New Zealand) can introduce weeds through seeds on boots and equipment, cause rubbish, disrupt wildlife and compact soils (see Figure 13.3.19). There are also issues with trampling of the slow-growing and vulnerable vegetation.

13.3.19 Although relatively low-impact, walking trails like the Milford Track have some impacts on the environment of Fiordland.

Recreational fishing has also been under some scrutiny by park managers and conservation groups. There are several large marine reserves where all fishing is banned in Fiordland, but large areas of the ecosystem are open to recreational fishers. Conservation groups have called on authorities to decrease fishing limits, arguing that recreational fishing should be for 'food not freezer'. This means that fishing should only be for people to immediately eat the fish, not to fish so much that they create a store of fish in their freezer for future consumption. There are concerns around several species, including bass, groper and scallops, with conservationists arguing that these species should be banned from recreational fishing to allow their stocks to recover from overfishing.

Activities

Acquiring and processing geographical information

1 Explain what an invasive species is.
2 Describe the impact of undaria on the marine environment of Fiordland.
3 Summarise how undaria arrived in Fiordland.
4 Explain how tahrs impact Fiordland.
5 Describe the effects of deer and possums on Fiordland's forests.
6 Explain why stoats and feral cats are considered such a significant threat to Fiordland wildlife.
7 How have rats impacted the biosphere of Fiordland?
8 Summarise the main causes of climate change.
9 Describe the impact of climate change on sea sponges in Fiordland.
10 Explain how sea sponge deaths impact the broader ecology of Fiordland.
11 Explain the impact of more severe storms on Fiordland.
12 Describe the nature of tourism in Fiordland.
13 Explain why tourism to Fiordland is considered concentrated.
14 Describe the main impacts of tourism on Milford Sound.
15 How do tourist boats affect seals in Milford Sound?
16 Describe the impacts created by cruise ships to Fiordland's ecosystem.
17 Explain the impacts associated with fisheries.

Applying and communicating geographical understanding

18 Using specific examples, write a report on how invasive species threaten Fiordland.
19 Study the box, Spotlight: Eradicating rats on Breaksea Sound's islands. Using this information, write a paragraph explaining why the eradication of rats was so important to the restoration of the ecosystem on the islands.
20 Study Figures 13.3.8 and 13.3.9 and complete the following activities.
   a Explain what data these graphs are displaying.
   b Describe the trend shown in the graphs.
21 Study Figures 13.3.8, 13.3.9 and 13.3.10 and the associated text. Write a report explaining the evidence of climate change around Fiordland.
22 Study the box, Spotlight: Fiords as 'carbon sinks'. Write a paragraph explaining why Fiordland is such an efficient carbon sink.
23 Complete a simple table that summarises the main impacts of human modifications on Fiordland.

Modification	Description of modification	Impact on the functioning of Fiordland's ecosystem

UNIT 13.4

Fiordland management: Responses and strategies

Fiordland's amazing beauty and relatively untouched environment have long been recognised. In 1905, nearly 9500 square kilometres of the region was set aside as a public reserve. In 1952, it was declared a national park in recognition of its significance to New Zealand (see Figure 13.4.1). It has since grown to its current size of more than 12 000 square kilometres. It became part of the Te Wahipounamu – South West New Zealand World Heritage Site in 1986, along with some areas outside of Fiordland. These declarations afford the environment of Fiordland considerable protections.

13.4.1 Made a national park in 1952, Fiordland is now also part of the Te Wahipounamu – South West New Zealand World Heritage Site

However, as outlined in Unit 13.3, this does not mean that Fiordland is free from human modifications. Human impacts require a range of strategies to minimise their effects on the functioning of the ecosystem, at the same time providing humans with opportunities, such as tourism within the national park.

Fiordland National Park is administered by the New Zealand Department of Conservation (DoC). A special committee, called the Southlands Conservation Board, is responsible for the formulation of key conservation policies relating to Fiordland and other key conservation sites in the south-west of New Zealand. This 11-person board has the important role of working with local conservation organisations, residents and businesses to promote the conservation of Fiordland and the surrounding areas. The Southlands Conservation Board provides advice to the New Zealand Conservation Authority, which is the part of DoC directly responsible for the protection of natural and cultural heritage throughout New Zealand. Environment Southland is the local government area in which Fiordland lies and it also plays an important role in the management of Fiordland.

● **SPOTLIGHT**

Fiordland Marine Guardians

The marine environment is a key part of the Fiordland ecosystem. This area covers all the waters of the fiords and an area up to 19.3 kilometres (12 miles) off the coast. A special advisory group, known as the Fiordland Marine Guardians, works to protect and conserve this part of the Fiordland ecosystem (see Figure 13.4.2).

13.4.2 The Fiordland Marine Guardians provide advice on the management of Fiordland's extensive marine environment.

The group is responsible for providing advice to the various government agencies that have responsibility for Fiordland's marine area. They also give input into broader marine environment matters that may have an impact on Fiordland, such as national fisheries policy. Fiordland Marine Guardians have an important legal status as they are recognised under the *Fiordland (Te Moana o Atawhenua) Marine Management Act 2005*. A key feature of the Marine Guardians is that they represent key stakeholders. The eight guardians are representatives of different groups. For example, commercial and recreational fishers, the tourism industry, marine scientists, conservation groups and residents. This provides a cross-section of opinions and experiences for the guardians to draw on.

Strategies involving the Māori peoples

The Māori are the Indigenous peoples of New Zealand. Throughout Māori history, Fiordland was a seasonal home to the southern Māori peoples. They harvested the resources of Fiordland, including seafood, seals and seabirds. Fiordland was also an important source of pounamu, often called greenstone or jade. This rock is highly valued in Māori culture and is used for carving jewellery, tools and weapons (see Figure 13.4.3). There are also important sites containing Māori rock art within Fiordland.

Protection of the Māori cultural heritage of Fiordland is an important part of the overall management of the national park. There are also aspects of early European heritage that are actively managed within the park, such as settler huts. Specific conservation plans are developed for each site. In the case of Māori sites, this is done in close consultation with representatives of the local Māori community. This community is the Ngāi Tahu iwi. **Iwi** roughly translates as nation.

13.4.3 A traditional Māori war axe carved from pounamu

Did you know?

New Zealand was one of the last places on Earth to be inhabited by humans. It is believed the Māori people first arrived in New Zealand around 1000 years ago and only migrated there in large numbers in the fourteenth century.

A key management strategy adopted throughout the park is to provide information to visitors relating to Māori culture and their links to Fiordland. Importantly, this information is carefully selected in close consultation with the Ngāi Tahu.

Customary harvesting of Fiordland resources by the Ngāi Tahu is a controversial issue. In a legal sense, customary harvesting of most flora and fauna within national parks is permitted only with special permits provided by the New Zealand Government. In most cases, cultural harvesting is encouraged to be carried out outside of the Fiordland National Park. However, there are exceptions for important cultural harvests and in cases where there are no other viable sources. For example, eel harvesting is permitted for non-commercial customary harvesting within the national park. Local park managers also keep a materials bank of culturally significant materials from within the park. This includes dead birds, tree logs and other materials that may hold cultural significance and are found within its boundaries. These materials can be accessed by Ngāi Tahu for cultural purposes.

Special protection zones

Part of the management of Fiordland National Park is the creation of special protection zones. These are areas where additional restrictions are put in place to help ensure that the impact of human activities is further reduced. Such areas typically contain more vulnerable aspects of the ecosystem.

China shops

Across Fiordland's marine zone, there are seven special areas that have been given further protections. These areas have very high ecological value and contain fragile and vulnerable ecology. For this reason, they have become known as 'china shops', as in fine china tableware, because china shops are full of fragile, valuable things.

The china shops contain significant populations of corals and/or sea pens. Sea pens are a type of cnidarian, in the same phylum as jellyfish. They get their name because of their feather-like bodies that resemble old-fashioned quill pens (see Figure 13.4.4). These extremely fragile creatures live in turbulent waters such as channels between islands or where fiords change directions sharply.

13.4.4 A large sea pen

The areas designated as china shops are clearly marked on marine maps and activities are tightly controlled. For example, they are no-anchor zones for boats, to ensure that the seabed is not disturbed. Fishing activities, such as lobster potting, are also forbidden in these areas.

The takahē special area

The takahē is one the rarest and most vulnerable birds in New Zealand (see Figure 13.1.11). It was thought to be extinct until 1948, when a small number were found living in the alpine tussock grass basins of the Murchison Mountains (see Figure 13.4.5). These mountains are found in the southern part of Fiordland and are extremely rugged and isolated. Following the discovery of the takahē, a special protection area was declared, known as the Takahē Special Area, and covering around 500 square kilometres.

13.4.5 The Murchison Mountains are some of the most inaccessible parts of Fiordland.

Access to the area is tightly controlled and is off limits to everyone, except for authorised researchers and specially trained staff who cull deer in the area; one of the main threats to the takahē. Stoat control is another important task carried out in the area. A massive increase in the stoat population in 2007 had a devastating impact on the takahē. A stoat eradication program was initiated, and the population of takahē has slowly recovered. Today, the control of introduced species, especially deer and stoats, are the primary management strategies within the special area.

For many years, eggs were taken from the wild population and incubated under special conditions with the chicks hand-raised to boost survival rates. Eggs are no longer taken, and instead birds from sanctuary populations are reintroduced into the wild population in the special area.

Managing invasive and introduced species

Introduced species are one of the key human impacts on Fiordland. They represent a significant threat to the vulnerable species of the ecosystem and are therefore a key focus area for managers of the national park. The management of introduced species has three goals:

1. to stop the establishment of any new introduced species within the park
2. to minimise the spread of introduced species that are established within the park to new areas of the park where they are not currently found
3. to eradicate or reduce in number introduced species that are currently established within the park.

While each of these goals requires different strategies, a common element to all of them is the collection of accurate data. Environmental scientists and managers require information on the diet, breeding cycles and preferred habitats of introduced species to manage them. Importantly, they must also have a strong understanding of the number of individuals within the target species and their current locations within the park and surrounding areas. This allows environmental scientists to establish baseline data against which to measure the effectiveness of their strategies and to make changes to them accordingly.

Managing invasive marine species

Fiordland is highly vulnerable to invasive marine species. The marine zone is extensive, and the area is a popular boating destination. The isolation of many of the fiords and surrounding waterways also make monitoring challenging and limits the ability of environmental managers to deal with outbreaks quickly.

Biosecurity has become the key strategy for managing the risk of invasive marine species. The main ways that invasive marine species are introduced is through the ballast waters of ships and biofouling (see Figure 13.4.6), where species grow on a part of the ship, such as a hull, anchor chain or mooring lines. Other risks are fishing and diving gear.

