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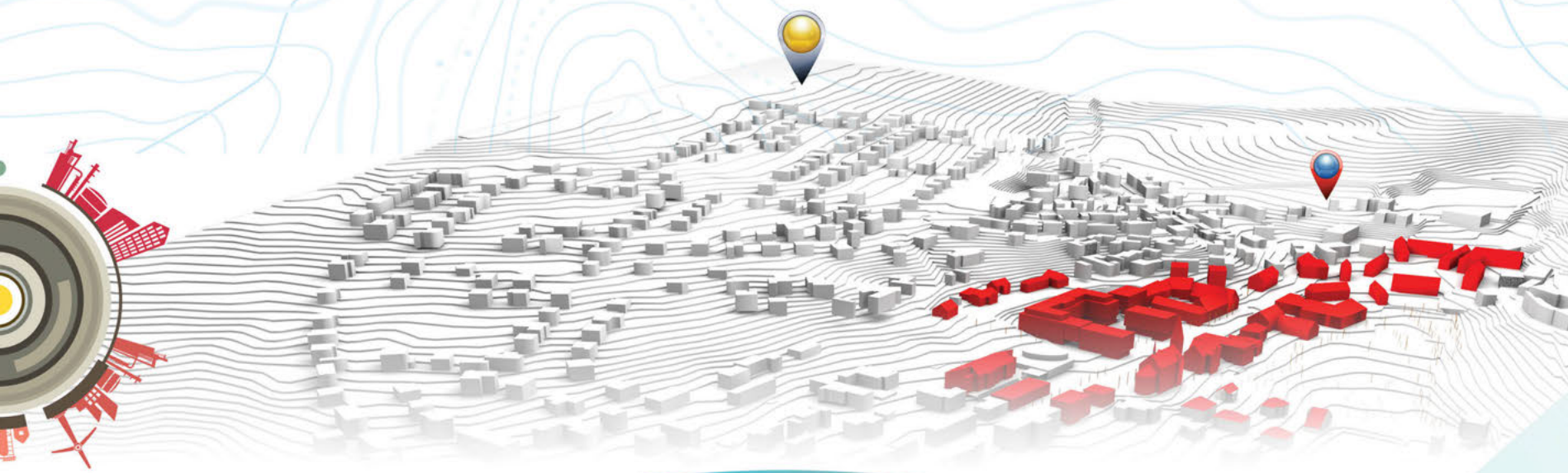
SKILLS IN GEOGRAPHY

Australian Curriculum



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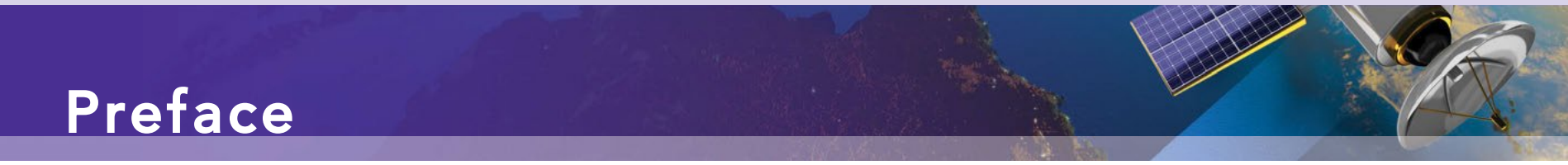
Preface



Skills In Geography: Australian Curriculum has been prepared for students studying the *Australian Curriculum: Geography* Years 7–10.

Featuring more than 350 items of stimulus material, the text guides students to a thorough understanding of the geographical tools and skills they are required to master, and provides them with opportunities to practise these skills. There is also an opportunity for students to develop their geography skills within the context of themes drawn from the Content Descriptors of the *Australian Curriculum: Geography*.

A detailed glossary is provided to help ensure that students know and understand the geography skills-based terminology used throughout the text.

The text is divided into nine sections:

- **Section One: Geography skills bank** provides a comprehensive coverage of the geography tools and skills students are expected to master in *Australian Curriculum: Geography* Years 7–10. Each skill is explained in clear, direct language and examples are provided where appropriate. For more complex skills, step-by-step instructions are included along with illustrative examples.
- **Section Two: Themes in Australian geography** provides students with a skill-based approach to major themes in Australian geography. Themes addressed include Australia's place and space, landforms and deserts, vegetation, climate, natural hazards, population and population movements.
- **Section Three: Australian topographic maps** provides students with the opportunity to apply their geography skills. It includes 20 large-format topographic map extracts plus related stimulus material (including climate data, satellite images and aerial and ground-level photographs) presented in an easy-to-use double-page format. Each map extract is accompanied by a graded set of activities. A special feature of this chapter is a focus on Gallipoli, a place special to many Australians.
- **Section Four: Themes in global geography** provides students with a skills-based approach to the study of major themes in global geography. Themes addressed include threats to the Earth's biomes, geomorphological hazards, population and urbanisation, global inequalities in human well-being, access to water and sanitation, food security, global connections, global tourism, global cruise industry, liveability of places and climate change.
- **Section Five: New Zealand** features eight topographic map extracts and associated activities. Of special note is the emphasis given to New Zealand's volcanic and glacial landscapes and landforms. Also included is a focus on New Zealand's climate.
- **Section Six: Papua New Guinea** provides students with a sequenced series of activities based on four large-format, topographic map extracts. The emphasis in this section is on PNG's coastal and mountainous landscapes. Also included are maps focused on the relationship between landform, climate and land use, and an examination of Australia's military campaign on the Kokoda Trail.
- **Section Seven: South America** features mountainous landscapes and also focuses on the Rio de Janeiro Summer Games 2016.
- **Section Eight: United Kingdom** features seven topographic map extracts highlighting the country's diverse urban and biophysical landscapes. In this section we also focus on perceptions of crime as an aspect of liveability.
- **Section Nine: Canada and the United States** provides five topographic map extracts and associated activities focusing on mountain and river landscapes. Also featured is a focus on the population and urban concentrations of North America.

The text is designed to supplement content-based geography textbooks, thus providing a balanced geography course focusing on both knowledge and skills.

The text can be used in a variety of ways. Teachers can elect to integrate the skills and thematic material covered in the text into the content of their lessons or they may opt for short, skills-based units of work at various stages of the course.

The text also lends itself to student-directed forms of instruction and would be an ideal resource for home-based study and revision.

Students using this text will develop a sound understanding of the skills central to the study of geography in secondary school.

Grant Kleeman

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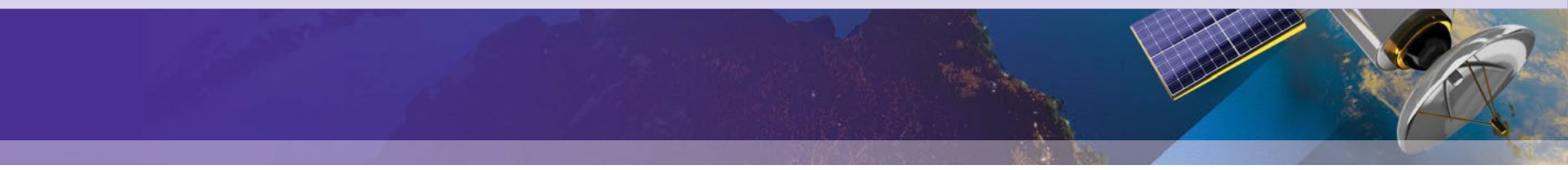

CURRICULUM MAPPING

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ABOUT THE AUTHOR

Dr Grant Kleeman is Director of Teacher Education at Sydney's Macquarie University. He is an experienced teacher educator, geography teacher, author, curriculum writer and examiner. Grant has been closely involved in the development of the *Australian Curriculum: Geography* (7–10) and Senior Secondary Geography Curriculum. He has also been active in professional associations for more than twenty years, and is currently Chairperson of the Australian Geography Teachers Association Inc (AGTA). and Vice President of the Geography Teachers Association of NSW (GTA). In 2007, the Geographical Society of NSW and the GTA awarded Grant the McDonald Holmes Medal for his 'Distinguished contribution to Geographical Education in Australia'. Grant is a Fellow of the Royal Geographical Society and the GTA NSW.

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Glossary

aerial photograph a photographic image of part of the Earth's surface, taken from an aircraft

area reference a sequence of four numbers used to locate relatively large features on a topographic map

aspect the direction in which a slope faces

atlas a book of maps

bar graph a graph in which bars are drawn proportional in length to the value they represent

barometer an instrument used to measure atmospheric pressure

bearing a direction given in terms of degrees from the north

biome vegetation community occupying a large area of the Earth's surface

cardinal direction the four main points of the compass: north, south, east and west

cartographer a person who designs and draws maps

choropleth map a map that shows the relationship between quantity, or density, and area, using colouring or shading

climate the long-term weather pattern of a place or region

climate graph a graph that shows the average daily maximum and minimum temperatures and precipitation data for a particular place

column graph a special kind of bar graph in which the bars are drawn vertically

compass an instrument used to determine direction

contour line a line joining places of equal height above sea level (asl)

contour map a representation of some part of the Earth's surface, using lines along which all points are of equal elevation above and below sea level

cross-section a side view or profile of the land

density the population (or number of objects) per unit area; usually 1 km^2

distance the length from one point to another; usually expressed as a unit of measurement

distribution the arrangement of items over a specified area

dot map a map using dots to show the arrangement, or distribution, of a feature, such as population

elevation the height of a point or place above mean sea level

Equator a line drawn around the broadest part of the Earth, halfway between the North Pole and South Pole

flowline map a map with arrows and lines showing the movement of goods, information and people between places, and the quality of such movements

food security the availability of food and one's access to it

geomorphological hazard naturally occurring crustal processes and conditions that present risks to life and property

gradient a measure of the steepness of a slope

grid a pattern of lines on a chart or map that allows readers to determine absolute location and helps them to analyse distribution patterns

grid reference a sequence of six numbers used to locate features on a topographic map

hachures lines used on some topographic maps to show slope direction and steepness

isobars lines on weather maps joining places of equal atmospheric pressure

landform a natural feature of the Earth's surface

landscape the overall appearance of an area, resulting from the interaction of landforms, vegetation, soils and rivers, together with transport networks, settlements, industry and agriculture

latitude the position of a point on the Earth's surface, expressed as its angular distance north and south from the Equator (0˚); the poles are 90˚ to the Equator

legend a set of symbols that represent features on a map or graph; the key to a map or graph

line graph a graph consisting of one or more straight or curved lines that show the relationship between two variables

line of sight whether one point on the Earth's surface is visible from another; that is, there is no landform feature obstructing the view

linear pattern an arrangement whereby points (or features, such as houses in the case of settlement) form or follow a line

liveability the qualities of a place (city, town, suburb or neighbourhood) that contribute to the quality of life experienced by those who live or visit there

local relief the difference in elevation between the highest and lowest points in a specified location

location the position of a feature on the Earth's surface expressed by means of a grid (latitude and longitude) or in relation to the position of other features or places

longitude the position of a point on the Earth's surface, expressed as the angular distance east or west of the Prime Meridian and 180˚

map a geographical representation of a section of the Earth's surface that is usually drawn to scale on a flat surface, such as a sheet of paper

map projection a map grid of lines of latitude and longitude, used as a base to draw the spherical Earth on a flat surface; there are hundreds of different map projections, all of which distort to some extent the surface features of the Earth's surface

natural hazard an event in the biophysical environment that is destructive to human life and property

oblique aerial photograph a photograph taken from an aircraft with the camera pointing at an oblique angle to the ground

picture graph a graph in which illustrations are used to represent data, with each symbol representing a certain value or quantity

pie graph a circle divided into segments by lines radiating from the centre; each segment of the graph is proportional to the value the segment represents

population pyramid a bar graph showing the distribution of a population by gender and age group

precis map a sketch map that highlights one particular feature of a map

quadrants the divisions of a map; maps are divided into quarters and named according to the points on the compass

relative location the location of a place or feature relative to other places and features

relief the shape of the land, including gradient and height differences within a landscape

remote sensing information gathering about the Earth's surface from a distance, using air photography, radar or satellites

satellite image an image produced by a variety of sensors (such as radar, microwave detectors and scanners), which measure and record electromagnetic radiation; the collected data are changed into a digital form for transmission to the ground, where they can be reconverted into imagery in a form resembling a photograph

scale the relationship or ratio between a linear measurement on a map and the corresponding distance on the Earth's surface

scatter graph a graph in which two sets of data are plotted to demonstrate the strength of their relationship

settlement a place inhabited by people on a permanent or semi-permanent basis

site the place where something is located, including its physical setting

situation the location of a feature or place relative to other features or places

sketch map a rough, hand-drawn map drawn in the field or from an aerial photograph; used to analyse landscapes

spot height points giving the exact height, or altitude, above sea level

ternary graph a triangular-shaped graph used when there are three sets of variables that together make up 100%

thematic map a map representing a specific spatial distribution, such as population density, climate and vegetation regions

time zones global divisions, usually 15˚ of longitude, where the time at the central meridian of the division represents the time for the whole division

topographic map a detailed map on a large scale (such as 1:25 000, 1:50 000 or 1:100 000) illustrating selected features of the physical and built environments

transect a cross-section showing the relationship between different features of the physical and built environments

trig station trigonometrical station, which is located on a prominent hill and used as a basis to survey the surrounding area

urbanisation the process by which an increasing proportion of a population lives in towns and cities; urbanisation is characterised by higher population densities than surrounding areas and provide an example of a constructed or built environment

vertical exaggeration the extent to which the vertical scale of a cross-section has been exaggerated in order to show any minor undulations in the topography

vertical photograph a photograph taken from an aircraft or satellite with the camera pointing directly down to the ground

weather the day-to-day state of the atmosphere at a particular place; the elements of weather are temperature, precipitation, humidity, atmospheric pressure and wind

weather map (also known as a synoptic chart) a map recording the meteorological conditions over a wide area for a particular time

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GEOGRAPHY SKILLS BANK

1.1 Maps

A map is one of the most important tools used by geographers. Maps provide us with information about places (including their location) and help us to identify patterns and changes in the landscape.

A map is a graphic representation of a place – an illustration of part of the Earth's surface drawn to scale on a sheet of paper or stored electronically as a computer database (for example, an in-car satellite or GPS navigation system).