13.4.6 Biofouling is evident on this boat's hull and machinery.

CLEAN VESSEL PASS

The Clean Vessel Pass is a special program established by Fiordland managers and administered by Environment Southland. Under the scheme, all vessels entering Fiordland's water must have a clean vessel pass, regardless of their size. It is illegal to bring a vessel into Fiordland without the pass. Under the scheme, 12-month passes are issued to vessels that meet strict biosecurity standards. These standards include:

- **a clean hull:** there must be no more than a slime layer on the hull of the vessel and only goose barnacles are allowed
- **clean gear:** all gear onboard the vessel, such as anchor chains, fishing equipment and mooring lines must be visibly clean and have no biofouling
- **clean ballast water:** the ballast water on board must be treated or be visibly clean
- **record-keeping:** vessel must have up-to-date records of how the above standards were met.

● SPOTLIGHT

Queen Elizabeth cruise ship denied entry

MS *Queen Elizabeth* is an enormous ultra-luxury cruise ship capable of carrying more than 2000 passengers and 1000 crew. The massive ship undertakes cruises around the world. However, a cruise departing Sydney in early 2023, which included a visit to Fiordland had to have its itinerary altered to avoid the area.

The change to the itinerary was made after MS *Queen Elizabeth's* operator, Cunard, was unable to obtain a clean vessel pass. The company had not had the ship's hull cleaned to stop biofouling. The decision to deny the pass resulted in more than NZ$320 000 in port fees lost to Environment Southland. The denial of the pass to such a prestigious ship and the consequent loss of revenue demonstrates the commitment of authorities to the clean vessel pass scheme.

Controlling deer and tahrs

Deer are the biggest animals in Fiordland and create considerable damage to the ecosystem. The only effective control strategy for deer is culling. This is done through a combination of aerial shooting from helicopters and hunters on the ground. A major deer cull took place in late summer 2022, in and around the Murchison Mountains, where the Takahē Special Area is located. This alpine zone is particularly vulnerable to deer that graze on the alpine vegetation, compact the soil and damage stream beds and banks.

The operation targeted hinds (female deer) of breeding age. This group was targeted because reducing their number has the greatest impact on population decrease. They are also the group that is less targeted by recreational hunters, who tend to shoot larger males.

Controlling deer through shooting can be seen as controversial. The animal is iconic, but there are few other effective management strategies. The use of helicopters allows environmental managers to access isolated regions such as the Murchison Mountains.

Like deer, the only effective control method for tahrs is hunting. This is largely done by recreational hunters, who are permitted to hunt tahrs under strict conditions in designated areas of the park. Some professional shooting is also done by park managers in more inaccessible areas of the park.

13.4.7 Traps are typically used to eradicate stoat and rat populations

Controlling rats and stoats

Strategies to control rats and stoats involve trapping. Traps are set along paths that the animals are expected to take and contain a lure. This is usually a chicken egg. Most traps use a mustelid trap, which is basically a large mouse trap. Other traps use poisons. All traps are set inside a box (see Figure 13.4.7). The box ensures that native species, especially ground-dwelling birds, are not unintentionally killed by the traps, as they are unable to fit through the small entry holes.

Possum control

The control of possums is a key environmental objective, not just in Fiordland, but across all of New Zealand. The main control methods are trapping and poisoning. The main poison used is called 1080. Its use is controversial in New Zealand (see Figure 13.4.8). There are concerns that the toxins and chemicals in 1080 can accumulate in the environment and enter the food chain through a process called bioaccumulation and can have long-lasting effects on the wider environment. There are also concerns that 1080 is an inhumane way to eradicate possums. Another objection is that sometimes native species are unintentionally killed by 1080 baits. Others have argued that while there are drawbacks to the use of 1080, it is by far the most effective method of tackling the problem of possums and the great damage they do.

13.4.8 The use of 1080 poison to control possums is very controversial in New Zealand.

Managing tourism activities

Tourism is the only significant human activity to take place in Fiordland. The isolation and relative inaccessibility of Fiordland have helped to reduce the impact of tourists across the ecosystem. In this way, the concentration of tourism in Milford Sound is a key management strategy. This is a common strategy used in several different ecosystems that are popular tourist destinations—for example, the Great Barrier Reef, where nearly all tourism is confined to less than 7 per cent of the reef's designated area.

Visitor caps

Some conservationists have called for caps to be placed on visitor numbers to Fiordland and specifically to Milford Sound. To date, these calls have not been adopted into the management plans for Milford Sound. However, in other parts of the park, such as specially protected areas, strict caps and no-visit areas are key management strategies. For example, the world-famous Milford Track has a cap of 40 independent walkers allowed to start the walk each day. Permits must be booked in advance and all hikers are required to have one. Hikers are not permitted to camp along the track and instead must use one of the designated huts or shelters, which further limits their impact.

Did you know?

According to travel guide company Loney Planet, the 32-km Routeburn Track in Fiordland is one of the top 10 walking tracks anywhere in the world.

Managing hikers

There are dozens of walks throughout Fiordland. Some of these are short walks of just a few hours duration and others are long treks that can take several days, such as the Dusky Track around Dusky Sound, which is designed as a 10-day trek. Trampling of vegetation can be a key impact of hikers, especially in the alpine zone where vegetation can be easily damaged. Well-signposted and maintained tracks are important management tools to minimise this impact, as they help to confine walkers to the designated paths. In some locations, raised footpaths are used to ensure that sensitive areas are further protected (see Figure 13.4.9).

13.4.9 A section of raised footpath on the Routeburn Track

Another potential impact of hikers is as vectors for invasive species. A vector is a method of transfer. Hiking boots and camping equipment are common vectors for weed seeds. The New Zealand Government has launched a campaign called Check, Clean, Dry. This is a nationwide campaign and is particularly relevant to Fiordland. The campaign is designed to remind people enjoying outdoor activities of the need to check equipment for seeds and plant material. Equipment must be thoroughly cleaned and dried to make sure no waterborne diseases or weeds are present. Hikers (trampers), along with boaters, are reminded of this program at all opportunities through signage at track heads, on hiking passes and maps, and in information centres throughout Fiordland.

Tourism as education

One of the benefits of tourism in near-pristine ecosystems such as Fiordland is its educative value. People experiencing the intrinsic value of ecosystems firsthand is an excellent way to help reinforce the importance of caring for the environment more broadly. Within Fiordland, many of the tourism businesses take this seriously and some are even using it as part of their tourism offerings.

For example, stoat and rat trapping is quite a labour-intensive management strategy, but is also highly effective. In a joint initiative with the Fiordland tourism sector, park managers are leveraging the growth of ecotourism to assist in this process. Some tourism providers are now offering hiking trips into parts of Fiordland that involve setting and checking on rat and stoat traps. This initiative serves both an educative and practical purpose, providing opportunities for environmentally conscious tourists to play an active role in the management of the park.

● SPOTLIGHT

The Sinbad Project

Sinbad Gully is a key conservation area located next to the iconic Mitre Peak. Three threatened species of lizards live in the Gully, including the Sinbad skink, and 20 species of native birds, including the tawaki (Fiordland penguin). A key focus of the project is the eradication of stoats and other introduced species. The high valley walls of the gully will help to ensure that the site cannot be re-invaded by the introduced species.

The project involves trapping and baiting of stoats, and fauna surveys and research to check on the success of management programs. One of the key partners in the Sinbad Project is Southern Discoveries, one of the major tourism businesses operating in Fiordland. In addition to contributing to the funding of the project, Southern Discoveries also educates its guests on the project and the wider environmental management of Fiordland.

Activities

Acquiring and processing geographical information

1 List the agencies that administer Fiordland National Park.
2 Explain how the Māori traditionally used Fiordland.
3 Explain the concept of customary harvesting.
4 Describe the involvement of Māori communities in the management of Fiordland.
5 Describe what a china shop is and how they are used in Fiordland.
6 Summarise the goals of managing introduced species in Fiordland.
7 Describe the clean vessel pass strategy.
8 Explain the purpose of visitor caps in Fiordland.
9 Summarise the strategies used to minimise the impacts of hikers in Fiordland.
10 Explain the value of tourism in educating individuals.

Applying and communicating geographical understanding

11 Study the box, Spotlight: Fiordland Marine Guardians. Complete the following activities.
   a Explain the purpose of the Fiordland Marine Guardians.
   b Describe the composition of the Fiordland Marine Guardians.
   c Assess whether a group like the Fiordland Marine Guardians is an effective management strategy. Justify your response.
12 Using examples, write a short report on how special protection areas are used in Fiordland.
13 Write a bullet point summary on how different introduced species are managed within Fiordland. Assess whether you consider these strategies to be effective.
14 Hold a class debate on the topic: 'Visitor caps should be introduced to Milford Sound'.

UNIT 13.5

Differences in ecosystem management: Fiordland and the West Norwegian Fjords

Norway is famous for its fjords. Note that in this section, the spelling fjords is used as this is the accepted spelling for Norway's fjords. Along its long west coast, there are many fjords and they have played a key role in the development of Norway, its culture and history.

Two fjords stand out for their significance and have become World Heritage Sites—the Geirangerfjord and Nærøyfjord. Together, the sites are known as the West Norwegian Fjords and represent the upper sections of two of the deepest and longest fjords in the world. The fjords are both in the southern part of Norway, but are separated from each other by about 120 kilometres (see Figure 13.5.1). These fjords are famed for their natural beauty. They are narrow and extremely steep, with almost sheer rock walls that rise about 1400 metres into the air and extend to the sea floor more than 500 metres (see Figure 13.5.2).

13.5.1 Location of the West Norwegian fjords

Management strategies used in the West Norwegian Fjords

13.5.2 The spectacular Nærøyfjord on Norway's west coast

Like New Zealand's Fiordland, the West Norwegian Fjords are World Heritage Sites that have considerable protection. Both sites are well regarded for their conservation and are listed as having a good conservation outlook, according to the International Union for the Conservation of Nature.

However, the sites are also quite different in many ways. Human activities in and around the Norwegian fjords are far more intense than in Fiordland. This is largely because the West Norwegian Fjords are more accessible, and they have also had a much longer period of intense human use compared to those in New Zealand. Another striking difference is that the West Norwegian Fjords are not a single continuous ecosystem as Fiordland is. Geirangerfjord and Nærøyfjord are two distinct sites, and this complicates their management as they are much smaller in extent, a key factor in their increasing vulnerability. There are also some concerns that there is no buffer zone between the boundaries of the site and human activities. This increases risks associated with these human activities, such as oil spills from shipping lanes near the sites, weed infestation and introduced species.

Human settlement within the fjords

13.5.3 The village of Tufto, one of several settlements within Nærøyfjord

In the Norwegian fjords only a portion of the fjords is protected. Just the uppermost portion of the fjords themselves lie within the World Heritage Site. This again reflects the far more intensive human use of the region. Farming activities, several towns and considerable infrastructure lie within the fjords themselves (see Figure 13.5.3). These are typically farming and fishing communities, many dating back to the Viking era, but they are increasingly focused on tourism, providing accommodation and other services to the vast number of visitors who venture to western Norway to visit the fjords.

A key aspect of the management of the West Norwegian Fjords is consideration of the cultural heritage that exists within and on the borders of the site. While Māori and some early European heritage exists within Fiordland, it is far less prevalent than in the West Norwegian Fjords.

Humans have inhabited this part of Norway for at least 10 000 years, and the fjords offer some of the best farming prospects in Norway. Today, government subsidies support farming activities in the fjords to maintain this cultural heritage, especially dairy farming. This is different to Fiordland, where there is an absence of farming activities.

Managing the terrestrial landscapes

A feature of Geirangerfjord and Nærøyfjord is that they are among only a small number of Norwegian fjords that are unaffected by hydroelectric power. Like Fiordland, this part of Norway receives huge quantities of rainfall. The rivers that flow into the fiords have over time been dammed and are used for hydroelectric power generation. Well over 90 per cent of Norway's power needs are met by hydroelectricity. Much of this

infrastructure was developed in the late nineteenth and early twentieth centuries to power the country's industrialisation. As the West Norwegian Fjords have no hydroelectric dams, they are largely intact, making them rare among the Norwegian fjords. Their intactness is a common characteristic they share with Fiordland.

As in Fiordland, there are extensive management plans in place to protect the flora and fauna of the fjords and their surrounding terrestrial zones. This includes a number of nature reserves where high-value ecology is protected. For example, the Hyskjet Nature Reserve is in Geirangerfjord. This encompasses an elm-linden forest, which is rich in understorey plants.

Managing tourism activities

Another shared feature of Fiordland and the West Norwegian Fjords is tourism. In relation to the Norwegian fjords, UNESCO notes, 'tourism pressures are intense in both fjords'. However, one of the key differences is that most tourists visit the fjords on cruise ships. While this is common in Fiordland, daytrippers coming by road dominate the New Zealand experience.

Management of cruise ships is the primary focus in Geirangerfjord and Nærøyfjord. While there are more than 100 cruise ship visits made to Fiordland every year, across the various fjords of Norway, more than 700 cruise ship visits were made in 2019, the year prior to the COVID-19 pandemic. The industry is booming again and is expected to double over the coming years. Many of these cruise ships are of the biggest size, carrying 4000–5000 passengers each (see Figure 13.5.4).

13.5.4 Cruise ships are the main way that tourists arrive in the West Norwegian Fjords.

Many people in Norway are concerned that the cruise industry is polluting and overwhelming small communities by bringing so many visitors all at once. In 2022, the Norwegian Government announced that they would introduce strict environmental conditions on cruise ships. Among these is a law set to be effective from 2026 that will require cruise ships visiting fjords, including Geirangerfjord and Nærøyfjord, to be zero emissions cruise ships. Few ships have applied for permits to dock in Geirangerfjord for 2026 as they cannot comply with this regulation. This is an interesting example of Norway prioritising its environmental goals over economics. In some ways, there are parallels to the way cruise ships are turned away from Fiordland when they fail to meet the requirements for a clean vessel pass.

Mining and aquaculture

There is no buffer zone between intensive human activities and the West Norwegian Fjords World Heritage Site. This places some additional stress on the ecosystem and complicates its management. An example of this is mining. A large quarry operated very close to Geirangerfjord, but has now closed. This represents a legacy environmental problem that environmental managers must deal with.

A by-product of different mining operations is left-over rock particles called tailings. In Norway, mining companies can apply for licences to dump these tailings into deep fjords. The tailings radically change the sea floor, killing life there and therefore changing the whole food chain. As neither Geirangerfjord nor Nærøyfjord is fully protected as a whole ecosystem, this poses a potential risk to the fjords that has been noted by conservation groups.

Aquaculture, particularly salmon farming, is a major economic activity across Norway's fjords. The industry is heavily regulated, but it does have environmental consequences, most notably in relation to waste materials from the salmon, including uneaten salmon feed which increases the nutrient levels within fjord waters. While this is more of an issue in other fjords in Norway, it is something that could still impact Geirangerfjord and Nærøyfjord as they are not protected across their entire length.

The tensions between more intensive economic activity, such as mining, and conservation is not something that is so relevant in Fiordland compared to the West Norwegian Fjords.

Activities

Acquiring and processing geographical information

1. Describe the nature and location of the West Norwegian Fjords.
2. Describe the nature of human settlement within the West Norwegian Fjords.
3. Outline the cultural heritage within the West Norwegian Fjords.
4. Explain the uniqueness of Geirangerfjord and Nærøyfjord compared to other Norwegian fjords.
5. Compare the management strategies around the terrestrial landscapes in Fiordland to those of Geirangerfjord and Nærøyfjord.
6. Describe the challenges created by tourism in Geirangerfjord and Nærøyfjord.
7. Explain the management approach to cruise ships that has been adopted in Norway and its potential impact on the industry.
8. Explain why there are risks from mining and aquaculture that need to be considered in Geirangerfjord and Nærøyfjord.

Applying and communicating geographical understanding

9. Write a short report comparing Fiordland National Park to the West Norwegian Fjords in terms of their structure.
10. As a class, discuss the challenges faced in managing West Norwegian Fjords compared to Fiordland. Consider what challenges are shared and what is unique to each site. Record your class's ideas using a graphic organiser.

UNIT 13.6

Research and innovation in the sustainable management of Fiordland

Sustainable management of New Zealand's Fiordland region relies heavily on thorough research and finding new ways to manage the challenges facing the national park. This research has important implications beyond Fiordland. For example, research on carbon sinks is important in terms of global climate change. Other research is far more specific and focuses on particular species, but is still critical to understanding the interrelatedness of the Fiordland ecosystem.

Research into carbon sinks

Fiords acting as effective carbon sinks is explored Unit 13.3. Fiords are effective carbon sinks, particularly those found in the temperate zones, such as those in Fiordland. Much of this research was led by Associate Professor Christopher Moy, a geologist at New Zealand's University of Otago. His research in Fiordland is playing a key role in better understanding the dynamics of human-induced climate change and the operation of carbon sinks. It is important foundational research that has significant implications beyond Fiordland. One of the key aspects of Associate Professor Moy's work is the collaborative approach his research has taken. He has worked and continues to work with many different researchers and groups, such as the Fiordland Marine Guardians, accessing their local knowledge and expertise.

Other research into Fiordland as a carbon sink is being conducted by climate scientists working at New Zealand's NIWA. They are researching the effectiveness of Fiordland's forests in absorbing and storing carbon. This has involved using remote vehicles to collect regular air samples well out to sea in the remote oceans off Fiordland and comparing the chemical structure of the air to samples of air taken on land Fiordland.

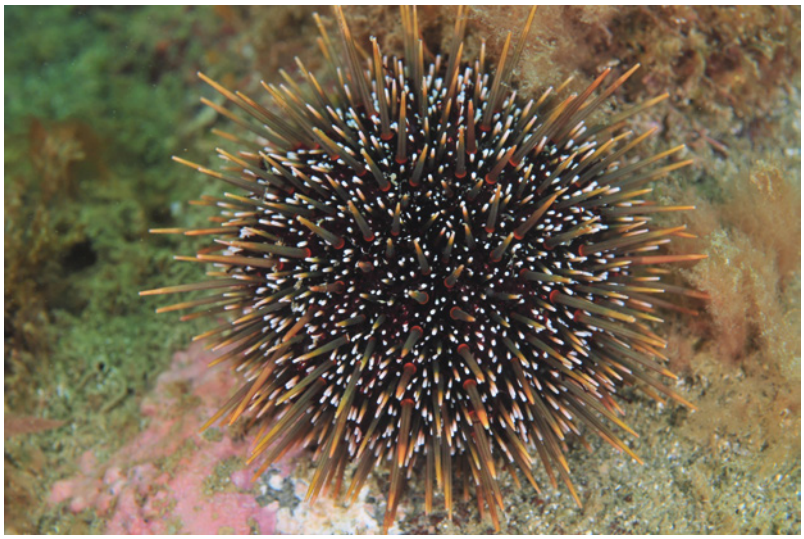
13.6.1 Fur seal surveys are now conducted regularly in Fiordland to assess the population.

Conservation research

Fiordland is a unique environment and its ecology contains many rare and endangered species. A key aspect of successful management of the ecosystem is research to collect data on flora and fauna throughout the park. For example, it is essential to gather baseline data on introduced species so that the effectiveness of control measures can be assessed and adapted as needed. The DoC is a leader in this work, as introduced species pose such a threat to the park.

Such work is also essential for creating baseline data for native species within Fiordland (see Figure 13.6.1). For many years this work was neglected, meaning much of the data is outdated. Slowly, this work is starting again. In 2021, a new initiative was launched by the DoC to begin comprehensive surveys of fur seals across Fiordland. This was vital research as the last survey was more than 50 years old. This new data can be used to evaluate the impacts of human modifications, such as climate change, and to assess the effectiveness of management strategies.

A similar project to survey species numbers has recently begun looking at kina (see Figure 13.6.2). This is a type of sea urchin that is sometimes considered to be a good indicator of Fiordland's marine ecosystem health. They are a native species, but if their numbers become too great, they can quickly impact the overall food chain causing a dynamic disequilibrium to occur. By conducting regular research on the kina, environmental scientists are better able to assess the impact of management strategies. For example, researchers are currently comparing populations of kina within the marine reserves in Fiordland with populations outside of the reserves.



13.6.2 Kina, a type of sea urchin

SPOTLIGHT

The Tawaki Project

The tawaki, or Fiordland penguin, is one of the iconic animals of Fiordland. It is one of the rarest penguins in the world and has experienced significant population decline in recent decades. They are found on a mere 500-kilometre stretch of coastline along the south-west coast of South Island. The Tawaki Project is a joint initiative of three environmental NGOs—Tawaki Trust, Global Penguin Society and Antarctic Research Trust—along with the University of Otago.

The Tawaki Project is undertaking research to better understand the spatial distribution of the tawaki, including where they go when at sea and to what depths. Their feeding and breeding habits are also important parts of the research. A thorough understanding of these aspects of the species is critical in developing effective strategies to manage and support their population within Fiordland.

Activities

Acquiring and processing geographical information

1 Explain the importance of carbon sink research in Fiordland.
2 Explain why baseline data are so important in ecosystem management.
3 Outline why research into kina is helpful in managing the Fiordland ecosystem.

Applying and communicating geographical understanding

4 Write a paragraph explaining research into carbon sinks in Fiordland.
5 Using examples, write a short report on conservation research in Fiordland.
6 Using the internet, undertake research into a current project in Fiordland concerning introduced species. Prepare a summary of this research.

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AIMS: Kate Green, p. 404c; Cathie Page, p. 404t; Christian Miller, p. 404b; Marie Roman, p. 404c (all).

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MODULE

G1 Exam skills: Extended-response questions

Note for students, parents and teachers

This module is intended only to supplement, reinforce and support the advice and materials provided by NSW Education Standards Authority (NESA). See the web addresses below for key information.

The first HSC examination for the revised Geography Stage 6 Syllabus will be held in 2025. At the time of writing, a sample examination for this syllabus is available at the last web address below.

Syllabus information, advice and support materials provided by NESA:

https://curriculum.nsw.edu.au/learning-areas/hsie/geography-11-12-2022/overview

NESA glossary:

https://curriculum.nsw.edu.au/resources/glossary

A NESA sample examination along with sample marking for the revised Geography Stage 6 Syllabus:

https://library.curriculum.nsw.edu.au/341419dc-8ec2-0289-7225-6db7f2d751ef/cd5456a2-4dfb-421d-91ea-192cce8376d2/geography-11-12-annotated-sample-examination-materials.PDF

This digital-only module offers support to students preparing to write extended responses in the HSC examination for the revised Geography Stage 6 Syllabus. This guide has developed its examples from the Year 12 syllabus focus area Rural and Urban Places.