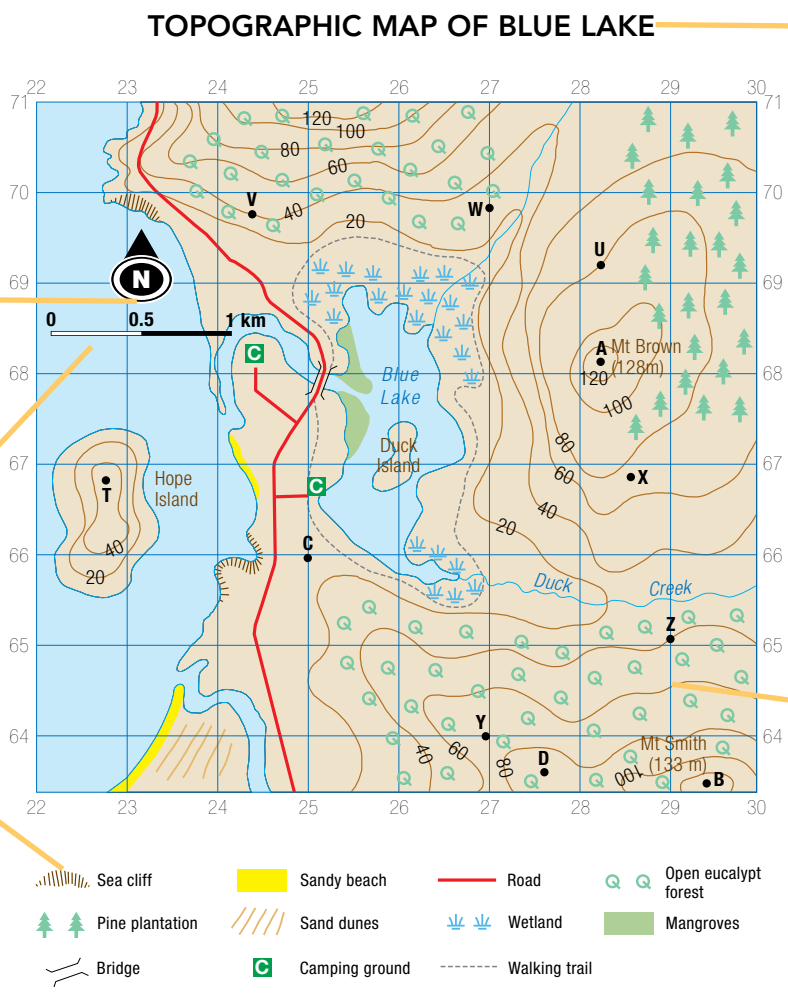
The amount and type of detail shown on a map depends on the scale and purpose of the map. Maps can range from the simple to the highly complex, but no map can show every feature of the Earth's surface. The features shown on maps are usually selected to meet a specific purpose. *Cartographers* (map makers) use colours, symbols and shading to illustrate how features of the Earth's surface are arranged and distributed.

Figure 1.1a Maps – you would be lost without them.

Direction indicator. To use a map we need to have an understanding of direction. To help us orientate the map the cartographer includes an arrow to show us where north is. Once we know where north is, we can work out other directions. Direction makes it easier to describe the location of places. (See Unit 1.4 Direction, bearings and quadrants, pages 8–9.)

Scale. Every map is smaller than the actual area it represents. The scale of the map tells us by how much it has been reduced in size. This, in turn, allows us to work out the distance between the features and places shown on a map. (See Unit 1.2 Scale, pages 4–5.)

Legend. A legend (or key, as it is sometimes called) tells us what the symbols used on the map represent.



Title. Map titles provide us with two important pieces of information: the name of the region or place shown on the map and what features are being shown.

Latitude and longitude. When latitude and longitude are indicated on a map they allow us to accurately locate the place on the Earth's surface. (See Unit 1.3 Locating places, pages 6–7.)

Grid. A grid, made up of a series of vertical and horizontal lines, makes it easy to find the location of a particular place or feature on a map. (See Unit 1.2 Scale, pages 4–5.)

Figure 1.1b Map essentials.

MAP ESSENTIALS

Map essentials usually include a title, direction indicator, scale, legend, border and an indication of latitude and longitude. When drawing your own maps make sure that you include each of these map essentials.

TYPES OF MAPS

There are many different types of maps. Each type is used to show or highlight a particular set of geographical features. The most common types of maps are shown in Figures 1.1c–1.1g.

The typical school atlas includes most, if not all, of these map types. Each is carefully selected by the cartographer as the best map type for communicating the required information.

Figure 1.1c *Physical map showing selected features of the physical environment surrounding North America's Great Lakes.* Physical maps show selected features of the physical environment, including mountains, plains, rivers, lakes, seas and oceans. Colour shading is often used to show height above sea level.

Figure 1.1d *Political map of North America's Great Lakes region.* Political maps show different political units (for example, countries and states), including their borders and capital cities.

Key concepts in geography

LOCATION
Location (or where things are) is the most fundamental of all geographical concepts. The first task of a geographer is to locate places. Maps are the tools they often use to accomplish this task.

PLACE
All places on Earth have distinctive characteristics that give them meaning and character and help to distinguish them from other places. These characteristics may include the physical and human elements of the environment.

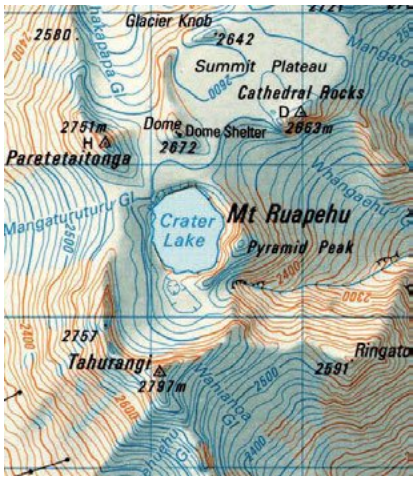


Figure 1.1e *Extract from the topographic map sheet for Mt Ruapehu, New Zealand.* A topographic map is a detailed, large-scale map of part of the Earth's surface, showing selected features of the biophysical, managed and constructed environments. It shows the height, relief and slope of the land; drainage patterns; and vegetation. It also indicates a range of built features, such as settlements and transport linkages. The ability to read, interpret and analyse topographic maps is a useful skill. It allows us to locate features of the physical and built environments, describe distributions and patterns, and identify relationships between features.

Constructing and interpreting choropleth maps

To construct a choropleth map, follow the steps below:

1. Examine the data and decide on the categories you will use. Make sure they are logically spaced; for example, 1–10, 11–20, 21–30 etc.
2. Ensure you have at least three categories of data.
3. Select a different shade of the one colour for each of your categories.
4. Colour in your map.
5. Include a legend that shows the value range for each colour used.

When interpreting choropleth maps it is important to remember that considerable differences can exist within a single area, even though the area may have only one colour or type of shading. World maps, for example, usually present data for particular countries. In these maps a whole country is shaded in one colour. This means that national borders often become the boundaries between different ranges of values. This can result in generalisations as it neglects to show localised variations in the feature being mapped.

WEATHER MAPS

Weather maps (or synoptic charts) are commonly seen in newspapers and in television news programs. These maps show the weather conditions over part of the Earth's surface at a particular point in time. They show air pressure, wind direction and strength, and the rainfall received in the previous 24 hours. They also show the location of cold fronts. Being able to interpret weather maps allows us to make predictions about the weather that a place will experience over the following few days. (See Unit 1.10 Climate graphs and weather maps, pages 21–22.)

FLOWLINE MAPS

Flowline maps show the movement of information, goods and people between places, and the quantity of such movements. Movements are shown by lines or arrows that link the place of origin with the destination. The amount of information, goods or people being moved between places is indicated by the width of the line or arrow. The map's legend indicates the value of the flowlines.

MAP SYMBOLS

Map symbols are used to show the location of selected features of the biophysical and constructed environments. Many symbols look like the features they represent. The colour(s) used for a symbol may also provide a clue to its meaning.

The importance of a feature may be shown by the size of the symbol or the thickness of the line. The meaning of each symbol is explained in the map's legend. (See the legend on page 2.)

The legend is an important feature of any map. It allows us to interpret the features shown on the map, and it provides us with information relating to the scale to which the map is drawn and the contour interval used. When working with maps always check these details. Never assume that the cartographer has used a particular scale or contour interval.

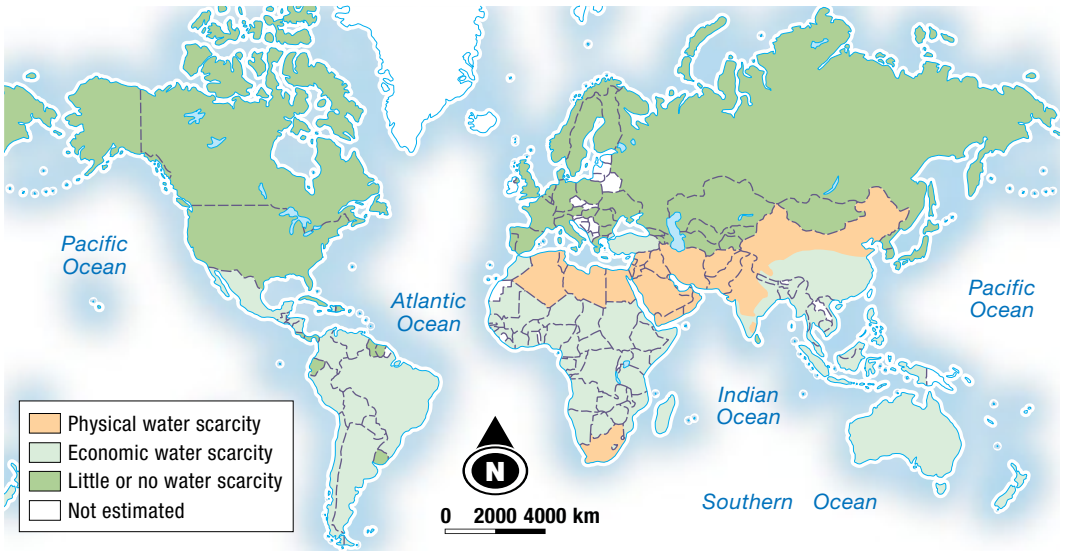


Figure 1.1f *Thematic map showing projected water scarcity, 2025.* A thematic map illustrates a particular theme or issue. Thematic maps may be used to show the distribution of one or more of the following: climate, vegetation types, average rainfall, average temperature, various development indicators, population and agricultural land uses. Thematic maps can be compared to identify links, or associations, between different sets of geographical information.

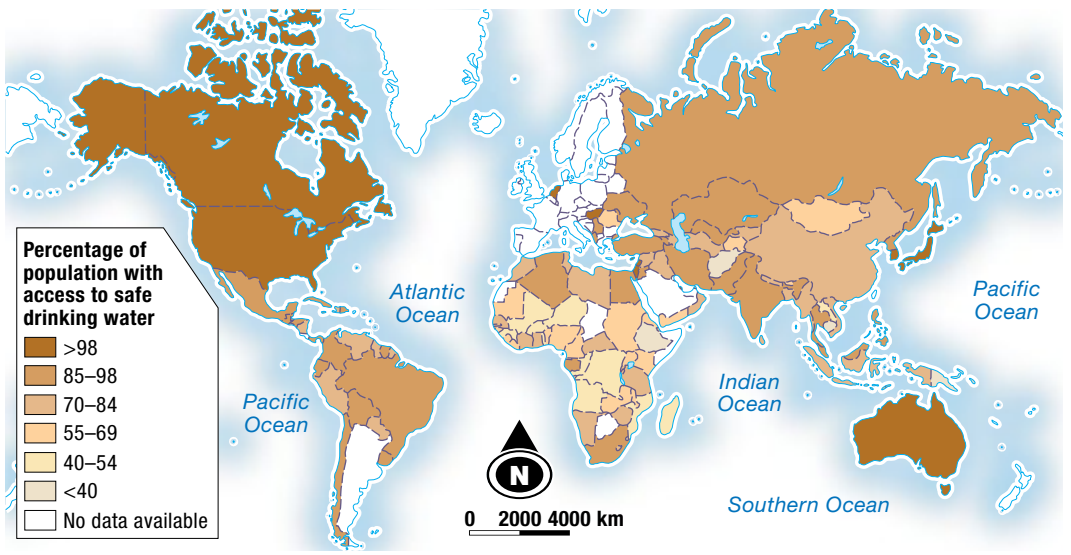


Figure 1.1g *Choropleth map showing access to safe drinking water.* Choropleth maps are often used to show thematic material. They use different shades of the one colour to show a pattern. The darker shades show the highest values and the lighter shades show the lowest values.

ACTIVITIES

1. Explain, in your own words, what a map is and the purpose of maps.
2. List the 'essentials' of a map.
3. Using an atlas, find examples of the types of maps described on pages 2–3.
4. Outline the role of a cartographer.
5. Distinguish between physical and political maps.
6. Explain the principal purpose of topographic maps.
7. Using this textbook, identify three thematic maps and three choropleth maps. Write down the figure number, caption and page reference of each map you identify.
8. *Political borders.* Some political (or geometric) boundaries follow straight lines while others follow natural features, such as rivers and mountain ranges. Find examples of each type of boundary on a map of the world. Which type of boundary is more common?
9. *Maps and literature.* Every story has a physical setting or location. Think of a book you have read recently. Identify the book's setting. Use an atlas to locate the places or features mentioned in the book. The places might include countries, states, cities, rivers, mountainous areas, lakes or oceans. If the book includes a journey, trace the route of the trip on the map in the atlas.
10. Use the legend for the topographic map in Unit 3.4 (page 48) to complete the following task. Draw the symbol used to show each of the following features:
    - **a** railway station
    - **b** embankment
    - **c** mine
    - **d** bridge
    - **e** cliff
    - **f** small dam
    - **g** exposed wreck
    - **h** swamp
    - **i** lighthouse.
11. Design your own symbol for each of the following features of the built environment:
    - **a** fast-food outlet
    - **b** shopping mall
    - **c** skateboard park
    - **d** playground
    - **e** movie theatre
    - **f** bicycle track
    - **g** surf club
    - **h** indoor sports complex
    - **i** school.
12. Draw a map of your school. Construct a legend using appropriate symbols and colours to locate the prominent features of the biophysical and constructed environments.

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1.2 Scale

Figure 1.2a 'I've been scaled!'

To draw a map of any part of the Earth's surface, the area must be reduced in size, or scaled down, so that it can fit on a sheet of paper. There is, therefore, a direct relationship between the size of features on a map and their actual size on the ground. In other words, maps are actually a scaled-down representation of part of the Earth's surface. To determine how large the real area is, it is always necessary for the map to indicate the scale at which it has been drawn.

Scale is expressed as the ratio of distances on the map to distances on the ground.

Scale can be expressed in three ways:

1 As a statement (in words); for example, '1 cm represents 100 000 cm' or '1 cm represents 1 km'.
2 As a ratio or representative fraction; for example, 1:100 000 or $\frac{1}{100\,000}$
3 As a linear scale. (See Figure 1.2b.)

Maps drawn at progressively smaller scales increase the area of the Earth that can be shown, but reduce the amount of detail that can be included. Maps drawn at progressively larger scales decrease the area that can be shown, but allow more detail to be shown. This means, for example, that a map drawn to a scale of 1:20 000 covers a smaller area of the Earth's surface but shows much more detail than a map drawn to a scale of 1:100 000. (See the box 'Large-scale maps vs small-scale maps'.)

The most common scales used for topographic maps are:

- 1:25 000, which is the same as 4 cm = 1 km, 1 cm = 0.25 km or 1 cm = 250 m
- 1:50 000, which is the same as 2 cm = 1 km, 1 cm = 0.5 km or 1 cm = 500 m
- 1:100 000, which is the same as 1 cm = 1 km or 1 cm = 1000 m
- 1:250 000, which is the same as 0.4 cm (4 mm) = 1 km, 1 cm = 2.5 km or 1 cm = 2500 m.

The scale of a map shows the relationship between distances on the map and distances on the ground. This means the scale can be used to calculate distances and areas.

Figure 1.2c shows two maps of Sydney. At a scale of 1:400 000 (top map) we can see all of the urban area. At a scale of 1:200 000 (bottom map) only inner Sydney can be shown.

CALCULATING DISTANCES

The distance between two points on a map can be found by measuring the distance on the map and then converting it from centimetres to kilometres and/or metres. Most students do this by using the map's linear scale.

There are several ways to measure the distance between two points on a map. Some students use a length of string, while others use a pair of dividers. The following methods are more likely to be accurate because they make it easier to work around curves and sharp corners.

MEASURING A STRAIGHT-LINE DISTANCE

To estimate a straight-line distance, place the edge of a sheet of paper between the two points and mark on the paper the distance between the points. Place the paper along the map's linear scale. Read off the distance on the scale. (See Figure 1.2d, page 5.)

MEASURING A DISTANCE ALONG A CURVED LINE

To estimate a distance along a curved line, place a sheet of paper on the map and mark off the starting point. Carefully move the paper so that its edge follows the curve, marking each section with a pencil as you go. Mark the end point and then place your sheet of paper on the linear scale. Read off the distance on the scale. (See Figure 1.2e, page 5.)

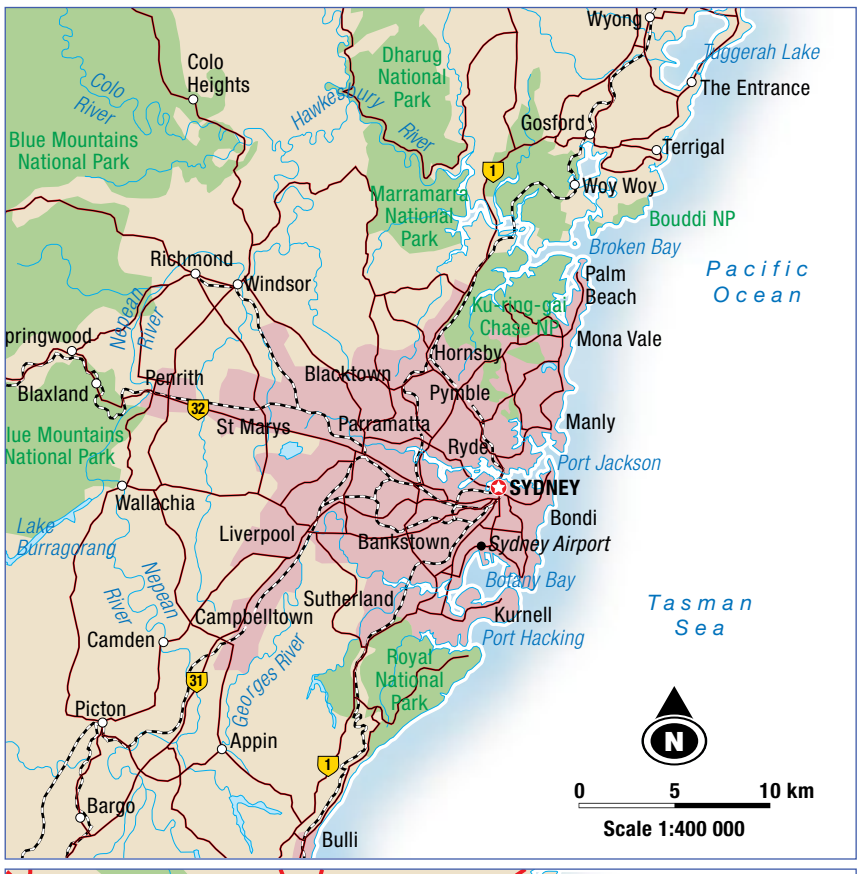

Figure 1.2c Different scales can show different levels of detail. The top map is drawn at a scale of 1:400 000 and the bottom map at 1:200 000.

Large-scale maps vs small-scale maps

A map that shows only a small area of the Earth's surface is referred to as a large-scale map. This is because the area of land being represented by the map has been scaled down less; in other words, the scale is larger. A large-scale map only shows a small area, but it shows it in great detail.

A map featuring a large area, such as an entire country, is considered to be a small-scale map. In order to show the entire country, the map must be scaled down until it is much smaller. A small-scale map shows more territory, but it is less detailed.

To fit a map of the world onto an A4 sheet of paper (measuring 297 mm x 210 mm) you would need to use a scale of approximately 1:135 000 000 (a smaller scale). To fit a map of Australia onto an A4 sheet of paper you would need to use a scale of approximately 1:20 000 000. At a scale of 1:25 000 (a larger scale) it would take 50 000 A4 sheets map sheets to map Australia.

Figure 1.2b Linear scale.

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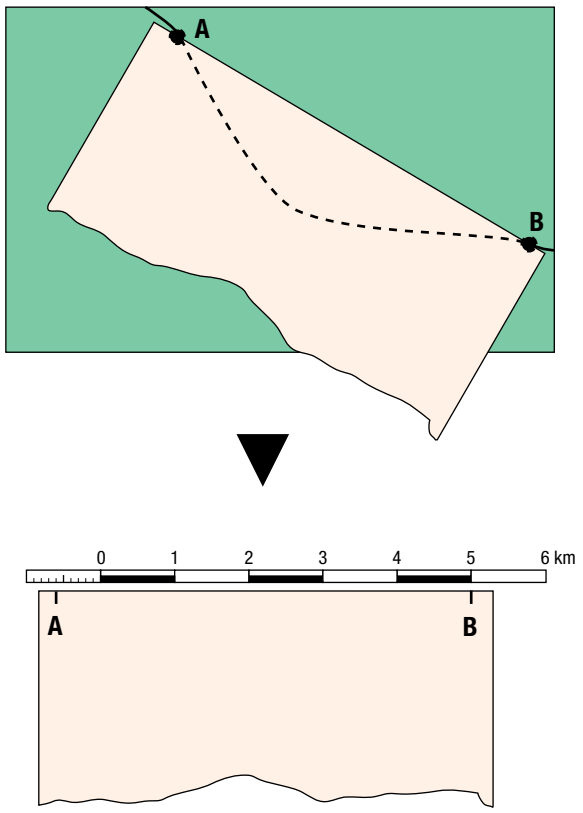

Figure 1.2d Measuring a straight-line distance on a map.

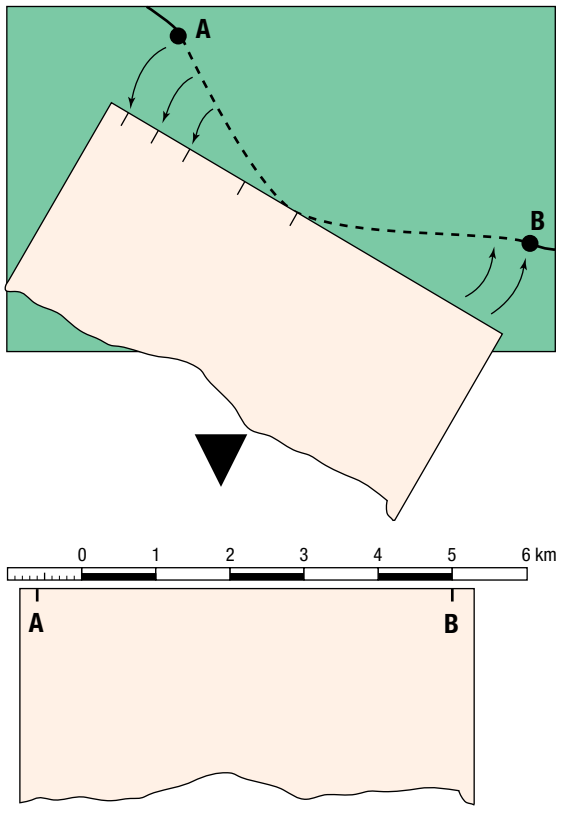

Figure 1.2e Measuring a distance along a curved line on a map.

Advanced skill: calculating time–distance relationships

When working with topographic maps you may be required to calculate how long it would take to travel a specific distance at a certain speed.

EXAMPLE

How long would it take to travel 30 km at 80 km/h?

1. Calculate how long it would take to travel 1 km at 80 km/h.
   Divide 60 (minutes) by 80 (speed in km/h).
   = 0.75 of a minute (that is, 45 seconds)
2. Multiply the time taken to travel 1 km by the distance to be travelled.
   = 0.75 x 30 km
   = 22.5 minutes

ESTIMATING AREA

The area of the Earth's surface covered by a map feature can be estimated using the scale of the map. It is possible to find the area of some features by multiplying the length of the feature by its breadth.

If a feature has an irregular shape, its area can be estimated by counting the number of grid squares that the feature covers. To do this, count the number of squares more than half covered by the feature and ignore those squares less than half covered by the feature. Your answer should normally be stated as square kilometres (km^2). (See Figure 1.2f.)

EXAMPLE

The area of the lake in Figure 1.2f is approximately 42 km^2.

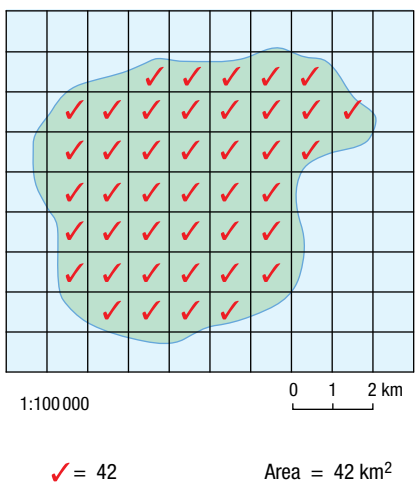

Figure 1.2f Estimating area.

CALCULATING DENSITY

The term 'density' refers to the number of people or objects per unit area, usually 1 km^2.

We can work out the density of features on a map by counting how many features are located within the specific area. (See Figure 1.2g.) Answers should be expressed in terms of the number of features per square kilometre.

EXAMPLE

The density of buildings in AR 2736 is 7/km^2.

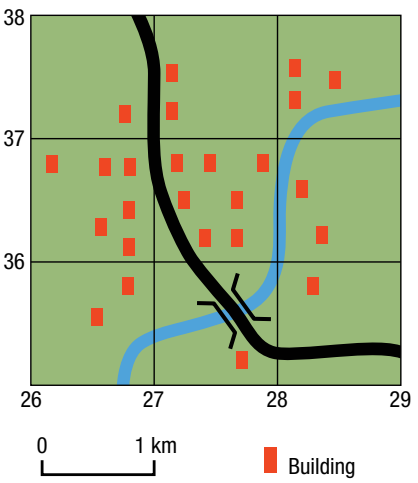

Figure 1.2g Calculating density.

ACTIVITIES

1. Why is scale used when drawing maps?
2. List the three ways in which scale can be expressed.
3. Copy the following table and complete it by adding the correct type of scale.

	Statement	*Representative fraction or ratio*	*Linear*
a	One cm represents 250 m		
b		$\frac{1}{50\,000}$ or 1:50 000	
c			0 1 2 km

4. Using the linear scale in Figure 1.2b (page 4) determine the length of each of the following lines.

a _____
b _____
c _____
d _____

5. What is meant by the term 'area'?
6. What is meant by the term 'density'?

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1.3 Locating places

Figure 1.3a You are here.

LOCATION

'Where is it?' is one of the most important questions asked by geographers. Every feature and place on the Earth's surface has a specific location. This location can be expressed in a number of ways. It can, for example, be expressed in terms of its distance from other features or places. We call this relative location. It can also be expressed in terms of its absolute location. This is the location of a point on the Earth's surface that can be expressed using a grid reference, such as latitude and longitude. The absolute location of a feature or place can be determined by using an alpha-numeric grid; grid and area references; or latitude and longitude.

ALPHA-NUMERIC GRIDS

Maps using alpha-numeric grids are divided by grid lines into a series of small squares. Along the top and bottom of the map, the squares are labelled with letters of the alphabet. Along the left and right-hand sides of the map, the squares are labelled with numbers. (See Figure 1.3c.) Using the grid is easy. For example, on the map shown in Figure 1.3c, Queen Victoria Memorial is located where 'G' and '5' intersect.

If you wanted to find a specific suburban street using a street directory you could go to the directory's index. This would give you a page reference and the alpha-numeric grid reference of the street. You then turn to the relevant page and use the alpha-numeric labels on the edges of the grid to locate the street. Practise using alpha-numeric grids by completing activity 4 on page 7.

GRID AND AREA REFERENCES

The location of features on topographic maps can be found by using grid and area references. Topographic maps have grid

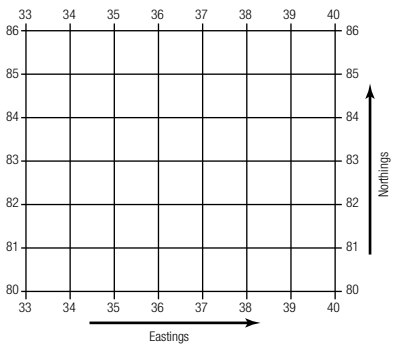


Figure 1.3b Grid lines.

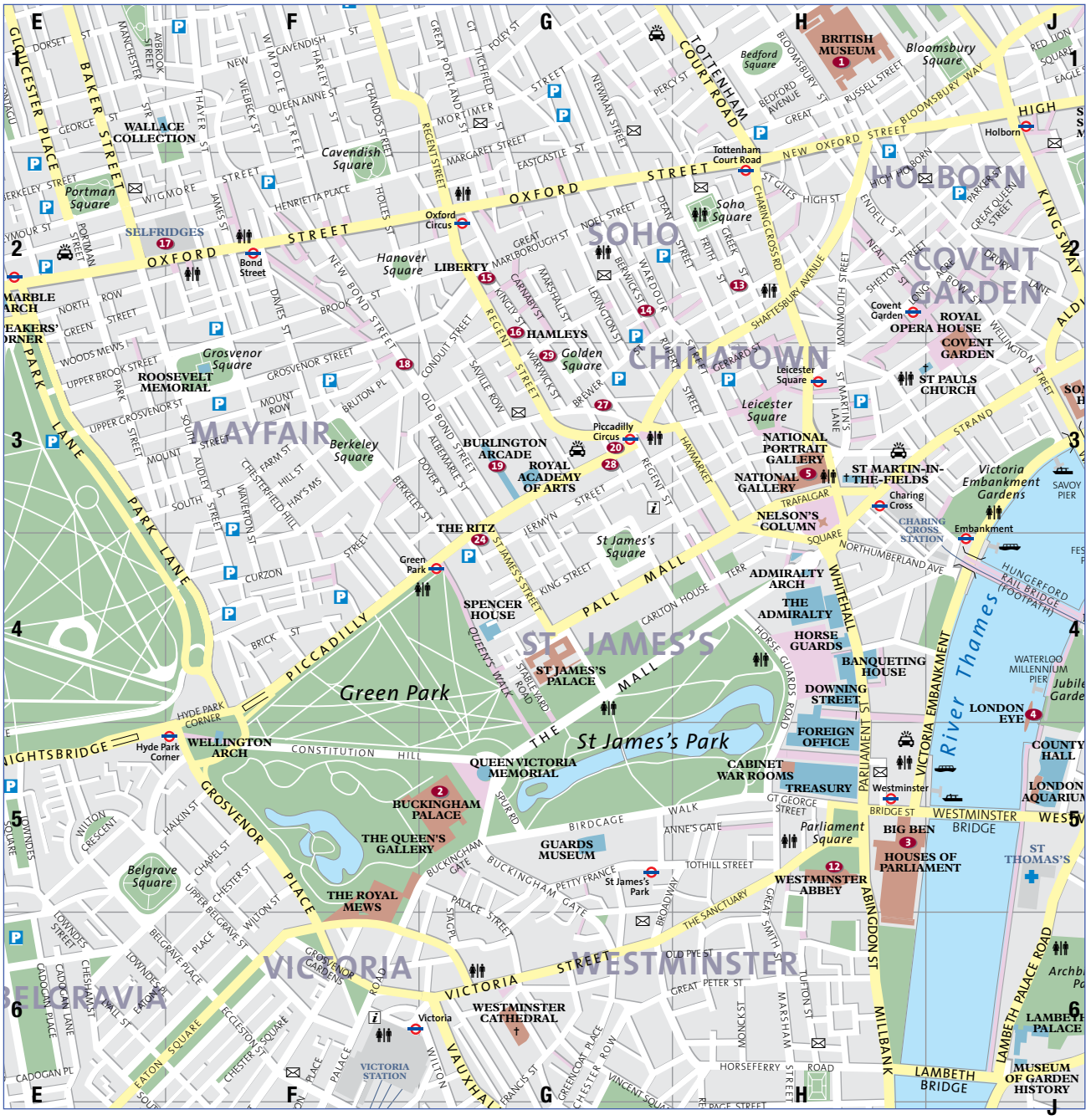


Figure 1.3c Extract from a London street directory.