How to begin

Before writing an extended response on the focus area Rural and Urban places, consider the advice included this module on:

- interpreting the question
- planning your response
- incorporating these elements in your response:
  - geographical terms
  - sources from the stimulus booklet
  - fieldwork and/or illustrative examples
  - geographical tools

G1.1.1 A rural place, Lake Sempach, Central Switzerland

G.1.2 An urban place, Hong Kong SAR, China

Interpret the question

Read all exam questions carefully to understand what you're being asked to write about. There is not a lot of time in an exam setting, but it is critical to spend some time interpreting the questions

Interpreting an extended-response exam question involves identifying the three main parts of the question. The three main parts are the directive term, the content area and the context. Breaking down the question in this way will help you to better understand it. When you understand the question, you will be better equipped to plan and write your response.

Read the extended-response question example below. Then read the instructions to help you interpret it.

Analyse the interdependent relationships between rural and urban places and their functions.

Guide to interpretation:

- directive term
- content area
- context

According to the NESA glossary of keywords, the directive term for this response is as follows.

Analyse: identify components and the relationship between them; draw out and relate implications.

According to the NESA Geography Stage 6 Syllabus, the areas of content and context include the following.

Analyse the interdependent relationship between rural and urban places and how this is demonstrated in their function for one another.

ACTIVITY

Interpret the question

Refer to the advice about interpreting an extended response exam-style question presented on pages 2 and 3, to help you complete this activity.

This is Question 21 in NESA's sample HSC examination. It is a structured extended response question with three parts: (a), (b) and (c).

Question 21:

Refer to the information below, Sources D, E and F in the Stimulus Booklet to answer Question 21.

(a) Describe geographical influences that have shaped the size and character of Denham.

(b) Explain how Denham and a rural place you have studied are linked to other places at a range of scales.

(c) Compare the potential changes that could affect Denham with the changes affecting an urban place that you have studied. In your response, refer to an urban place within a larger settlement.

Instructions

Write down each of the three parts of this question in your notebook.

Use the colour coding system to identify the directive term, the content and the context of each question.

Guide to interpretation:

- directive term
- content area
- context

Check your answers on page 4.

G1.1.3 Denham WA

Common directive terms

Below are some NESA definitions of common directive terms and their definitions.

- **Analyse:** identify components and the relationship between them; draw out and relate implications.
- **Compare:** show how things are similar or different.
- **Describe:** provide characteristics and features.
- **Contrast:** show how things are different or opposite.
- **Evaluate:** make a judgement based on criteria; determine the value of.
- **Explain:** relate cause and effect; make the relationships between things evident; provide why and/or how.

ACTIVITY ANSWERS

Interpret the question

Interpreting Question 21 (a)

Describe geographical influences that have shaped the size and character of Denham.

Guide to interpretation:

- directive term
- content area
- context

According to the NESA glossary, the directive term for this response is as follows. Describe: provide characteristics and features.

According to NESA Geography Stage 6 Syllabus, the areas of content and context include the following.

- Geographic influences, size and character: relevant geographical factors such as physical location, climate, topography, population and demographics, services and natural processes.
- Denham: this is the rural place given as the object focus of the question. Information and data about this rural place is detailed in a text source within the question and in the Stimulus Booklet in Sources D, E and F. Use these sources, referencing them, when responding to the question.

Interpreting Question 21 (b)

Explain how Denham and a rural place you have studied are linked to other places at a range of scales.

Guide to interpretation:

- directive term
- content area
- context

According to the NESA glossary, the directive term for this response is as follows. Explain: relate cause and effect; make the relationships between things evident; provide why and/or how.

According to information in this textbook and the NESA Geography Stage 6 Syllabus, the areas of content and context include the following.

- Linked to other places at a range of scales: These links refer to connections to other places at local, regional, national or global scales. These connections could be economic, political, social, cultural or environmental links. Your response will need to refer to a variety of different scales, not just one.
- Denham and a rural place: Denham is the rural place given as part of the object focus of the question. Information and data about this rural place is detailed in a text source within the question and in the Stimulus Booklet in Sources D, E and F. Use these sources as your information about Denham and reference them when responding to the question. You are also required to provide specific details about another rural area that you have studied. Using geographical information about Denham and another rural place, you will answer the question.

Interpreting Question 21 (c)

Compare the potential changes that could affect Denham with the changes affecting an urban place that you have studied. In your response, refer to an urban place within a larger settlement.

Guide to interpretation:

- directive term
- content area
- context

According to the NESA glossary, the directive term for this response is as follows. Compare: show how things are similar or different.

According to information in *Global Interactions 12* and the NESA Geography Stage 6 Syllabus, the areas of content and context include the following.

- The potential changes that could affect: the spatial patterns of poverty and wealth may include where, when, how much, who, changes over time and connection to broad patterns, as well as specific suburbs of the chosen large city.
- Denham: Denham is the rural place given as part of the object focus of the question. Information and data about this rural place is detailed in a text source within the question and in the Stimulus Booklet in Sources D, E and F. Use these sources as your information about Denham, making explicit mention of them when responding to the question.
- An urban place that you have studied: Choose an urban place that you have already studied, that you are confident in your understanding of its changes, including the causes and effects that have made it the urban place it is today. Consider choosing one of the chapter case studies from *Global Interactions 12*. You may choose to mention Darling Harbour and the Bays Precinct, New York City or Mumbai, which are the case studies in section two of the book.
- Urban place within a larger settlement: When considering your urban place for this response, choose an urban place that is not isolated but situated within a larger context of its settlement. Think about places that are interconnected not only to their own geographical location, but to other global urban places.

Plan the response

Although not directly assessable, spending two or three minutes creating a plan for your extended response in an exam can help you organise your thoughts and keep you focused on the question when you are writing your response. It will enable you to develop a structure and identify the key points to be addressed in your response. It can be helpful to use writing structures such as sub-headings and dot points to organise the paragraphs.

A potential structure for a plan to answer Question 21 (b) in NESA's HSC sample exam is outlined below. Please note this is only one method of structuring a response. You may find another way of structuring a response more beneficial to you.

To help you plan your response, consider the instructions and outline for this example extended-response question.

To create a plan for your response, start by referring to your interpretation of the question. See the box below.

Interpretation of Question 21 (b)

Explain how Denham and a rural place you have studied are linked to other places at a range of scales.

Guide to interpretation:

- directive term
- content area
- context

Here is the suggested interpretation of the question.

- Explain: relate cause and effect; make the relationships between things evident; provide why and/or how.
- Linked to other places at a range of scales: These links refer to connections to other places at local, regional, national or global scales. These connections could be economic, political, social, cultural or environmental links. Your response will need to refer to a variety of different scales, not just one.
- Denham and a rural place: Denham is the rural place given as part of the object focus of the question. Information and data about this rural place are detailed in a text source within the question and in the Stimulus Booklet in Sources D, E and F. Use these sources as your information about Denham and reference them when responding to the question. You are also required to provide specific details about another rural area that you have studied.

The interpretations of each part of the question presented above offer a great start to the type of content to include in your response. The next step is to organise these content descriptions into a structure.

Structure

Structuring is an important part of creating your plan. It creates a skeleton on which the information can be organised. A simple structure with a clear introduction, a clear body with various paragraphs that present information and a succinct conclusion that summarises the key points addressed in your extended response is an example of a structure. A simple structure like this is suitable for an extended response at Year 12 level.

INTRODUCTION (1 paragraph)
BODY (4–5 paragraphs)
CONCLUSION (1 paragraph)

The number of paragraphs you should include in an extended response depends on the question's overall weighting in the exam.

Consider how many marks the question—in this case, the particular part of the question—is worth and how long it is recommended for you to answer the question.

NESA recommends you only spend 35 minutes in total on the whole of Question 21. Part b is worth six marks. This doesn't give you a lot of time to spend on this question, so 4–5 paragraphs are the maximum you should write for the body of question 21 (b).

PLAN

The following suggested plan uses previous knowledge of Tamworth as the comparative rural place that was studied in *Global Interactions 12* case study in Chapter 7. The following planned response could be amended, added to, clarified and elaborated on, or adjusted to suit your chosen rural place and its features. Note that this structured plan here is only one of many ways you could choose to structure and organise your response.

Planning tips	Plan structure and the descriptions of the content	Content ideas for Question 21 (b) response

INTRODUCTION (1 paragraph)

- Provide a thesis statement on the extent to which Denham and Tamworth are linked to other places at a range of scales.
- If there is room, include in the introduction (and/or also throughout) your answer your understanding of the scales of local, regional, national and global links by referring to them.
- Provide a brief description Denham and Tamworth, including reference to their location, situation, physical geographical features, demographics that make up the place, a brief history of its settlement and its role in its broader social context.
- Introduce the criteria of evaluation that you will be using in your discussion of both Denham and Tamworth as being linked to other places, such as cultural links, economic links and transport links.

Subheadings can assist you in planning and structuring your response and can also make it easier for the marker to follow your response. For instance, if you're discussing links between different places, you could use subheadings to identify each type of connection. An alternative approach would be to organise your response under subheadings for each location, Denham and Tamworth.

BODY (4–5 paragraphs)

Cultural links (paragraphs 1 and 2)

Use paragraphs 1 and 2 to describe your first type of link. In this case, it could be the cultural links between Denham and Tamworth with other places.

Economic, social, cultural and environmental links are ways that places are linked to each other. You will need to decide which links your response focuses on. As it's a 6-mark question, you can't cover all four types extensively. Reflect on the links to other places of your studied rural place and compare it to the information about Denham in the exam materials. Avoid discussing types of links not mentioned about Denham in the question or Stimulus Booklet just because you're familiar with them in your rural place.

In paragraph 1, identify the cultural links of Denham to other places. Note that you will need to rely on the text source information supplied as part of the question and the three visual sources in the Stimulus Booklet. Use these to make some general assumptions about Denham's cultural links.

Paragraph 1 could include:

- Denham, the main settlement in Shark Bay, Western Australia, is a tourist hub for the UNESCO World Heritage Area, drawing about 100 000 visitors yearly.
- The majority of visitors come to Wulyibidi (Peron Penisula) to see wildlife and natural features and go on cultural tours.
- Denham shares cultural ties with Wulyidibi (Peron Peninsula) and the wider Shark Bay area.
- Denham's location on Malgana Country is of ongoing cultural connection and significance to First Nations peoples.
- Denham's speedway could serve as cultural link, drawing motorsport enthusiasts from surrounding towns and potentially interstate or international visitors.

Where information is supplied as part the exam, in the case of Denham, your response should use the specific information provided in the exam question and in the Stimulus Booklet to make key points. In some cases, you may need to analyse these sources closely to extract information. Reference these sources in your response.

In paragraph 2, identify Tamworth's cultural links to other places. Your knowledge of Tamworth will be based on your previous study of this rural centre and what you remember about it.