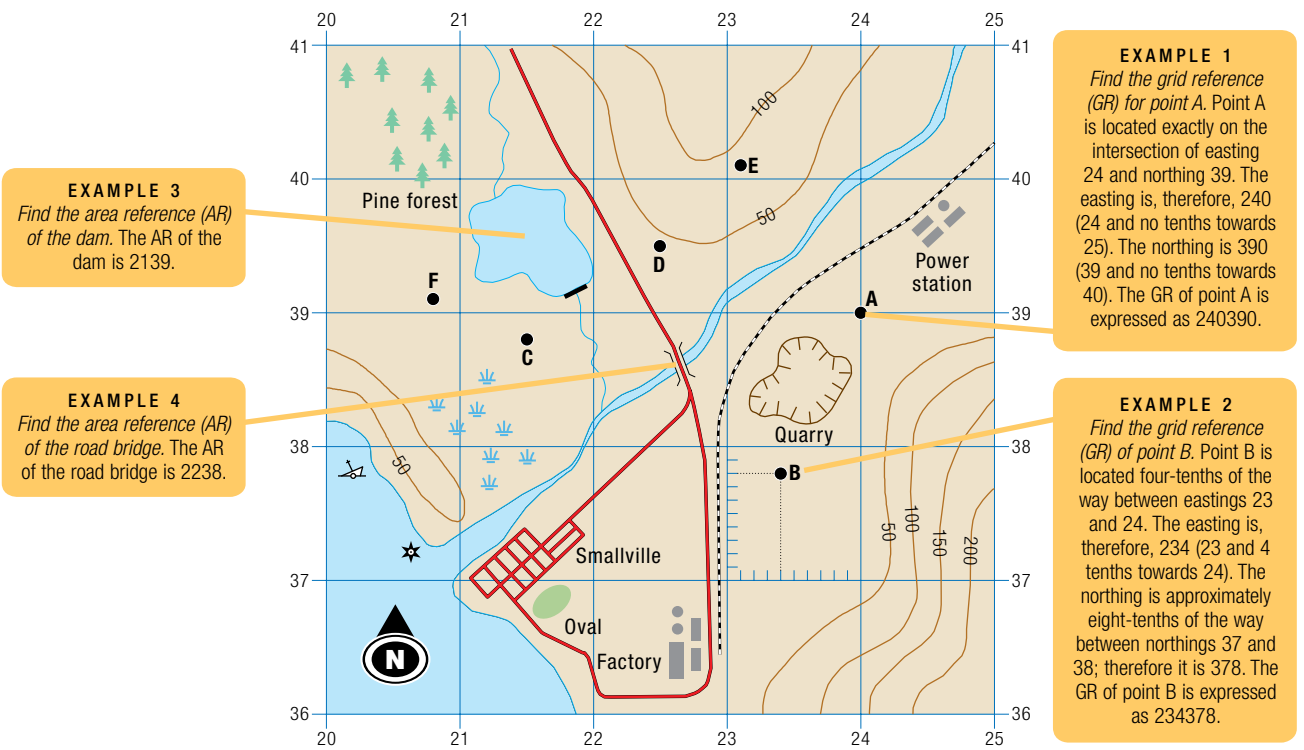


Figure 1.3d Grid reference example.

lines, which are a series of equally spaced, numbered vertical and horizontal lines. The horizontal lines are called *northings* and the vertical lines are called *eastings*. (See Figure 1.3b, page 6.) Northings are numbered from the south to north (from bottom to top). Eastings are numbered from west to east (from left to right).

GRID REFERENCES

To locate quite small features (such as a building or bridge) on a topographic map a six-figure grid reference is used. The first three single numbers (or digits) refer to the eastings and the last three refer to the northings that surround the map. (See Figure 1.3d, page 6.) The third digit required for each coordinate is obtained by dividing each easting and northing into tenths.

AREA REFERENCES

Some map features (for example, a lake or small town) can cover quite a large area within a grid square. We usually locate such features using an area reference (AR). An AR has only four digits.

To find the AR of a feature we first identify the easting line just to the left of it and then the northing below it. This means that we refer to the eastings and northings of the lower left-hand corner of the grid square in which the feature appears.

Where a feature extends beyond one grid square, the AR should be based on the lower left-hand corner of the square that contains the main part of the feature. Try activity 6c below.

LATITUDE AND LONGITUDE

Most maps include lines of latitude and longitude. These allow us to quickly and accurately locate places and features on the Earth's surface.

LATITUDE

Lines of latitude (see Figure 1.3e) are imaginary lines that run in an east–west direction around the Earth. Because they are parallel to each other they are often referred to as *parallels of latitude*.

The most important line of latitude is the *Equator* (0°). The Equator divides the Earth into two halves: the *Northern Hemisphere* and the *Southern Hemisphere*. All other lines of latitude are either north or south of the Equator and are given a number between 0° and 90°. The North Pole is 90° north and the South Pole 90° south.

Some of the other important lines of latitude are the Tropic of Cancer (23 1/2°N), the Tropic of Capricorn (23 1/2°S), the Arctic Circle (66 1/2° N) and the Antarctic Circle (66 1/2°S).

LONGITUDE

Lines of longitude (see Figure 1.3f) run in a north–south direction. They are not parallel to one another, but pass through both the North and South Poles. Any number of these lines can be drawn, but they all converge and meet at the poles. These imaginary lines are called *meridians of longitude*.

The most important line of longitude is the *Prime Meridian* (0°), which passes through the Greenwich Observatory just outside London, England. All other lines of longitude are located either east or west of the Prime Meridian.

Another important line of longitude is the *International Date Line*, which is on the opposite side of the world to the Prime Meridian, at 180°. Together, the Prime Meridian and International Date Line divide the Earth into two halves. The half to the west of the Prime Meridian is the *Western Hemisphere*. The half to the east is the *Eastern Hemisphere*.

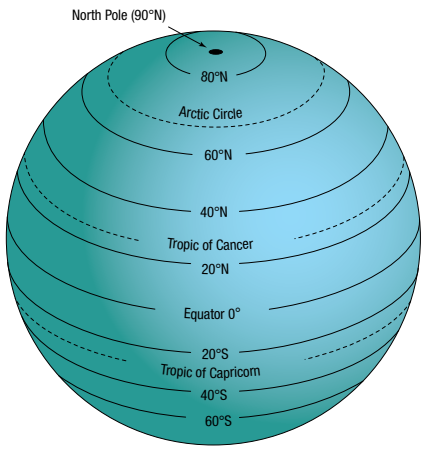


Figure 1.3e Parallels of latitude.

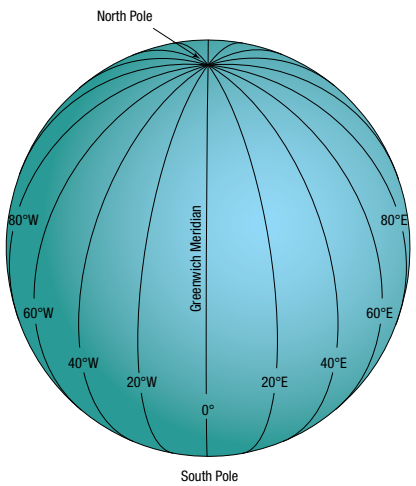


Figure 1.3f Meridians of longitude.

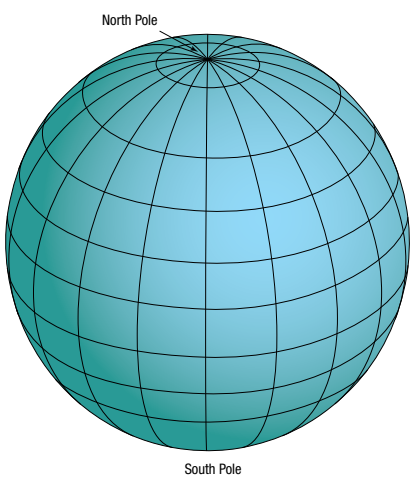


Figure 1.3g The grid pattern produced by lines of latitude and longitude.

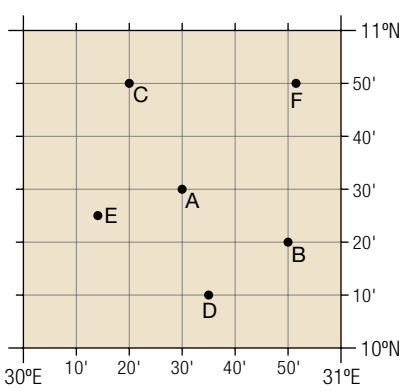


Figure 1.3h A latitude and longitude grid showing minutes.

FINDING PLACES USING LATITUDE AND LONGITUDE

Put together, lines of latitude and longitude form a grid that allows us to pinpoint places and features on the Earth's surface. (See Figure 1.3g.) To be even more accurate, each degree of latitude and longitude can be divided into smaller units, called minutes. There are 60 minutes in each degree. (See Figure 1.3h.)

When using latitude and longitude to describe the location of a particular place, we always give the latitude first and then the longitude.

If you are given the latitude and longitude of a place and asked to find it, follow these three steps:

1. Using a world map, find a general location of the latitude and longitude you have been given.
2. Turn to a map of the region or continent and locate the latitude and longitude more accurately.
3. You can check your answer by locating the place name in the index of an atlas. Most atlases include the latitude and longitude of each place. (See Figure 1.3i.)

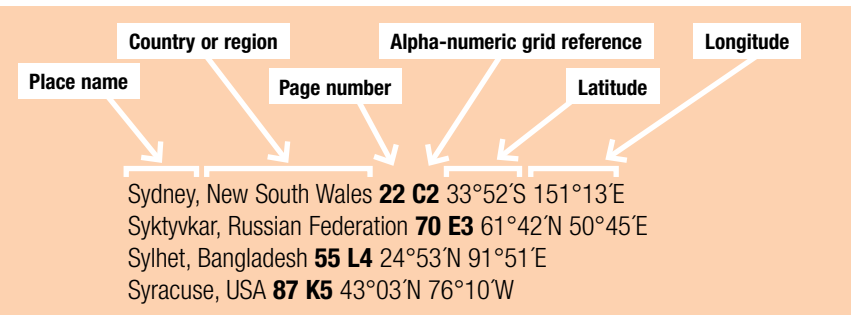
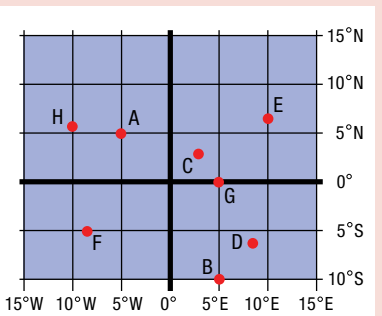


Figure 1.3i Extract from the index of an atlas.

ACTIVITIES

1. Explain the difference between relative location and absolute location.
2. State the name given to the grid typically used on maps in street directories.
3. Distinguish between northings and eastings on topographic maps.
4. Study Figure 1.3c (page 6) and then complete the following tasks:
   - **a** Identify the features located at each of the following alpha-numeric grid references:
     - **i** G4
     - **ii** H1.
   - **b** State the alpha-numeric grid of each of the following features:
     - **i** Buckingham Palace
     - **ii** Admiralty Arch
     - **iii** Westminster Abbey
     - **iv** Horse Guards
     - **v** Houses of Parliament
     - **vi** Westminster Cathedral.
   - **c** State the area reference of each of the following features:
     - **i** pine forest
     - **ii** quarry
     - **iii** factory
     - **iv** power station.
5. Identify the circumstances in which area references are used instead of grid references.
6. Study Figure 1.3d (page 6) and then complete the following tasks.
   - **a** State the grid reference of points C to F.
   - **b** State the grid reference of each of the following features:
     - **i** dam wall
     - **ii** roadbridge
     - **iii** oval
     - **iv** shipwreck.
7. Define the terms 'parallel of latitude' and 'meridian of longitude'.
8. Explain the difference between parallels of latitude and meridians of longitude.
9. Describe the location and significance of the Prime Meridian and the International Date Line.
10. Study Figure 1.3h. State the latitude and longitude, in degrees and minutes, of points A–F.
11. State the latitude and longitude of points A–H.



12. With the aid of an atlas, copy and complete Table 1.3a.

Table 1.3a

	Place/feature	*Latitude and longitude*
a		17°58′S 25°45′E
b	Mt Kilimanjaro, Africa	
c	Mt Everest, Asia	
d		5°58′N 62°32′W
e	Grand Canyon, North America	
f	Yosemite National Park, North America	
g		13°08′S 72°30′W
h	Mount McKinley, North America	
i	Niagara Falls, North America	
j		79°04′S 86°21′W

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1.4 Direction, bearings and quadrants

Figure 1.4a Which way to go?

DIRECTION

Direction is important because it shows where one place is in relation to other places; that is, their *relative location*. Direction is usually given in terms of the points on a compass, but it may also be given as a bearing.

North, south, east and west are known as the *cardinal points* of the compass. The points that give us a more specific indication of direction are called the *intermediate points*. Geographers use these points to describe the position of one place or feature in relation to another. Figure 1.4b shows the 16 points of the compass.

Maps usually have an arrow indicating where north is. Most maps are designed so that north is at the top of the map. Just to make sure, check the direction arrow, which is usually located near the legend.

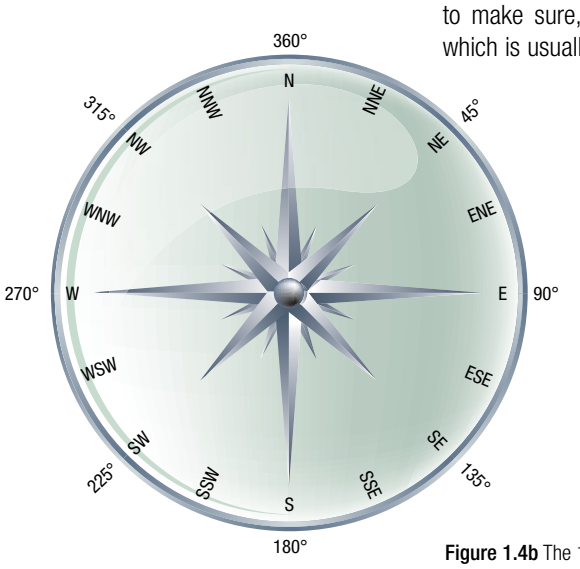

Figure 1.4b The 16 points of the compass.

Magnetic compass

A *magnetic compass* (see Figure 1.4c) can be used in association with a map in a number of ways. If we are observing a landscape during fieldwork, for example, we can lay out the map and then turn it around until the magnetic north arrow on the map is the same as the north point shown on the compass. This is called *orientating* the map. It makes it easy to identify different features, which should be in the same direction as they appear on the map.