Paragraph 2 could include:

- Tamworth has a strong cultural and community identity, with residents attached to their Tamworth heritage.
- Tamworth has a multicultural population with family links to around 80 countries. Around 25 per cent of residents have one parent born overseas.
- Tamworth is Kamilaroi Country and has strong historical ties and is of ongoing cultural importance to the Kamilaroi people.
- Sister city relationships include Gore District Council (Southland, New Zealand), Chaoyang District (Beijing, China), Nashville (Tennessee, USA), Sannohe Town (Aomori Prefecture, Japan), and Tamworth Borough Council (Staffordshire, England).
- Particularly strong connections exist between Tamworth and Gore and Nashville due to a mutual interest in country music.

Where your response relies on existing knowledge of places you have previously studied, try to present specific examples and details to show your understanding.

Planning tips	Plan structure and the descriptions of the content	Content ideas for Question 21 (b) response

Where information is supplied as part the exam, in the case of Denham, your response should use the specific information provided in the exam question and in the Stimulus Booklet to make key points. In some cases, you may need to analyse these sources closely to extract information. Reference these sources in your response.

Where your response relies on existing knowledge of places you have previously studied, try to present specific examples and details to show your understanding.

Transport links (paragraphs 3 and 4)

Use paragraphs 3 and 4 to describe the second type of link. In this case, it could be the transport links that Denham and Tamworth have with other places.

In paragraph 3 identify the transport links of Denham to other places. You will have to closely review the information given to you in the question and the Stimulus Booklet. Make some general statements and assumptions about Denham's transport links.

In paragraph 4, write about Tamworth's transport links to other places. Remember that in your response you should make explicit reference to specific details about the rural place you have studied. Do not be vague. Use specific examples to reinforce your argument.

CONCLUSION (1 paragraph)

Conclude your response with a statement of overall evaluation on the extent to which Denham and Tamworth are connected and interdependent on other places. Briefly summarise the key points made in your earlier paragraphs to support your thesis about how both these places are comparatively connected to other places in a number of ways, at a range of scales. You may choose to end by naming other deeper links not yet mentioned, or the potential for future links in other criteria for both these places, such as sustainability.

Paragraph 3 could include:

- Denham is located 837 kilometres north of WA's capital city, Perth. This distance is connected through the main highway that runs adjacent to the west coast of Australia.
- Denham is linked by transport to Perth and other rural places by road and by air, via its airport.
- Source E indicates Denham has a caravan park, suggesting that Denham attracts people from other places travelling by caravan and has a need to provide services to those travellers.
- Source D indicates an airport, which suggests Denham has transport links with other rural places in the region at the local level, Perth, as well as being connected (or the potential to be connected) to other places at national and potentially global scales.

Paragraph 4 could include:

- Tamworth is accessible via major highways: the New England Highway from Newcastle to north of Toowoomba, and the Oxley Highway from Port Macquarie to Nevertire.
- North Western Line connects Sydney and Armidale via Tamworth by rail, with NSW TrainLink serving regional areas.
- The Tamworth Intermodal Rail Line links West Tamworth and Westdale locally.
- Tamworth Regional Airport offers flights to Sydney, Brisbane, Melbourne and the Sunshine Coast, connecting nationally.
- Operated by Tamworth Regional Council, the airport hosts Qantas Link Dash 8, International Flight Training, BAE Systems and CAE Australia Flight Training, serving as economic links state-wide and nationally.

Quick plans for responses

The plan provided on pages 7 and 8 is quite a detailed one. In an exam situation, time is a factor. If you are running low on time, you can still create a basic plan for your response. Some quick plans are included here for some example responses to questions.

Alternatively, you can use these basic plans to build out a more detailed plan.

If the question asks you to ...	You should respond by ...
Compare the differences between rural and urban settlements, giving examples of specific rural and urban settlements you have studied.	Begin by defining the terms rural and urban settlements, naming different rural and urban settlements (i.e., hamlets, villages and small towns, as well as cities and megacities). Outline the differences between rural and urban places (such as trends in location, climate, population, function, liveability, access to facilities and healthcare, etc.). Incorporate in your response, similarities or differences any other rural and urban places you have studied in class (i.e., Tamworth for a rural region, or Mumbai for an urban region).

If the question asks you to ...	You should respond by ...
Describe the importance of coasts in terms of settlement location, giving examples of other large coastal settlements.	Define coastal settlements and outline the various factors that influence the size and spatial distributions of the settlement location, making special mention of different influences for coastal settlement (such as providing a suitable climate, natural resources and economic development suitable for large settlements). Remember to make explicit mention of different coastal settlements you have studied and why such settlements have been so successfully settled, such as Alexandria, Egypt for location, the US East Coast for climate and topography, the port of Rotterdam in the Netherlands for economic development. Focus on more than one coastal settlement and give detailed examples or case studies that may have been covered in class or in *Global Interactions 12*, and any examples from the Stimulus Booklet you are given in the exam. You are also welcome to use other known illustrative examples from the recent news and media that will support your response.

If the question asks you to ...	You should respond by ...
Explain what is meant by urban sprawl, giving details about one other case of urban sprawl that you have studied.	Begin by defining urban sprawl and how urban sprawl has transformed in recent centuries since the introduction of new transportation, such as railways and cars. Mention at least one other case study of urban sprawl you have studied (e.g. Wilton and Appin outside Sydney). If you cannot remember one studied in class, mention other known illustrative examples from recent news and media that will support your response.

If the question asks you to ...	You should respond by ...
Analyse the key elements of the smart growth approach to urban planning, giving example of one urban city that you have studied that has successfully used smart growth strategies.	Begin by defining the term smart growth, and outlining the key elements of smart growth strategies, giving an example (i.e., Portland Oregon, USA). This explicit example should be the example that you mention as the city that has successfully used smart growth strategies. Mention at least one other urban city that has used smart growth strategies. This can be a case you have studied in class or from recent news and media.

Use geographical terms in your response

Sustained and appropriate use of geographical terminology that is specific to geography is important to include in exam-style responses. Using the correct geographical terminology in the right context demonstrates a rich, deep and genuine understanding of geography and the focus area(s) being addressed in the question.

Use geographical terms relevant to the content area of the question. For example, in your extended response to a rural and urban places question, you might use terms such as remote settlement, metropolitan area, megacity and urban sprawl.

Include brief definitions of all geographical terms you use. Your definition of metropolitan area might read, 'A metropolitan area refers to a city including its commuting zone, as well as suburban, peri-urban and rural areas that are economically and socially linked to the city, such as New York City.'

ACTIVITY

Use geographical terms

Download Worksheet 2 from the Worksheets toolbox in the Student Resources folder and complete the activities. Refer to the image to navigate to the worksheets in the eBook edition.

Below are some key terms associated with the study of rural and urban places according to the revised NESA syllabus. Typically, it is expected that such terms would be included throughout any short answers and extended responses.

Brownfield	Settlement
Conurbation	Situation
Hamlet	Spatial distribution
Hinterland	Threshold
Interdependence	Urban agglomeration
Liveability	Urban sprawl
Megacity	Village
Peri-urban	

Using sources from the Stimulus Booklet in your response

The Stimulus Booklet contains a range of geographical data and information, typically in the form of any combination of text, graphs, tables, diagrams, photographs, maps and other visual representations.

While the data in the Stimulus Booklet has specific applications within many of the multiple-choice and short-answer questions, it is also designed to be interpreted, applied and used to reinforce key arguments you are making in your extended responses.

It is anticipated that students will not have specifically studied the places, environments, communities and activities profiled in the Stimulus Booklet. However, it is expected that students will know how to interpret and apply the data and information in the context of the question, while also incorporating examples of known case studies and content related to the HSC course.

Closely review the sources in the exam's Stimulus Booklet that relate to the question. Incorporate data and information into your response to support key points and to demonstrate your application skills.

Types of sources in the Stimulus Booklet

Figures G1.1.4 to G1.1.9 are examples of types of geographical data and information about rural and urban places that may be included in a Stimulus Booklet. These include text, graphs, tables, diagrams, photographs, maps and other visual representations. Each of these sources can be interpreted and applied individually and/or collectively to support points being made in an extended-response answer.

SPOTLIGHT

Rural NSW's GP crisis

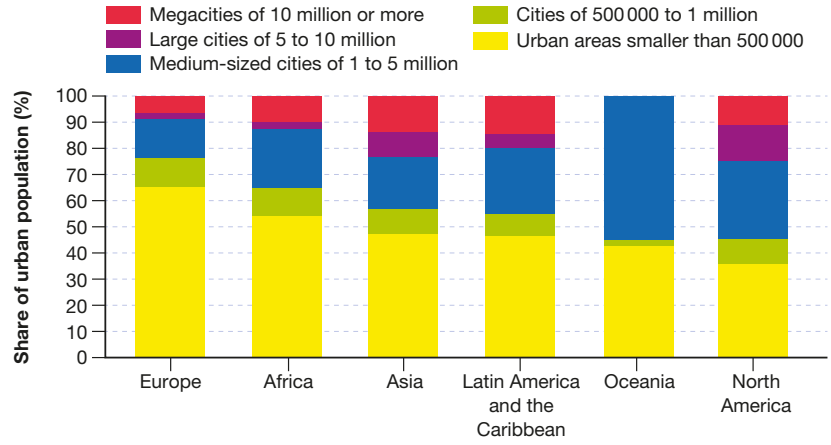
While Australia has one of the world's highest ratios of doctors per head of population, this workforce is not evenly distributed. In late 2022, towns across NSW were facing critical doctor shortages.

Authorities reported that there were fewer than 200 general practice (GP) proceduralists (those who also work as doctors at local hospitals) working in rural NSW. It is feared that this number could dwindle to fewer than 100 by 2030.

The lack of GPs has been blamed on financial pressures that threaten the sustainability of rural practices, the increasing specialisation of the medical workforce and generational change as the decreasing number of rural GPs struggle with increasing workload pressure, discourage young doctors seeking a better work-life balance.

Clearly, there is a need to develop strategies that will attract GPs working in urban places to rural places, as well as providing additional support to those already based regionally. If nothing is done, at least 45 towns across the regional NSW are at risk of being without a GP within the next 10 years.

G1.1.4 This Spotlight text feature is an example of a text source about rural places.