FINDING DIRECTION USING A MAGNETIC COMPASS

A magnetic compass is an instrument used to find direction. It has a magnetised needle that will always point to the Earth's magnetic north pole.

To locate north, position the magnetic compass so that the needle points towards the 'N' marked on the face of the compass. You are now facing towards the north. South is behind you, west is to your left and east is towards your right.

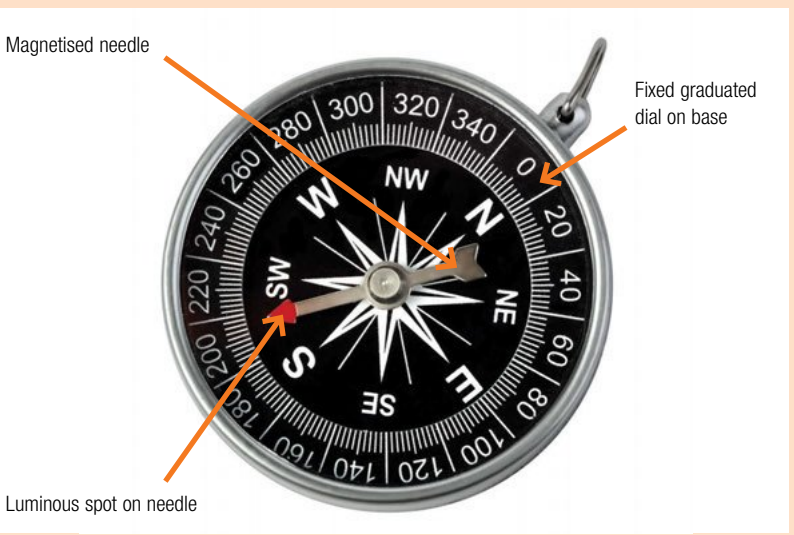

Figure 1.4c A magnetic compass.

Finding direction without a compass

During daylight you can use your watch to find north. Point the '12' of the watch towards the sun. Halfway between the '12' and the hour hand will be north. (See Figure 1.4d.)

At night the Southern Cross constellation can be used to find direction. Locate the five stars of the Southern Cross and the two bright 'pointers' (Alpha and Beta Centauri). Project a line through the axis of the Southern Cross, and another at right angles to a line joining the two pointers. Where these two lines intersect, extend a line directly to the horizon. You have located south. (See Figure 1.4e.)

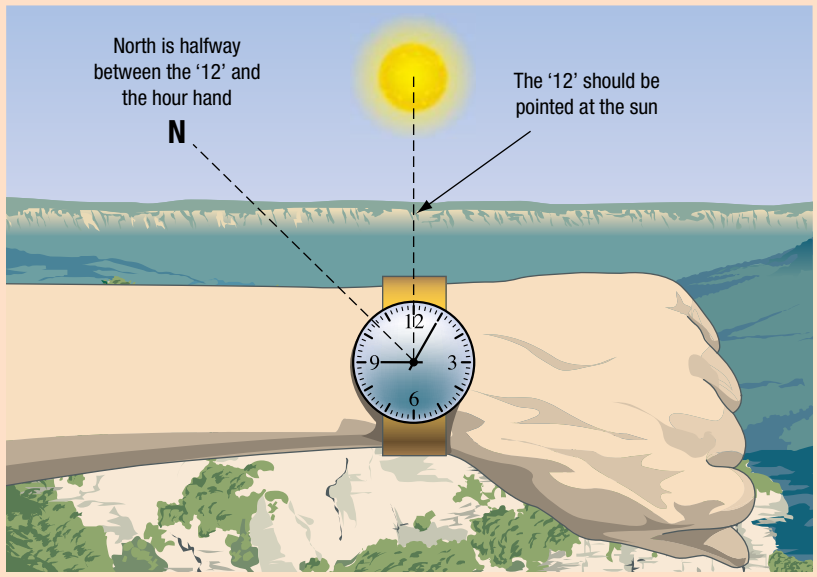

Figure 1.4d Finding north with the aid of a watch.

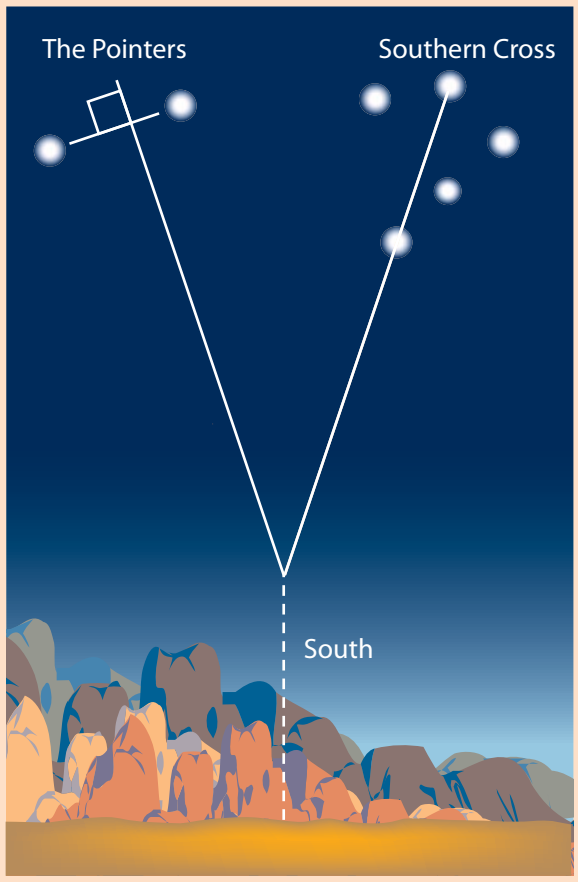

Figure 1.4e Finding direction at night.

ACTIVITIES

1. Define the geographical term 'direction'.
2. Identify the cardinal points of a compass.
3. With the aid of a pair of compasses, draw your own 16-point compass.
4. State what a magnetic compass is used for.
5. Explain how you can find north without the aid of a compass in both the day and night.

Locating north on topographic maps

Topographic maps usually include a reference to several north points:

- True north (TN) – the direction of the Earth's geographic North Pole. Meridians of longitude converge on the geographic North Pole.
- Grid north (GN) – the direction of vertical grid lines on a topographic map. Grid north is used when measuring bearings.
- Magnetic north (MN) – the direction in which the magnetic needle points; that is, towards the magnetic north pole. The MN pole varies slightly from the North Pole; the amount of variation changing from year to year.

When using a map and compass in the field, use the MN arrow. If you are referring to directions from a map, use TN. Topographic maps are generally designed so that north is at the top of the map. (See Figure 1.4f.)

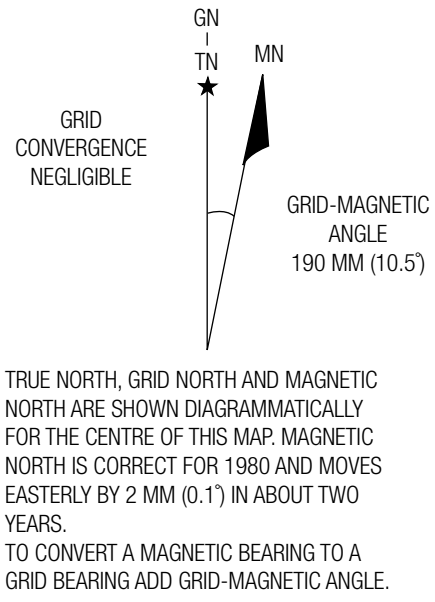

Figure 1.4f Direction indicator from an Australian topographic map sheet.

Using direction to describe general location

Direction is often used to identify regions of a country, state or urban area. Figure 1.4g shows how compass points can be used to identify regions of Australia.

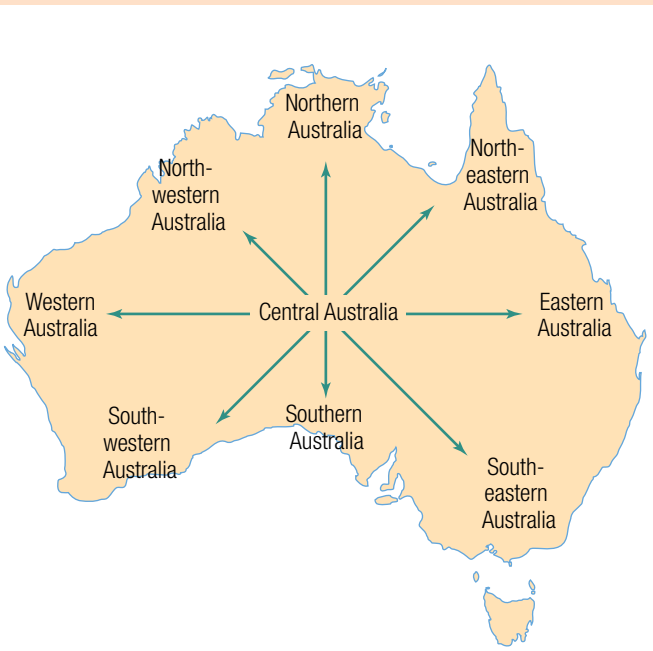

Figure 1.4g The compass points can be used to describe and locate regions of Australia.

ACTIVITIES

6 State why geographers use bearings. Explain how bearings are calculated.

7 Explain what is meant by the term 'quadrant'.

BEARINGS

Geographers often use bearings to give an accurate indication of the direction of one point from another. A bearing is an angle, measured clockwise, that a line makes with a fixed zero line. Unless stated otherwise, the zero line is always taken to be north.

Bearings are calculated by measuring the angle from north in a clockwise direction. It is important to remember that any bearing to the east of the north–south line falls between 0˚ and 180˚. Bearings of any direction to the west of the north–south line fall between 180˚ and 360˚. (See Figure 1.4h.) In example 1 the bearing of B from A is 145˚, and in example 2 the bearing of B from A is 205˚.

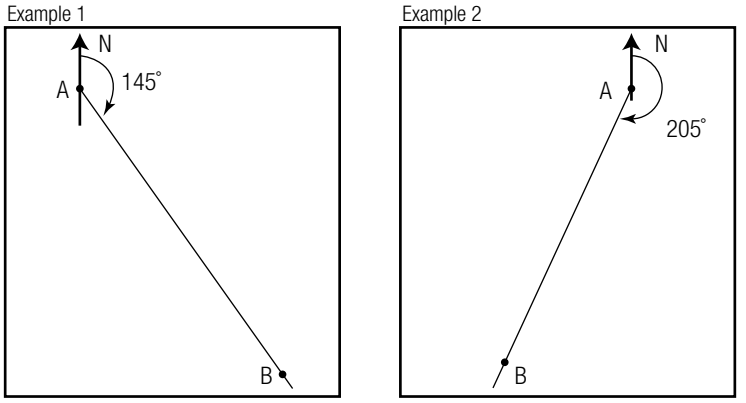

Figure 1.4h Finding bearings.

To accurately measure a bearing on a map a protractor must be used. To measure the bearing of point Y from point X in Figure 1.4i follow the steps given below:

Step 1 Using a ruler and sharp pencil join points X and Y. If the distance between the two points is small, extend the line through point Y so that it can be seen.

Step 2 Place a clear plastic protractor on the map. Position the protractor so that the centre point is directly over point X, and 0˚ is pointing to GN; that is, parallel to the eastings.

Step 3 Read the bearing off the graduated edge of the protractor where it meets the pencil line.

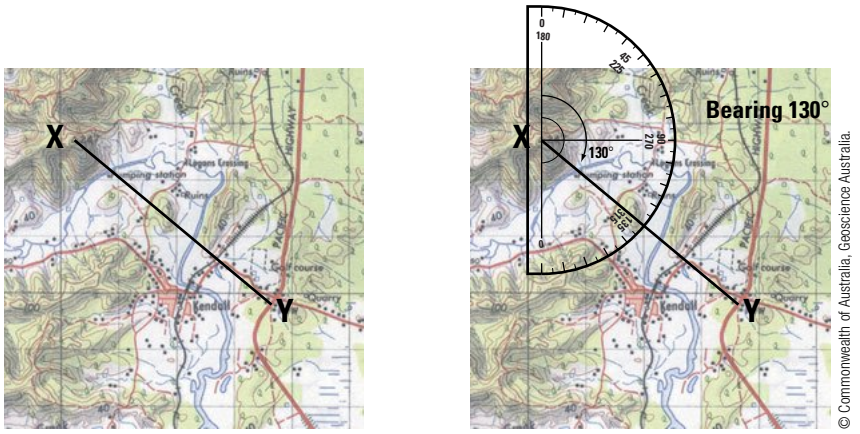

Figure 1.4i Using a protractor to determine the bearing of point Y from point X.

QUADRANTS

To help us find the location of features on topographic maps their relative position is sometimes expressed in terms of *quadrants*. (See Figure 1.4j.) These divide the map into quarters. They get their names from the points of the compass.

North-west quadrant	North-east quadrant
South-west quadrant	South-east quadrant

Figure 1.4j The quadrants of a map.

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1.5 Relief

Figure 1.5a Contoured!

Relief is a term geographers use to describe the shape of the land, including its height above sea level (asl) and the steepness of its slopes.

Because maps are usually drawn on flat sheets of paper it has been necessary for cartographers (map makers) to develop ways of showing what the landscape is like. These techniques include the use of spot heights, shading, colour layering and contour lines.

SPOT HEIGHTS

A *spot height* is usually shown on a map as a black dot with the height written next to it. It gives the exact elevation (or height) above sea level of a particular location or feature. Major spot heights are sometimes shown as trigonometric (trig) stations. These are usually found on the top of significant (prominent) landform features and are normally marked with a structure of some kind; for example, a block of concrete and a black disc on a metal pole.

While spot heights are useful in determining the elevation of a landform feature, they do not tell us much about the shape of the land. Contour lines and shading are much more effective at conveying this.

SHADING

Map *shading* is a very effective method of highlighting landform features. The shading makes the landform features 'stand out' from the map, creating a three-dimensional effect. (See Figure 1.5b.)

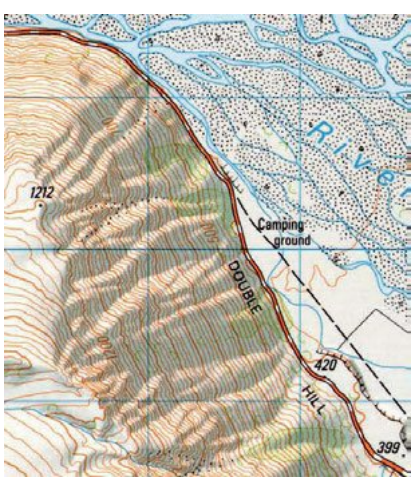

Figure 1.5b Shading on Lake Coleridge topographic map extract. Shading creates a three-dimensional visual effect.

COLOUR LAYERING

Some cartographers use colour layering to distinguish between different elevations. The legends of these maps include a graded colour scale that enables the user to interpret the map. (See Figure 1.5c.)

Figure 1.5c Colour layering on Dungarvan topographic map extract. © Crown Copyright 2013 Ordnance Survey license number 100043500

CONTOUR LINES

The most effective way to show relief on a map involves the use of contour lines. *Contour lines* join places of equal height above sea level. Below sea level the lines are referred to as marine contours (or *bathytherms*). Being able to interpret contour lines provides geographers with information about the:

- *shape* of the land
- *slope* of the land
- *height* of features above sea level.