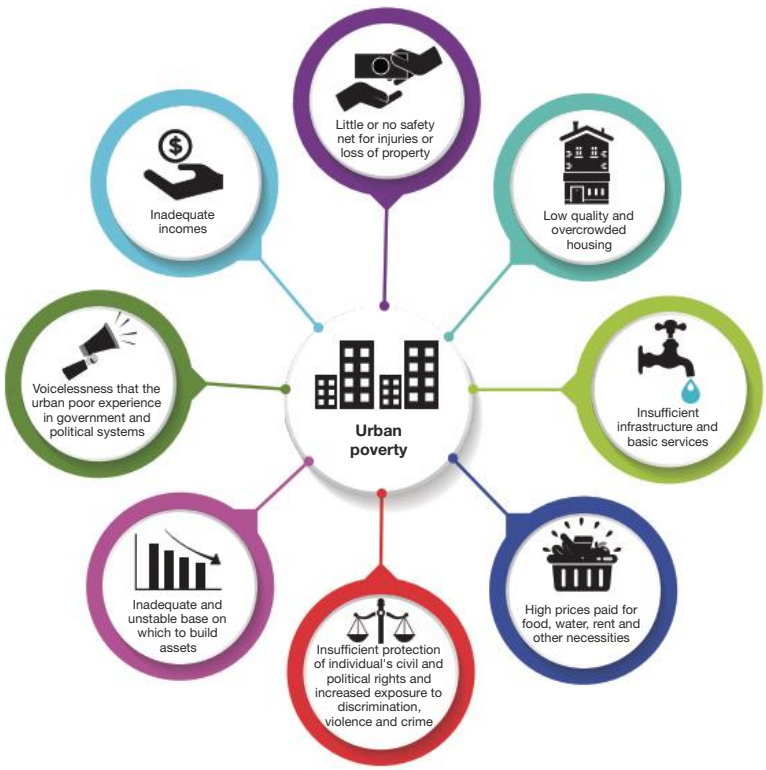


G1.1.5 This stacked bar graph about city population distribution is an example of a graph source about urban places.

Borough	Population 2010	Population 2020	Population increase	Rate of increase (%)
Brooklyn	2 504 700	2 736 074	231 374	9.2
Queens	2 230 722	2 405 464	174 742	7.8
Manhattan	1 585 873	1 694 251	108 378	6.8
Bronx	1 385 108	1 472 654	87 546	6.3
Staten Island	468 730	495 747	27 017	5.8

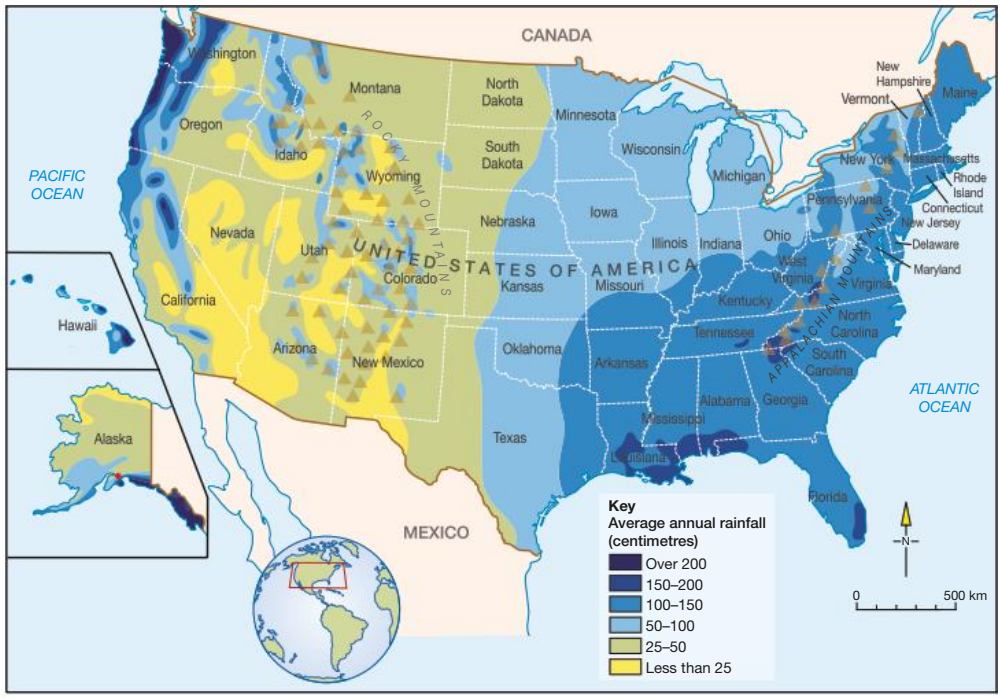
Source: US Census

G1.1.6 This population table is an example of a table source about an urban place.



G1.1.7 This spider diagram about urban poverty is an example of a diagram source about urban places.

G1.1.8 This photograph is an example of a photograph source about a rural place.



G1.1.9 This rainfall map is an example of a map source about rural and urban places.

● **ACTIVITY**

Using sources from the Stimulus Booklet

For this activity, you are answering Question 21 from the NESA HSC sample exam. These are the three parts of that extended response question:

(a) Describe geographical influences that have shaped the size and character of Denham.

(b) Explain how Denham and a rural place you have studied are linked to other places at a range of scales.

(c) Compare the potential changes that could affect Denham with the changes affecting an urban place that you have studied. In your response, refer to an urban place within a larger settlement.

Instructions

Write down the three parts of Question 21 listed above.

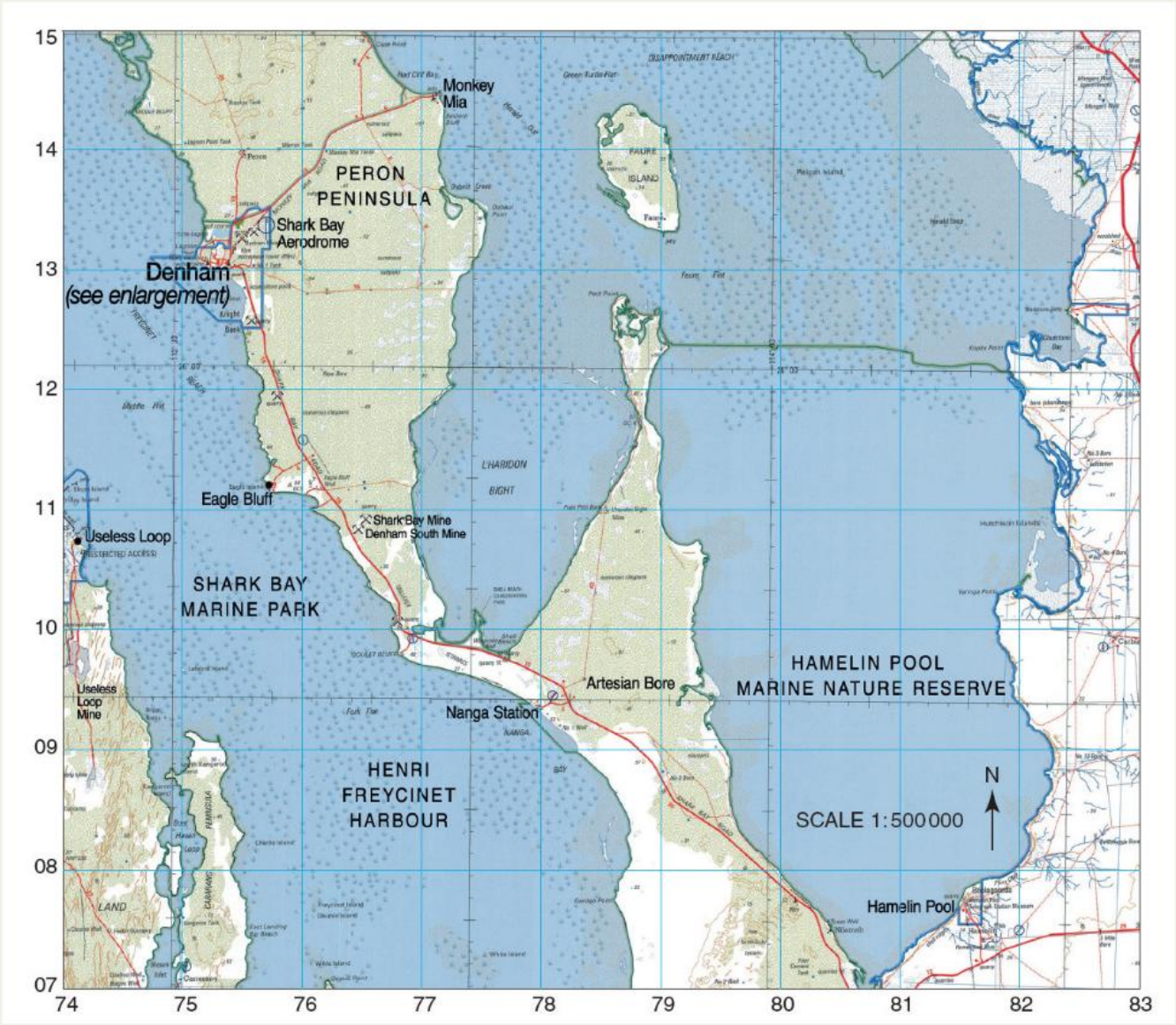
Closely review the four sources that relate to Question 21. One of these is a text source, which is included on the same page as the question in the sample exam. The three others are listed as sources D, E and F in the sample exam Stimulus Booklet. The four sources are shown below as Figures G1.1.10 to G1.1.13.

Make notes about the key elements from each of the sources that you could use to support your argument in your response to each of the three parts of the question.

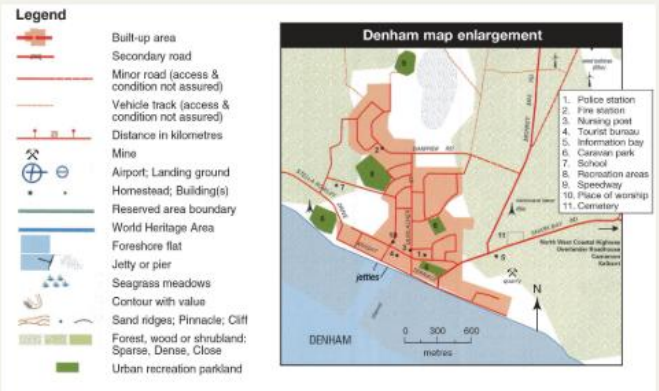
See answers on page 17–20.

> Denham is the main settlement in the Shark Bay area on the coast of Western Australia on Malgana Country. It is located 837 km northwest of Perth (25°55'S latitude). There is an average rainfall of approximately 222 mm per year with approximately 23 wet days. Denham has fewer than 1000 residents and is the main tourist centre of the UNESCO Shark Bay World Heritage Area. It provides goods and services for residents and visitors. Shark Bay attracts approximately 100 000 visitors each year, many of whom come to Wulyibidi (Peron Peninsula) to experience the wildlife, natural features and cultural tours.

G1.1.10 The text source included as one of the sources to use for Question 21 on the NESA sample HSC examination.



G1.1.11 Source D: Shark Bay topographic map extract (Western Australia)—one of the sources to use for Question 21 of the NESA sample HSC exam.



G1.1.12 Source E: map enlargement—one of the sources to use for Question 21 of the NESA sample HSC exam.

G1.1.13 Source F: Denham (photograph)—one of the sources to use for Question 21 of the NESA sample HSC exam.

ACTIVITY ANSWERS

Incorporate sources from a Stimulus Booklet

There is a lot of geographical information included in these sources, much of which can be used to support your response. For example in answering:

- Question 21 (a) you might use the text source in G.1.10 to describe the average rainfall in Denham.
- Question 21 (a), you might use Source D to describe Denham's site on the Peron Peninsula.
- Question 21 (b) you might use Source E to identify that Denham has a tourist bureau.
- Question 21 (c), you can use Source F to see that Denham is on the coast and largely flat, which may inform potential changes that you suggest could affect Denham.