Each contour line represents a specific height above sea level. Therefore, every point along a contour line has the same value. The spacing of the contour lines on a map indicates the steepness of slopes. Areas where contour lines are close together have steep slopes, and areas where there are only a few widely spaced contour lines are very flat. (See Figure 1.5d.)

The spacing of the contour lines also gives us an idea of the slope's shape. Evenly spaced contours indicate a uniform slope. When the spacing between contour lines (reading from high to low) decreases, the slope is *convex*. When the spacing between contour lines (reading from high to low) increases, the slope is *concave*. (See Figure 1.5e.)

A skilled user of topographic maps can visualise the shape of particular features by studying the patterns created by the contour lines. Some examples of common landform features and their associated contour patterns are shown in Figure 1.5g (page 11).

The *contour interval* (CI) is the difference in height between two adjacent contour lines. This interval is always constant on any particular map.

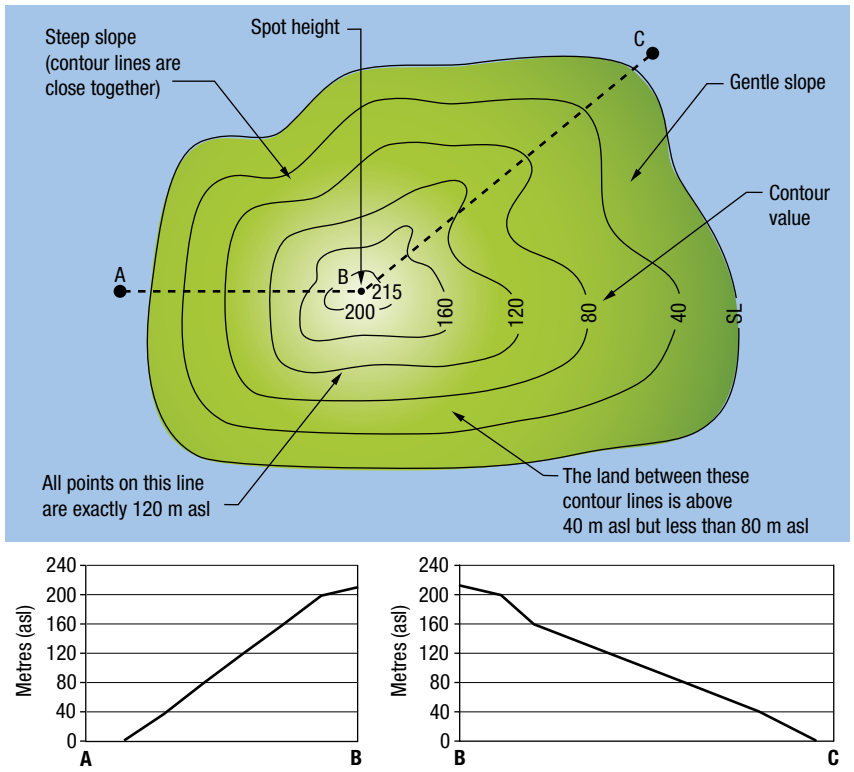

Figure 1.5d Features of a contour line. The cross-sections A–B and B–C show the shape and steepness of selected slopes.

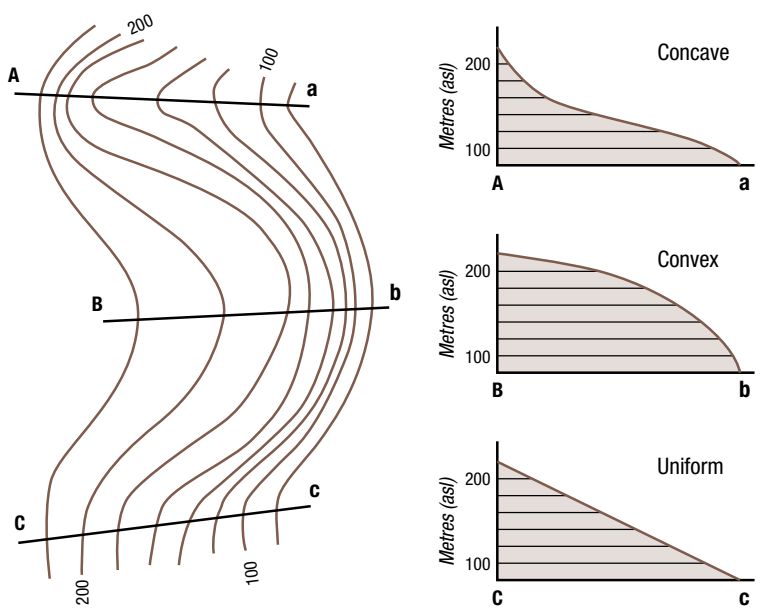

Figure 1.5e Contour patterns and the shape of slopes.

ASPECT

Aspect refers to the direction in which a slope faces. The aspect of a particular slope can be determined by examining the height and pattern of the contour lines. The slope shown in Figure 1.5f has a north-westerly aspect.

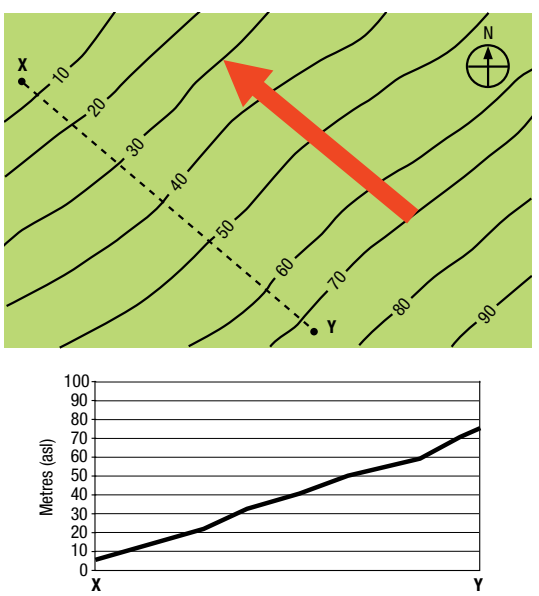

Figure 1.5f Determining aspect.

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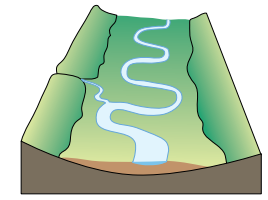
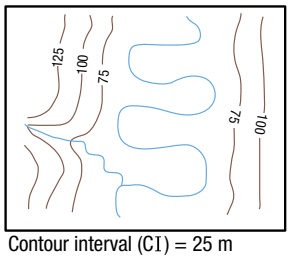
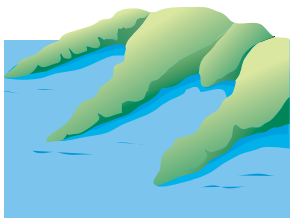


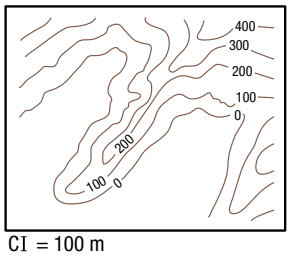
Floodplain



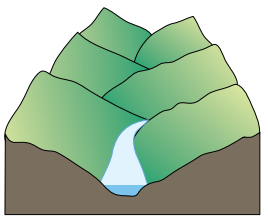
Contour interval (CI) = 25 m



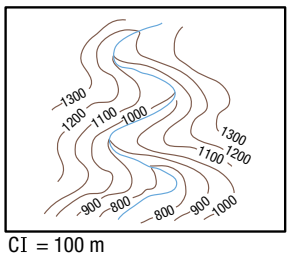
Drowned coastline



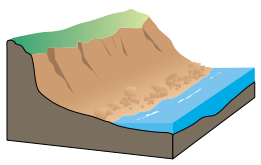
CI = 100 m



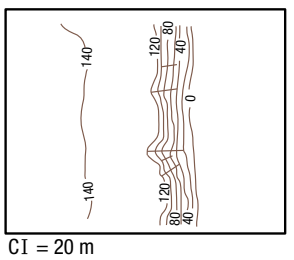
Interlocking spurs



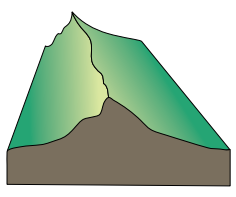
CI = 100 m



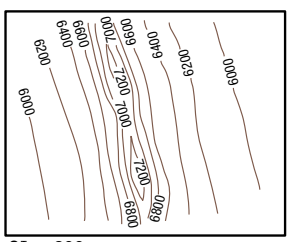
Cliffed beach



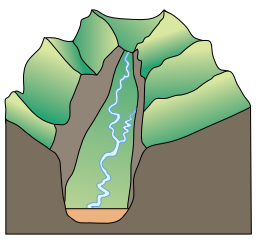
CI = 20 m



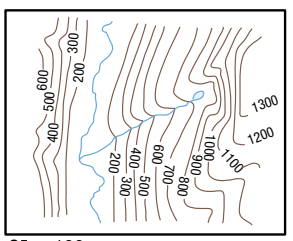
Ridge



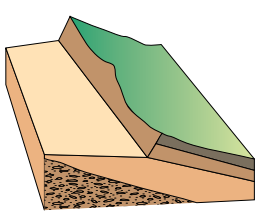
CI = 200 m



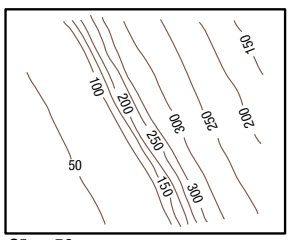
Truncated spurs



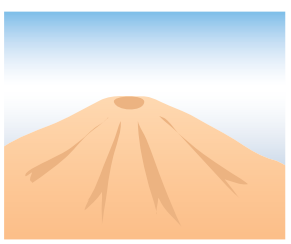
CI = 100 m



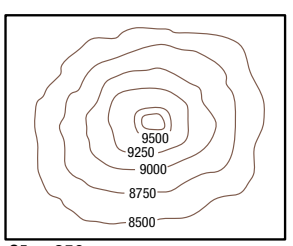
Scarp



CI = 50 m



Conical mountain



CI = 250 m

Figure 1.5g Common landform features and their contour patterns.

When a cross-section is drawn from a topographic map, the relief (or shape) of the land is often exaggerated so that relatively small variations in the landscape are clearly visible. To accurately interpret a cross-sectional profile we need to determine how much exaggeration has occurred. To do this we measure the number of times the vertical scale of the cross-section has been exaggerated (or 'stretched') compared with the actual shape. We call this calculation *vertical exaggeration*.

Using contour lines: estimating height above sea level

In the absence of a spot height, it is possible to estimate the height above sea level of a feature by studying the contour lines on a topographic map.

EXAMPLE 1

Estimate the height of the hill at point A in Figure 1.5h. Point A lies above 200 m but it is obviously less than 250 m. Your answer should be expressed as a statement; that is, 'Point A is more than 200 m but less than 250 m above sea level' or 'Point A is >200 m but <250 m'.

EXAMPLE 2

Estimate the height of point B in Figure 1.5h. Point B lies between the 50 m and 100 m contour lines. Your answer should be expressed as a statement; for example, 'Point B is >50 m <100 m'.

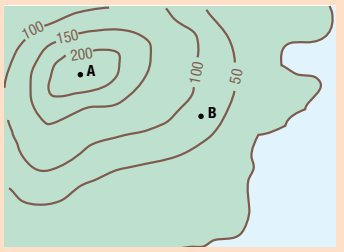


Figure 1.5h Contour sketch.

Note: In some cases it may be possible to express your answer as an estimate, but check with your teacher to see whether this method is acceptable. If you can express your answer as an estimate, your answers would be:

- *Example 1.* 'Point A is approximately 225 m' (or any number between, but not including, 200 m and 250 m).
- *Example 2.* 'Point B is approximately 75 m' (or any number between, but not including, 50 m and 100 m).

Advanced skill: calculating local relief

Local relief is the variation in height over a relatively small, defined area. It is determined by calculating the difference in height between the highest and lowest points in the area.

EXAMPLE

Calculate the local relief between points X and Y in Figure 1.5i.

150 m	–	50 m	=	100 m
(Highest point: X)		(Lowest point)		(Local relief)

Note: Always ensure you include the appropriate unit of measurement with your answer.

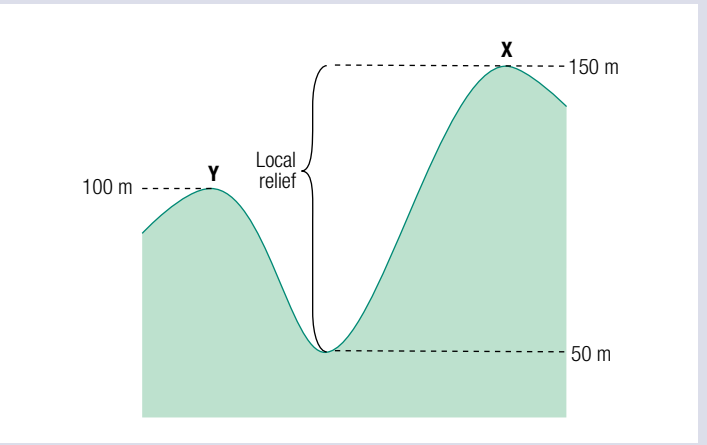


Figure 1.5i Calculating local relief.

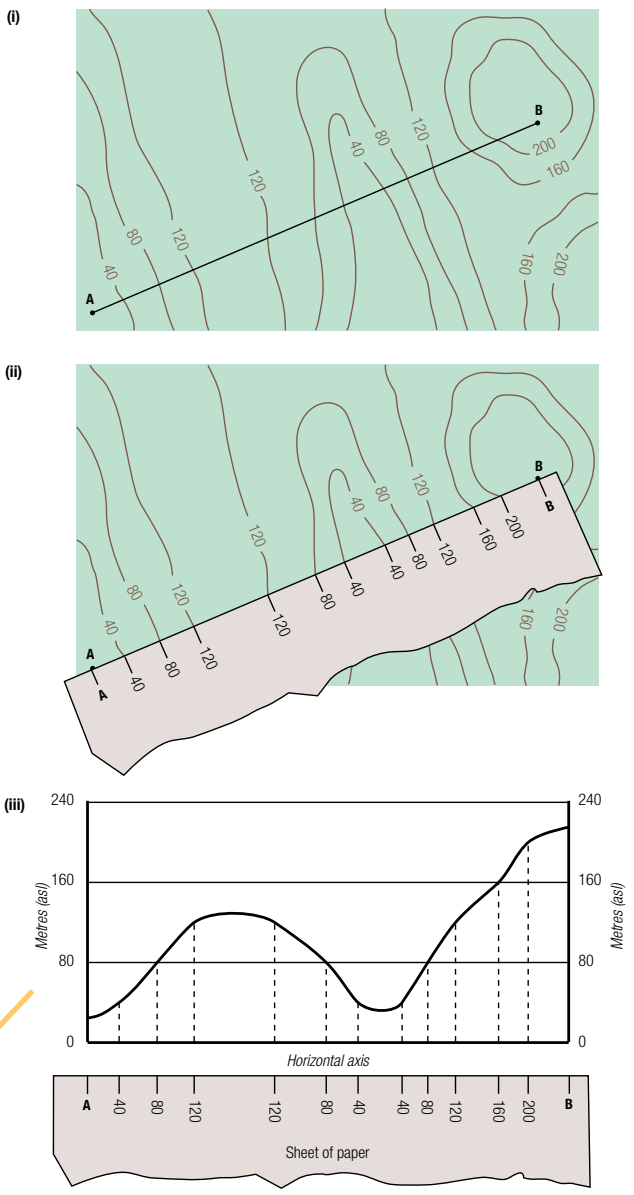


Figure 1.5j Steps in drawing a cross-section.

CROSS-SECTIONS

A *cross-section* is a side view (or profile) of the land. Drawing a cross-section from a topographic map is a useful way of interpreting contour lines and gaining a visual impression of the shape of the land. The following method can be used when drawing a cross-sectional profile between two points; in this case points A and B.

STEPS IN DRAWING A CROSS-SECTION

Drawing a cross-section involves the following steps:

1. Place the straight edge of a sheet of paper along a line joining points A and B. Mark points A and B on your sheet of paper. (See Figure 1.5j (i).)
2. Starting from point A, mark the position where the edge of your sheet of paper cuts each contour line. Write the value of each contour on your sheet of paper. (See Figure 1.5j (ii).)
3. Draw the horizontal and vertical axes for your cross-section. The length of the horizontal axis should equal the length of the line A–B. The vertical axis, showing the height of the land above sea level, should use a scale appropriate to your needs.
4. Place your sheet of paper along the horizontal axis and then plot the contour points and heights as if you were drawing a line graph. (See Figure 1.5j (iii).)
5. Join the dots with a single smooth, curved line and then shade in the area under the line to highlight the relief.

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Advanced skill: calculating vertical exaggeration

The formula used to calculate vertical exaggeration (VE) is shown below.

$$VE = \frac{\text{Vertical scale (VS)}}{\text{Horizontal scale (HS)}}$$

The *vertical scale* is the scale used on the vertical axis of the cross-section. The *horizontal scale* is the scale of the map from which the cross-section was drawn. The most common error students make is not converting the vertical and horizontal scales to a common unit of measurement; for example, metres. Answers must be expressed as a single number. Vertical exaggeration has no units of measurement nor is it expressed as a fraction.

EXAMPLE

Calculate the vertical exaggeration of the cross-section shown in Figure 1.5j, page 11.

$$VE = \frac{VS}{HS} = \frac{\text{1 cm represents 80 m}}{\text{1 cm represents 1 km}}$$

Convert the numerator and denominator to the same unit of measurement.

$$= \frac{\text{1 cm represents 80 m}}{\text{1 cm represents 1000 m}}$$

$$= \frac{\frac{1}{80}}{\frac{1}{1000}}$$

Invert the denominator, then multiply.

$$= \frac{1}{80} \times \frac{1000}{1}$$

VE = 12.5 times

Advanced skill: calculating gradient

Using the contour lines and scale on a map, it is possible to calculate the average gradient, or steepness, of a slope, road or river. The gradient is usually expressed as a fraction or ratio. It is calculated by dividing the difference in height (or vertical interval) between the two points by the horizontal distance between them. Figure 1.5k gives us an idea of how steep a slope is for selected gradients.

Calculating the gradient between two points involves the two following steps.

STEP 1

Determine the two pieces of information required to complete the calculation.

- The first piece of information required is the difference in height between the two points. This is called the *vertical interval*, or *rise*. Find this by subtracting the lowest point from the highest point.
- The second piece of information required is the *horizontal distance* between the two points. This is sometimes referred to as the *run*. Find this by measuring the distance between the two points on the map and then using the scale to determine the actual distance.

STEP 2

To calculate the gradient of a slope use the following formula.

$$\text{Gradient} = \frac{\text{Vertical interval (rise)}}{\text{Horizontal distance (run)}}$$

Note: Because the gradient of a slope is expressed as a ratio, the measurements for the rise (numerator) and run (denominator) must be in the same unit of measurement; for example, metres.

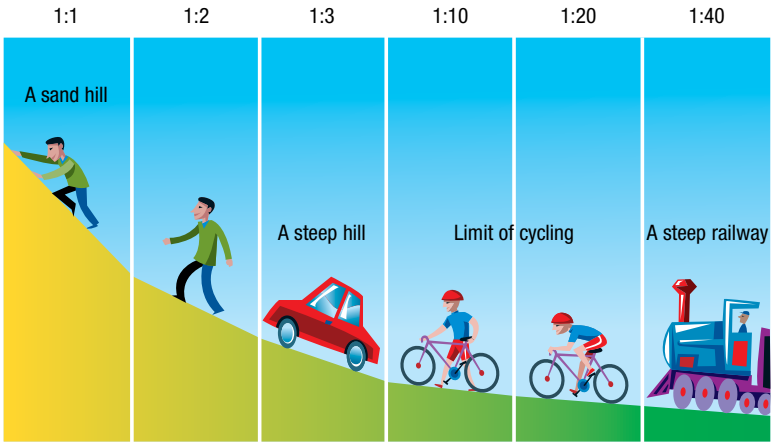

Figure 1.5k Gradients.

EXAMPLE

Calculate the gradient of the slope between points X and Y in Figure 1.5f, page 10.

$$\text{Gradient} = \frac{\text{Vertical interval (rise)}}{\text{Horizontal distance (run)}}$$

$$= \frac{70 \text{ m}}{4500 \text{ m}}$$

$$= \frac{7 \text{ (numerator)}}{450 \text{ (denominator)}}$$

= 1 in 64 or 1:64

This means that for every 64 m travelled in a horizontal direction, you go up 1 m. If you refer to Figure 1.5k you will see that this is quite a gentle slope. The average person should be able to cycle up such a slope.

ACTIVITIES

1. Explain what is meant by the term 'relief'.
2. Identify the technique used to show relief on maps.
3. State what contour lines represent.
4. Explain what the interpretation of contour lines tells us about relief.
5. Explain what is meant by the term 'contour interval'.
6. Explain what is meant by the term 'local relief'.
7. Explain why geographers construct cross-sections from topographic maps.
8. State what is meant by the term 'vertical exaggeration'.
9. Explain what is meant by the term 'aspect'.
10. Explain what is meant by the term 'gradient'.

Study Figure 1.5l and then complete the following tasks.

11. What is the contour interval on the Blue Lake topographic map?
12. Identify the feature of the physical environment located at:
    a GR 283681 **b** GR 295635
    c GR 232698 **d** GR 260670.
13. Identify the feature of the human or built environment located at:
    a GR 252679 **b** GR 251668.
14. What is the physical landform feature located at AR 2363?
15. What is the land use found in AR 2970?
16. What is the vegetation type found in AR 2668?
17. What is the direction of Hope Island from the summit of Mt Smith?
18. What is the direction of Duck Island from the summit of Mt Brown?
19. In what direction is Duck Creek flowing in AR 2865?
20. What is the bearing of Mt Smith from Mt Brown?
21. What is the straight-line distance between the summits of Mt Brown and Mt Smith?
22. What is the difference in elevation between Mt Brown and Mt Smith?
23. What is the elevation of the following locations?
    a U (AR 2869) **b** V (AR 2469)
    c W (GR 270698) **d** X (GR 287669)
    e Y (GR 270640) **f** Z (GR 290650)
24. Calculate the local relief experienced on a traverse from Mt Brown to Mt Smith.
25. What is the aspect of the slope in each of the following locations?
    a AR 2670 **b** AR 2766
26. Construct the cross-section between point A (AR 2868) and point B (AR 2963), using a vertical scale of 1:40 m.
27. Construct the cross-section between point C (GR 2566) and point D (AR 2763), using a vertical scale of 1:80 m.
28. Calculate the vertical exaggeration of the cross-section A–B.
29. Calculate the vertical exaggeration of the cross-section C–D.
30. Calculate the gradient of the slope C–D.

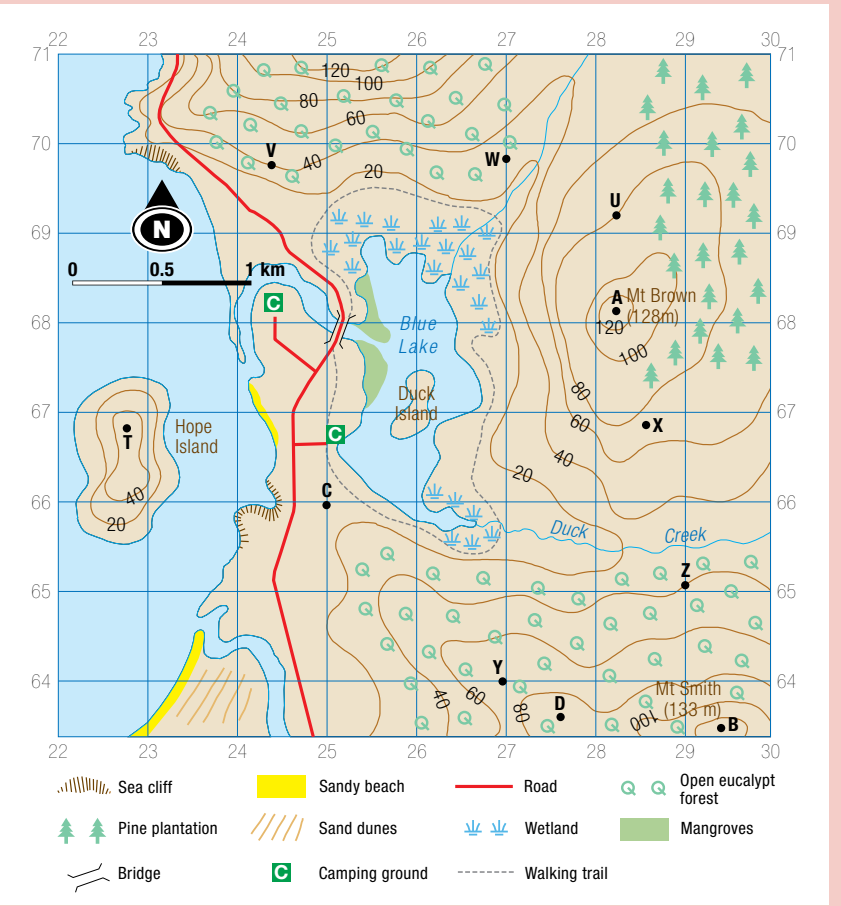

Figure 1.5l Topographic map of Blue Lake. Scale 1 cm = 40 000 cm.

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1.6 Landform features

Figure 1.6a Vertically exaggerated!

The landforms featured on topographic maps have been shaped by the processes of weathering and erosion. *Weathering* involves the chemical and physical breakdown of rock into smaller fragments. Running water, wind and ice (the *agents of erosion*) then erode, transport and deposit large amounts of weathered material. The landform features created by weathering and erosion can be classified as either *erosional* or *depositional*. Being able to identify and name these landform features is an important geographical skill.

COMMON LANDFORM FEATURES

Figure 1.6b illustrates some common landform features that are shown on topographic maps and can be observed during fieldwork. These features include the following:

- *Basin* – an area of relatively level ground surrounded by hills or an area drained by a river and its tributaries.
- *Crest* – the highest part of a hill or mountain range.
- *Escarpment* – the steep hillside formed by a sudden drop in elevation, usually from a plateau.
- *Gorge or canyon* – a deep ravine, usually with very steep sides.
- *Knoll* – a low, detached hill.
- *Plateau* – a large, elevated area of relatively flat land.
- *Ravine* – a long, deep valley carved out by a stream.
- *Re-entrant* – a valley or ravine, usually between two spurs, running inwards towards the hill or mountain top.
- *Ridge* – the line along a hill or range of hills or mountains from which the water flows in opposite directions; sometimes referred to as a 'watershed'.
- *Saddle* – a depression between the tops of adjacent hills or mountains.
- *Spur* – a ridge running out from a hill or mountain.

ARID LANDFORM FEATURES

Running water is the most important agent of erosion in arid (desert) environments. Although it does not rain there often, when it does the rain is often very heavy and results in flash flooding. Because there is no vegetation, run-off is very rapid and can erode large amounts of weathered material.

Surface run-off is channelled into dry riverbeds (*wadis*) that cut through plateaus, forming canyons or gorges. As plateaus are eroded, *mesas* (sometimes known as outliers) and *buttes* (see Figures 1.6c and 1.6d) are left isolated from the retreating *escarpment*. Mesas are wider than they are high, while buttes are higher than they are wide.

The eroded material is often deposited onto lowlands, forming *alluvial fans*. These spread out across the desert basin (or *bolson*), where the fine particles can be shaped into dunes by the wind.

Where water flows into a desert depression, *playa lakes* form. When the water eventually evaporates, *salt* (or *clay*) *pans* are formed.

Inselbergs are large masses of resistant rock that rise abruptly from the surrounding plain. They are exposed when the softer surrounding rock material is eroded. Uluru (Ayers Rock) is one of the world's best-known inselbergs.

Distinctive dune types include *star dunes*, *longitudinal dunes*, *transverse dunes* and *barchan dunes*.

The distinctive landform features of arid lands are shown in Figure 1.6c.

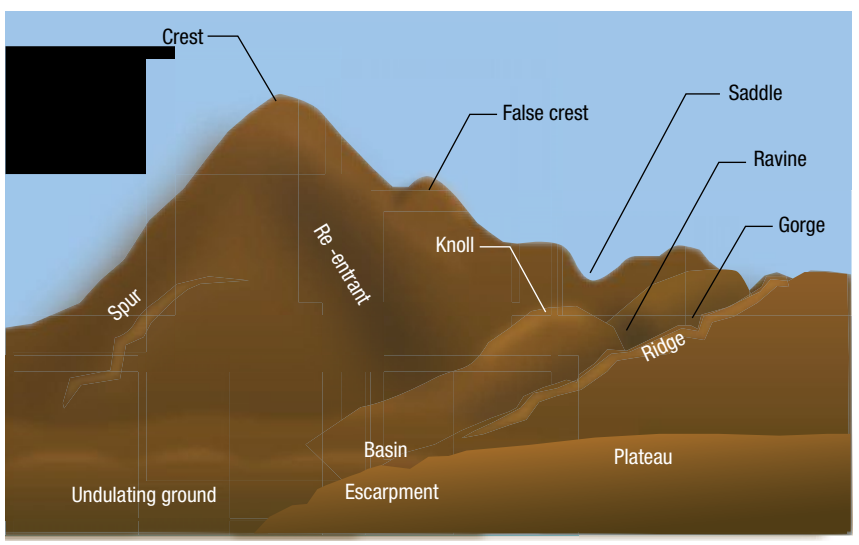

Figure 1.6b Some common landform features.

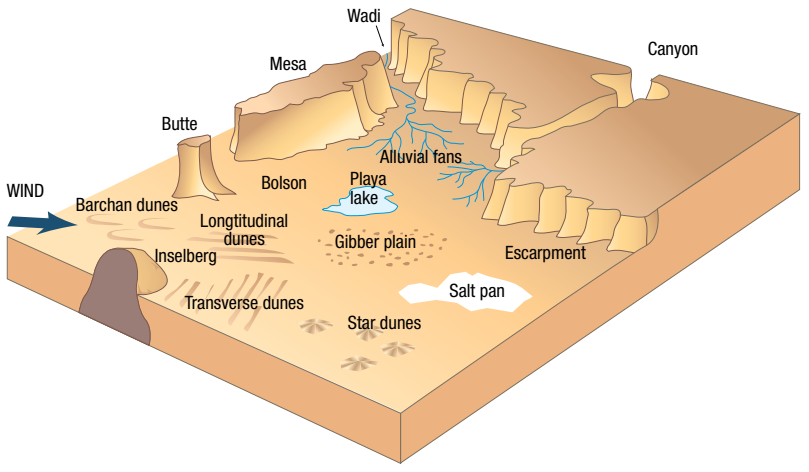

Figure 1.6c Landforms of arid environments.