Use fieldwork and illustrative examples in your response

Use fieldwork or illustrative examples to support the key points of your response to help demonstrate your geographical knowledge and understanding.

Fieldwork

Fieldwork refers to a geographical inquiry and investigation completed in a particular environment or place. It uses both primary and secondary research methodologies to explore and determine an answer to an inquiry question. The Rural and Urban Places topic provides an opportunity for fieldwork to be completed in a large city, regional centre, small town, country town or suburb.

The primary research methodologies need to include data (quantitative) and information (qualitative). Examples of fieldwork activities that use primary research methodologies in urban and rural places could include observation notes, annotated field sketches, taking photographs, interviews, and/or tallies of building or transport types in the chosen place.

Secondary research methodologies are used to support and add depth, and/or provide points of similarity or difference to the data and information collected in the field.

Illustrative examples

Illustrative examples are known examples from the media. These examples may come from newspaper articles, podcasts, documentaries or books. These examples should support your key points. They can be useful to also demonstrate your application skills and your understanding of recent events or issues that affect a range of urban places at a variety of scales.

ILLUSTRATIVE EXAMPLES FOR RURAL AND URBAN PLACES

There are many illustrated examples included in *Global Interactions 12*, throughout the main text and especially in the Spotlight features throughout the book. Some illustrated examples of rural and urban places from the book are included below.

● SPOTLIGHT

Las Vegas: Defying the restraints of climate

Las Vegas (see Figure 6.2.5) is a city that has grown rapidly, despite its location in one of the driest parts of the United States. The city's population has increased from 530 000 in 1984 to 2 899 000 in 2023, making of one of the fastest growing cities in the country. The growth has been driven by the city's large gambling, convention and entertainment industries. Together these attracted 38.8 million visitors in 2022. This influx creates jobs for skilled and unskilled workers who flood into the city.

The city's rapidly expanding urban area (see Figure 6.2.6) is located within a basin on the floor of the Mojave Desert and is surrounded by mountain ranges. The landscape is rocky and arid, with drought-resistant vegetation. The peaks surrounding Las Vegas reach elevations of over 3000 metres and act as barriers to the flow of moisture.

Amid a prolonged megadrought that has depleted water resources across the South-West USA, the need to save every drop of water has intensified. Water conservation is now a way of life in Las Vegas. Lake Mead, the city's principal source of water was at 45 per cent capacity in mid-2023. Strategies to reduce water consumption include the banning of mega-pools, water recycling, replacing 'non-functional' lawns with artificial turf or gravel, and restrictions on garden watering.

6.2.5 Las Vegas attracted 38.8 million visitors in 2022.

6.2.6 The Las Vegas urban area in 1984 and 2024

G1.1.14 This Spotlight is an illustrated example of climate impacts on an urban place and the human adaptations that the people of Las Vegas have made in addressing these challenges.

● SPOTLIGHT

Darling Square sustainability strategies

Darling Square was designed and promoted to be eco-friendly. Car access is restricted to enhance air quality, reduce carbon dioxide emissions and provide pedestrian-friendly spaces at street level (see Figure 8.4.5). Energy-efficient building design reduces the running time for air conditioners and heaters. Energy-efficient lighting is used in public spaces. Onsite car sharing is provided, and an active urban lifestyle is promoted through the provision of cycling facilities in public spaces and buildings. Additionally, all apartments include water-efficient fixtures, fittings and appliances. Smart water metering (a water meter that automatically tracks and records the amount of water you use in your home) is used throughout. A multiple green star rating was awarded for the five buildings within the precinct.

8.4.5 Providing landscaped pedestrian-friendly spaces at street level is an important consideration in areas dominated by high-density residential towers.

G1.1.15 This Spotlight is an illustrated example of how urban precincts can be designed with sustainability in mind. It outlines eco-friendly measures that have made Darling Square a multi-green star-rated building development.

Fieldwork for rural and urban places

Think about fieldwork activities you have completed during class and about fieldwork activities you could hypothetically do. If relevant, mention examples from fieldwork in your response to support key points and demonstrate your application skills.

Think about how you could apply the question you are given to a rural place if the fieldwork you completed was within an urban context, or vice versa.

When planning fieldwork, an overarching inquiry question will provide an organisational frame for your project. First, relevant and valid data need to be located, identified, collected and recorded, then synthesised and evaluated to form a response to the overarching inquiry question.

● **ACTIVITY**

Fieldwork using photographs

Complete fieldwork referring to the information under the heading, Use fieldwork and illustrative examples in your response on page 14 and using any combination of the Source 1 photographs in Figures G1.1.16 to G1.1.25.

Download Worksheet 1 from the Worksheets toolbox in the Student Resources folder and complete the activities.

Source 1: Urban scenes around New York City

G1.1.16 New York City, a place of great economic and cultural authority.

G1.1.20 Times Square is the entertainment heart of Manhattan and NYC more generally.

G1.1.23 Residential brownstone row houses on the Upper East Side of New York City.

G1.1.17 Iconic perspective of New York City's Manhattan Island, showing one of the most densely settled places on Earth.

G1.1.21 The New York Stock Exchange on Wall Street in the Financial District

G1.1.24 Homelessness is a product of the poverty experienced by some New Yorkers.

G1.1.18 Manhattan's Chinatown

G1.1.22 There are currently 41 theatres operating on Broadway.

G1.1.25 Traffic jam in Times Square

G1.1.19 Central Park in autumn

Use geographical tools

In exam situations, where time is limited, consider if you can show information or data more efficiently through graphs and statistics or other visual representations. Figures G1.1.16 to G1.1.21 are examples of geographical tools.

Where appropriate, use geographical tools to support your response. In extended-response questions that relate to the topic of Rural and Urban Places, there are many instances you might consider using geographical tools. Below are some examples.

- Provide graphs and tables to describe hierarchies of settlements based on population.
- Create a data table to report on urban growth at a global scale.
- Create a diagram to summarise the different relationships that exist between two places.

Sometimes a visual representation can support your answer. For instance, provide annotated sketch-maps to support your discussion about spatial distributions of remote settlements, villages, suburbs, regional centres, cities, megacities and urban mega-regions.

Example of a high-level extended response

The response that follows shows an example of a high-level response to Question 21 in the NESA HSC sample exam.

It demonstrates a clear structure as well as appropriate use of geographical terminology related to the subject of geography and the topic of Rural and Urban Places. The response below provides sustained, detailed use of specific case studies, as well as sustained and appropriate use of illustrative examples from the Stimulus Booklet. It also maintains a clear connection to the directive term of the question.

Question 21

(a) Describe geographical influences that have shaped the size and character of Denham. (4 marks)

Denham (as indicated in sources D, E and F) is a remote coastal settlement on the west coast of Australia in the state of Western Australia, located in the Shark Bay area. About 837 km north of Perth, and with a population of fewer than 1000 residents (as depicted in Source F), Denham is geographically isolated in comparison to other major rural areas in WA. Despite this isolation, Denham services the surrounding Shark Bay and Peron Peninsula region.

As indicated in Source D, Denham's is located near the Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve, both of which are popular tourist attractions. According to the data provided on Denham, most tourists come to Denham to visit the surrounding Shark Bay area to experience wildlife, natural features and cultural tours that are accessed via roads, jetties and watercraft, as depicted in Source E.

As seen in Source F, Denham is largely flat and sparse, with little vegetated landscape. This is supported by the data given that indicates that Denham only receives approximately 222 mm of rainfall annually, with a total of only 23 wet days. According to Source D, Denham has two mines and an airport, which both serves the local population and is a transport link to other regional hubs and places around the state and country. Source E highlights that Denham has a local police station, fire station, nursing post, tourist bureau, caravan park, a local school, a recreational park and at least one cemetery and one place of worship to service the local population. It also has a speedway.

These geographical factors and features combined with its unique context have contributed to Denham's size and character today.

(b) Explain how Denham and a rural place you have studied are linked to other places at a range of scales. (6 marks)

Please note: this response example follows the advice provided pages 6–7 of this chapter about planning a response to this question.

More about geographical tools

Find out more about Geographical tools in the revised syllabus on the NESA website.

https://curriculum.nsw.edu.au/learning-areas/hsie/geography-11-12-2022

Note for students, parents and teachers

Core information and support materials for the sample exam, including sample marking guidelines, are included on the NESA website. **A NESA sample exam along with sample marking for the revised Geography Stage 6 Syllabus** are found here:

https://library.curriculum.nsw.edu.au/341419dc-8ec2-0289-7225-6db7f2d751ef/cd5456a2-4dfb-421d-91ea-192cce8376d2/geography-11-12-annotated-sample-examination-materials.PDF

The high-level response included here to Question 21 in the NESA HSC sample exam is an example only, intended to show what a full response might look like based on NESA's marking guidelines for this sample exam.

Review NESA's sample response to Part A

Review the full sample answer for Question 21 (a) presented in marking guidelines of the NESA website:

https://library.curriculum.nsw.edu.au/341419dc-8ec2-0289-7225-6db7f2d751ef/cd5456a2-4dfb-421d-91ea-192cce8376d2/geography-11-12-annotated-sample-examination-materials.PDF

Introduction

Both Denham and Tamworth are linked to other places at a range of scales, particularly through their cultural and transportation links. With a population of fewer than 1000 people, Denham is a small rural town 837 km north of Perth in Western Australia in the Shark Bay area. Tamworth, by contrast, is a relatively large rural town with a population of 43 857 people in New South Wales and is a productive agricultural hub that serves the New England and North-West regions of NSW.

Cultural Links

As seen in Source D, Denham is the main settlement in the Shark Bay area of WA, and as such is the main tourist centre of the UNESCO Shark Bay World Heritage Area. This gives the area links to other global UNESCO sites as well as making it a popular tourist site on local, national and international scales. The popularity of the site is evidenced by the approximately 100 000 visitors who visit each year. These visitors often come to the Wulyibidi (Peron Peninsula) to see the rich wildlife, natural features of the landscape and cultural tours. Denham is culturally linked predominantly and most significantly to the Wulyidibi (Peron Peninsula) and the broader Shark Bay area. Additionally, Denham is on Malgana Country and has important cultural links to the First Nations Australians from the area, whether they are living there now or have moved to other places.

Tamworth is the central regional hub for the areas that surround it, giving it strong cultural links across the region. Tamworth is on Kamilaroi Country and has strong ongoing cultural links with the Kamilaroi people that live there as well as those living in other places. Tamworth has established strong international cultural links as an official sister city of five other places: the Gore District Council, Southland, New Zealand; the Chaoyang District, Beijing, China; Nashville, Tennessee, USA; Sannohe Town, Aomori Prefecture, Japan; and Tamworth Borough Council, Staffordshire, UK. Tamworth's strong country music scene and its world-class equestrian centre attract people locally, regionally, nationally and internationally.

Transportation Links

A highway is the primary transport link that connects Denham to Perth and other rural places on the west coast of Western Australia. According to Source E, Denham has also a caravan park. This caravan park being almost right at the centre of Denham suggests that for a town with fewer than 1000 residents, Denham attracts caravaners and offers services to those travelling to Denham by motor vehicle. Additionally, according to Source D, Denham has Shark Bay airport. In this way, Denham also has transport links with other rural places in the region at the local level, as well as being connected (or the potential to be connected) to other places at the state, national and global scale.

Tamworth is on two major highways, the New England Highway from Newcastle to north of Toowoomba and the Oxley Highway from Port Macquarie and Nevertire. They are important local and regional transport links. The North Western railway serves as a state transport link to move passengers and cargo between Sydney and Armidale via Walcha, the NSW TrainLink, that serves NSW regional areas that also runs through Tamworth, connecting Tamworth to other local rural places at the regional level. Tamworth also has a regional airport that services national links via air travel from Sydney, Brisbane, Melbourne and the Sunshine Coast. It also offers an access point for international visitors.

Conclusion

Upon analysis, it is evident these two rural places have significant links at a range of scales with other places. Denham and Tamworth are both centres of activity for surrounding areas, though at very different sizes. Denham is the gateway for tourists into the remote Shark Bay area. Tamworth is a regional hub for its surrounding areas. Both Denham and Tamworth, as rural places are fundamentally linked and deeply connected to other places at a range of different scales. Both Denham and Tamworth have links that speak to their cultural, economic and transport connection to other places that attest to the interconnectedness of all places.

(c) Compare the potential changes that could affect Denham with the changes affecting an urban place that you have studied. In your response, refer to an urban place within a larger settlement. (10 marks)

Introduction

Although only a small city with a population of fewer than 1000 people, Denham has significant potential for change. This response details the potential changes that could affect Denham by considering the recent changes that have affected New York City, which is a significant urban place within a larger settlement of the United States. In outlining some economic and cultural changes that have affected New York City, this response identifies the similarities and differences of these changes as potential areas of change for Denham.

Changes For New York City

Economic—Economic restructuring

Perhaps one of the most obvious and notable changes to have taken place in New York City is the intentional economic restructuring of the city. New York has changed from being a primarily manufacturing economy (where goods are made and then distributed) to a service-based economy (where services rather than goods are exchanged). This change has had profound implications for the productive capacity of New York and has contributed to the vastly changing demographics, income distribution and social hierarchies in the city. As such, New York is largely susceptible to and deeply affected by any sudden changes to the economy, such as the Global Financial Crisis of 2008 or the COVID-19 pandemic and the associated lockdowns. In both examples, there were widespread rates of unemployment, especially in the services industries of leisure, entertainment and hospitality. These changes have resulted in a significant change in the spatial pattern of socio-economic classes, with people in lower socio-economic classes being relocated to the periphery of the metropolitan area.

Environmental—Climate change action

Despite being a large urban city, New York City and New York State are committed to being at the forefront against climate change. Although it produces large carbon emissions, New York City is committed to reducing its environmental footprint through different initiatives, such as Clean Path NY, which will provide more than 20 wind and solar power generation projects across New York State. When complete, these wind and solar projects will provide more than 7.5 million megawatt-hours of carbon emissions-free energy into New York City every year, reducing New York City's carbon emissions by 22% and removing 49 million metric tons of carbon dioxide in the atmosphere before 2040. This will not only provide an environmental benefit to the city but will also result in social benefits with improved air quality and a reduction in diseases associated with pollution. Additionally, New York City also plans on achieving 70% renewable energy by 2030 and 100% by 2040, in an effort to combat climate change. New York City has proposed to accomplish this by subsidising electric vehicles, helping private companies complete energy retrofits and introducing property taxes to incentivise solar energy use. Although the result of this change is not completely evident yet, the plan and actions to implement this change is historically a relatively new endeavour that seeks to actively make a positive impact to climate change.

Potential changes for Denham

Economic—Economic restructuring

Denham has the potential to be affected also by its economic restructuring. According to the evidence provided in Source D with the presence of a mine, it appears that Denham was at some point an economy focusing heavily on the mining industry. However, as outlined in the data given in the question, Denham is now described as a service-based economy, dependent largely on its tourism industry, with approximately 100 000 tourists visiting the area each year. As such, it is likely that Denham will also have to face the difficulties and challenges associated with economic restructuring.

Environmental—Climate change action

Considering the context in which Denham is situated, on the Coast of Western Australia, it would be a positive and beneficial change if Denham's council and population focussed on efforts on addressing sea-level rise and sustainability tourism in its context. Although the sources presented here do not indicate whether Denham is actively seeking to address environmental concerns relevant to its context, an area of potential growth and development for Denham would be to consider addressing rising sea levels in the Shark Bay area and taking steps to implement long-term goals towards sustainability tourism (in fishing, wildlife, bush tours etc.).

Conclusion

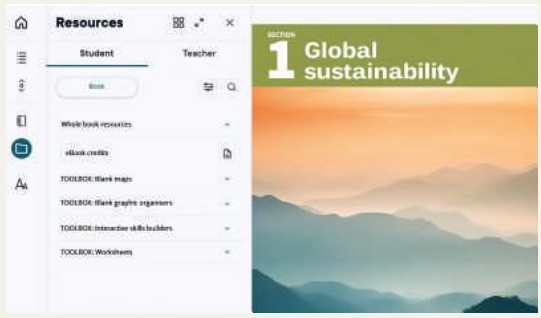
Urban places within a larger settlement, such as New York City, can offer some insights into how potential changes could affect a smaller rural place, like Denham. They can offer a glimpse of what rural places like Denham could become if they choose to implement the successful strategies for change as demonstrated by New York, as well as the potential challenges that it may face.

ACTIVITY

Assess the sample response

Once you have read the high-level extended response, complete an analysis and assessment of it in Worksheet 3.

Download Worksheet 3 from the Worksheets toolbox in Student Resources folder and complete the activities.



Example of a medium-level extended response

It can be useful to compare the difference between a high-level response and a less comprehensive response. The following is an example of a medium-level response to Question 21 in the NESA HSC sample exam.

Compare the potential changes that could affect Denham with the changes affecting an urban place that you have studied. In your response, refer to an urban place within a larger settlement.

Although this medium-level sample response demonstrates some use of geographical terminology appropriate to the subject of geography and the topic of Rural and Urban Places, it only provides a basic response to the question and no explicit reference to the sources provided in the Stimulus Booklet. This response does use the case studies studied in class, but only at a basic elementary level and not in any great depth or detail. Furthermore, there is also a loose connection to the directive term of the question. Instead, this response is more focused on regurgitating and manipulating content already present in the question and Stimulus Booklet rather than processing, interpreting, and applying the given data to communicate appropriate geographical findings.

Question 21

(a) Describe geographical influences that have shaped the size and character of Denham. (4 marks)

Denham coastal settlement north of Perth in the Shark Bay area on Malgana Country in Western Australia. Denham is relatively flat, dry and not well developed in infrastructure and industry or natural resources. Denham only receives about 222 mm of rainfall a year and has a population of fewer than 1000 people.

Denham serves as the central location for tourism area in the Shark Bay area and tourists come from all over the Peron Peninsula and Wulyibidi to see the wildlife, natural features and cultural tours.

(b) Explain how Denham and a rural place you have studied are linked to other places at a range of scales. (6 marks)

Introduction

Denham and Tamworth are rural places that are linked to other places at different ranges and scales. Two of these are their cultural and transportation links.

Cultural Links

Denham is the main rural centre in the Shark Bay area of Western Australia and is the main tourist centre in the area. There are about 100 000 visitors who come from the Wulyibidi each year to visit Denham. Denham is culturally connected to the area by offering different tours for those who come to visit.

Tamworth is also a rural centre in New South Wales. Tamworth has a long cultural connection to being Indigenous land by once held by the Kamilaroi people. Tamworth is also connected via technology (such as the internet and television) that make it linked to everyone else in the country and the world.

Transportation Links

Denham has a main highway that connects it to Perth and other small towns in Western Australia, which is the state level of connection to other places. Also, Denham has airport for landing of aircrafts enabling Denham to be connected via transport links to other places.

Tamworth is also connected to other places via two highways, including New England Highway from Newcastle to north of Toowoomba and the Oxley Highway from Port Macquarie to Nevertire. There is also a new train railway system being developed to help connect Tamworth more locally, linking Tamworth with Westdale more easily. Finally, Tamworth also has an airport with flights to and from Sydney, Brisbane, Melbourne and the Sunshine Coast.

Conclusion

Both Denham and Tamworth are linked to places at a range of scales. All these links show that rural Australian towns are very connected in many ways to different places, including both other rural and even urban areas.

(c) Compare the potential changes that could affect Denham with the changes affecting an urban place that you have studied. In your response, refer to an urban place within a larger settlement. (10 marks)

Introduction

There are many potential economic, cultural and environmental changes that could occur and affect Denham for the better, especially economically, socially, culturally and environmentally. These changes are compared to the changes that have affected New York City, a metropolitan urban place.

Note for students, parents and teachers

Core information and support materials for the sample examination, including sample marking guidelines, are included on the NESA website.

A NESA sample examination along with sample marking for the revised Geography Stage 6 Syllabus:

https://library.curriculum.nsw.edu.au/341419dc-8ec2-0289-7225-6db7f2d751ef/cd5456a2-4dfb-421d-91ea-192cce8376d2/geography-11-12-annotated-sample-examination-materials.PDF

The medium-level response included here to Question 21 in the NESA HSC sample exam is an example only, intended to show what a complete but not exemplary response might look like based on NESA's marking guidelines for this sample exam.

Changes for New York City

Economic—Economic restructuring

New York has changed from being a primarily manufacturing economy to a service-based economy. This economic change has affected the demographics, the income distribution and the social make-up of New York City including unemployment and decreased economic production, especially during economic disasters such as the COVID-19 pandemic.

Environmental—Climate change action

New York City has made recent legislative changes to reduce its carbon footprint. It is working to achieve this by installing new wind- and solar-generated power projects around the state, as well as helping private companies and businesses to achieve this with subsidies. New York City is also subsidising costs of electric vehicles and energy retrofits to these private companies.

Potential changes for Denham

Economic—Economic Restructuring

Denham also has the potential to be affected economically because of its restructured economy. Denham was once a mining settlement. But now, it has changed to be a service-based economy, with the primary industry being the tourism industry. This may mean that Denham could also experience economic disaster like New York, if its primary industry is solely tourism.

Environmental—Climate change action

Denham could potentially change to be more environmentally proactive against climate change. Because Denham is right by the ocean and is affected by rising sea levels, Denham could create public policies and initiatives that focus on implementing more sustainability in their marine tourism industry.

Conclusion

Urban places can offer a great source of inspiration to rural areas in the ways in which they can develop and transform for the better. Denham has great potential for positive economic, social, cultural and environmental change, after considering the changes that have taken place in New York City.

● **ACTIVITY**

Assess this sample response

Once you have read the medium-level extended response, complete an analysis and assessment of it in Worksheet 4.

Download Worksheet 4 from the Worksheets folder in the Student Resources folder and complete the activities. Refer to the image below to navigate to the Worksheets folder in the eBook edition.