Figure 1.6d Buttes in Monument Valley, United States.

Figure 1.6e The spectacular coastline of Big Sur on the west coast of the United States is dominated by erosional landform features.

COASTAL LANDFORM FEATURES

Coastal environments are constantly changing. Some are eroded by storm waves, while others move towards the sea when waves deposit large amounts of sand. The features of *erosional coasts* include *headlands* and *bays, rock platforms* and *cliffs*, *sea caves*, and *sea stacks* and *arches*. (See Figures 1.6e and 1.6f.)

When storm waves crash against a cliff, they widen and deepen the cracks in the rock face. Eventually, the cliff is undercut, collapses and retreats.

The features of *depositional coasts* include *sand dunes*, *tombolos*, *sandbars* and *sand spits*. In good weather, waves and onshore winds deposit large amounts of sand. This builds up a protective barrier between the land and the sea. Over time this barrier is strengthened by the growth of vegetation. (See Figure 1.6g.)

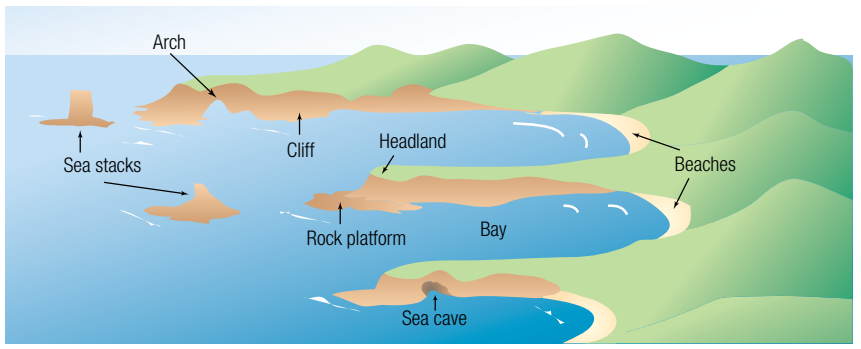

Figure 1.6f Erosional features of the coastal environment.

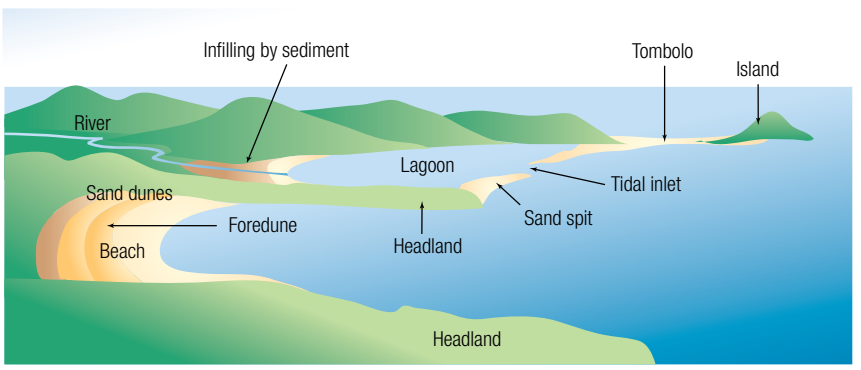

Figure 1.6g Depositional features of the coastal environment.

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GLACIAL LANDFORM FEATURES

Glaciers are slow-moving rivers of compacted snow. They form when compacted snow, which has gathered over many years, gradually moves downhill under the influence of gravity.

Glaciers and *ice sheets* are very effective at eroding and transporting rock. The surface of the land is scratched and worn down by rock fragments that have been picked up from the ground and frozen into the base of the glacier. This process is known as *abrasion*. Figures 1.6h and 1.6i show some of the distinctive landform features associated with glaciers.

Figure 1.6h Switzerland's Aletsch Glacier.

RIVERS: SHAPING THE LAND

Rivers shape the land by eroding, transporting and depositing material. In their mountainous *headwaters*, rivers erode downwards. This forms narrow *V-shaped valleys*. The point at which the river starts is called its *source*.

Away from the mountains, valleys become wider and some of the river's load of *sediment* is deposited. Closer to the sea, the river flows across a wide, flat plain, depositing fine particles of soil called *alluvium*. These alluvial soils are usually very fertile. Where the river enters the sea, an *estuary* (or *delta*) forms.

A *catchment*, or drainage basin, is the area of land that is drained by a river and its tributaries. (*Tributaries* are smaller rivers and streams that flow into larger rivers.) The boundary of the catchment is marked by a ridge of elevated land. This boundary is called a *watershed*. (See Figure 1.6k.)

Some rivers only flow after heavy rainfall. These are called *intermittent rivers*. On topographic maps they are usually shown by a broken blue line.

River *meanders* develop when the river undercuts the outside bank of a river channel and deposits silt and sand on the inside bend. During floods, loops in the river may be cut off, forming a *billabong* (or *oxbow lake*). (See Figures 1.6l and 1.6m.) Figure 1.6j illustrates the landform features commonly found on the floodplain of a river.

Waterfalls develop when a hard layer of rock forms a barrier to a river's downcutting action. The power of the falling water forms a plunge pool at the base of the waterfall. (See Figure 1.6n.) Often, the rock below the more resistant layer will be eroded, creating a cave-like formation or rock shelter.

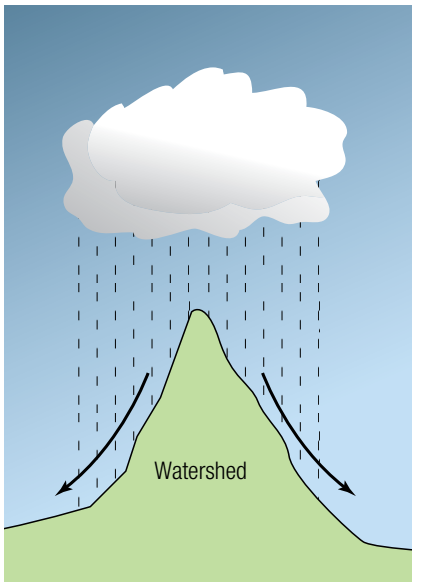

Figure 1.6k A watershed divides one catchment from another.

Figure 1.6l Meander bends.

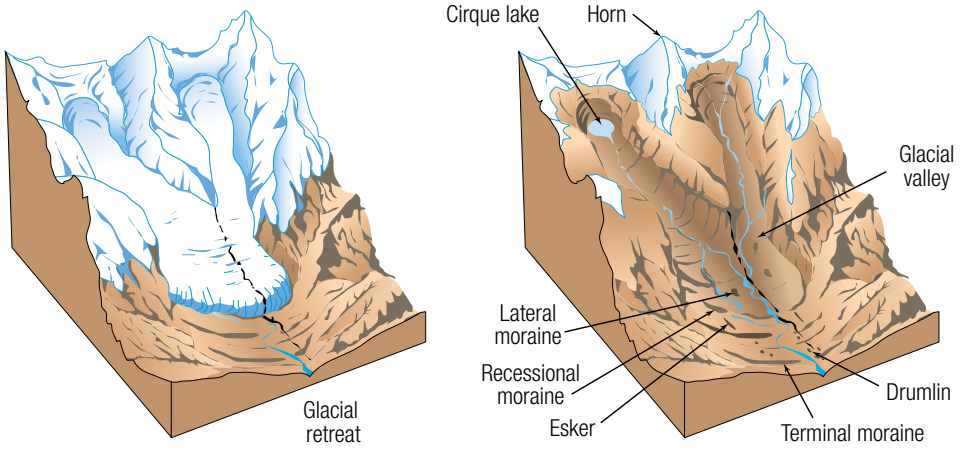

Figure 1.6i Glacial landform features.

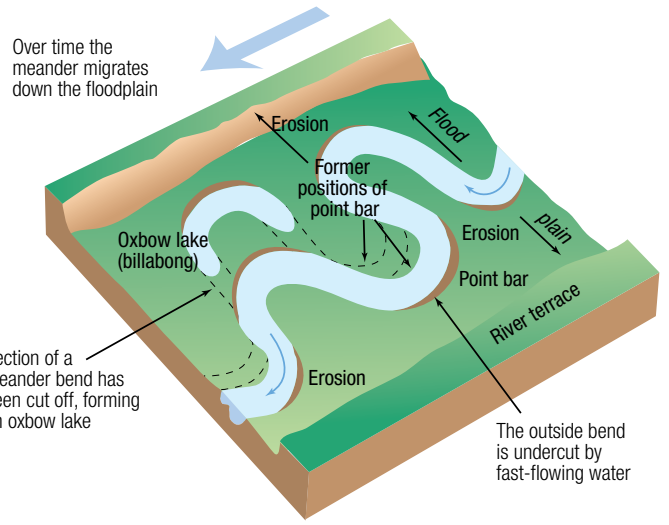

Figure 1.6m Formation of river meanders.

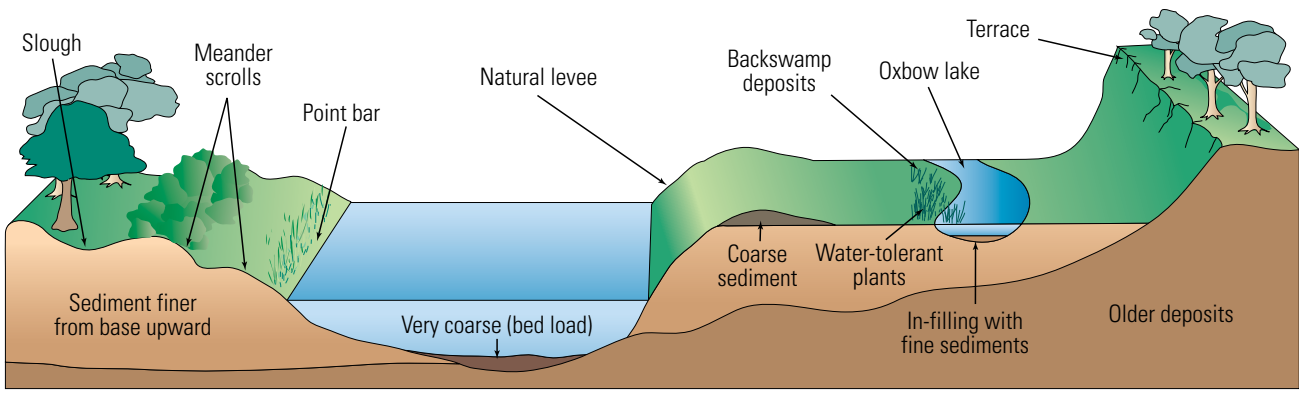

Figure 1.6j Landform features on the floodplain of a river.

Figure 1.6n The Iguazu waterfalls on the Argentine–Brazilian border.

ACTIVITIES

1. Distinguish between the processes of weathering and erosion.
2. What are the agents of erosion?
3. Draw a series of sketches featuring the following landform features: escarpment, gorge, plateau, saddle and spur. Draw one sketch per feature.
4. What is the most important agent of erosion in deserts?
5. Distinguish between a mesa and a butte.
6. What is an inselberg?
7. List the landform features commonly associated with:
   a. erosional coasts
   b. depositional coasts.
8. What is a glacier? How is it formed?
9. What is abrasion? How do glaciers abrade the landscape?
10. Research task: investigate how cirque lakes are formed.
11. Draw an annotated sketch featuring the landform features associated with the work of rivers.

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1.7 Interpreting topographic maps

Figure 1.7a What landform is that?

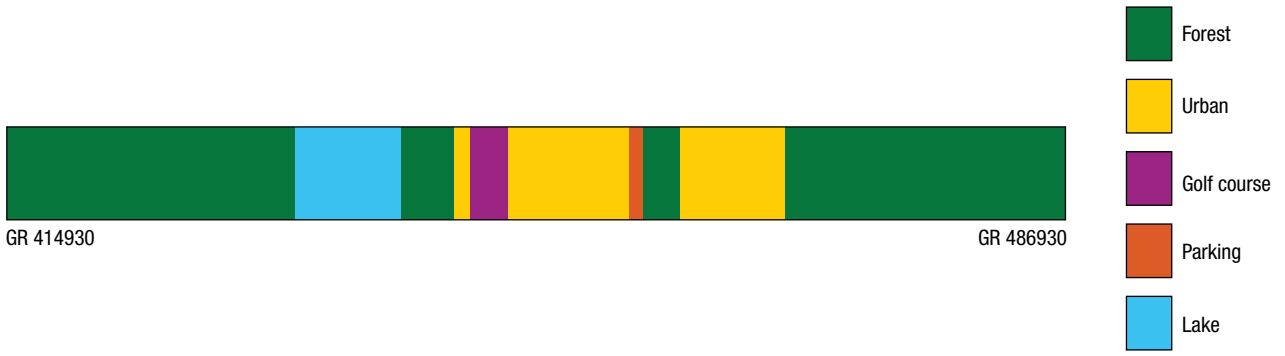

Figure 1.7c Transect along northing 93 between GR 414930 and GR 486930 on the Whistler topographic map extract. (See page 163.)

PRECIS MAPS

Topographic maps, aerial photographs and satellite images contain large amounts of detail, so it is often useful to construct a *precis (or single-feature) map* highlighting one particular feature of the map, photograph or image. By comparing precis maps it is often possible to identify the relationship between two features; for example, between landform and settlement patterns or transport networks.

To draw a precis map follow the steps below:

1. Identify the feature or pattern to be studied, such as landforms, drainage, vegetation, settlement, transport or land use.
2. Examine the distribution of the feature on the map, photograph or image and the pattern this distribution creates.
3. Draw a simple outline map of the map, photograph or image.
4. Add the distribution of the feature.
5. Label each area or construct a legend that identifies the features numbered or shaded on the map.

Figure 1.7b illustrates the vegetation pattern on the Madang topographic map extract. (See page 128.)

Figure 1.7b Precis map of the Madang topographic map extract showing the pattern of vegetation.

TRANSECTS

Transects show the relationship between different features of the physical and built environments along a cross-section or between two points. Once a transect is drawn, you can use it to make generalisations about features, such as landforms, vegetation, soils, geology, transport, settlement and agricultural land use.

Figure 1.7c shows a vegetation transect along northing 93 between GR 414930 and GR 486930 on the Whistler topographic map extract. (See page 163.)

DRAINAGE PATTERNS

A *drainage pattern* is the arrangement of rivers and their tributaries within a drainage basin. Most of these patterns develop over a long period of time and usually adjust themselves to the structure (or geology) of the drainage basin. The most common drainage patterns formed include the following:

- *Parallel*. This is perhaps the simplest of all drainage patterns. It generally occurs on newly uplifted land and where rivers and tributaries flow downhill more or less parallel with each other. The pattern created features a number of parallel rivers. (See Figure 1.7d (i).)
- *Dendritic*. Derived from the Greek word *dendron*, meaning tree, this is a tree-like pattern. The tributaries converge on the main river channel. Dendritic patterns generally develop in areas that have one rock type. (See Figure 1.7d (ii).)
- *Radial*. In areas dominated by dome-shaped mountains or volcanic cones, rivers radiate outwards from a central point like the spokes of a wheel. (See Figure 1.7d (iii).)
- *Trellis or rectangular*. In areas where there are areas of resistant and less-resistant rock, tributaries will join the main river at right angles. (See Figure 1.7d (iv).)

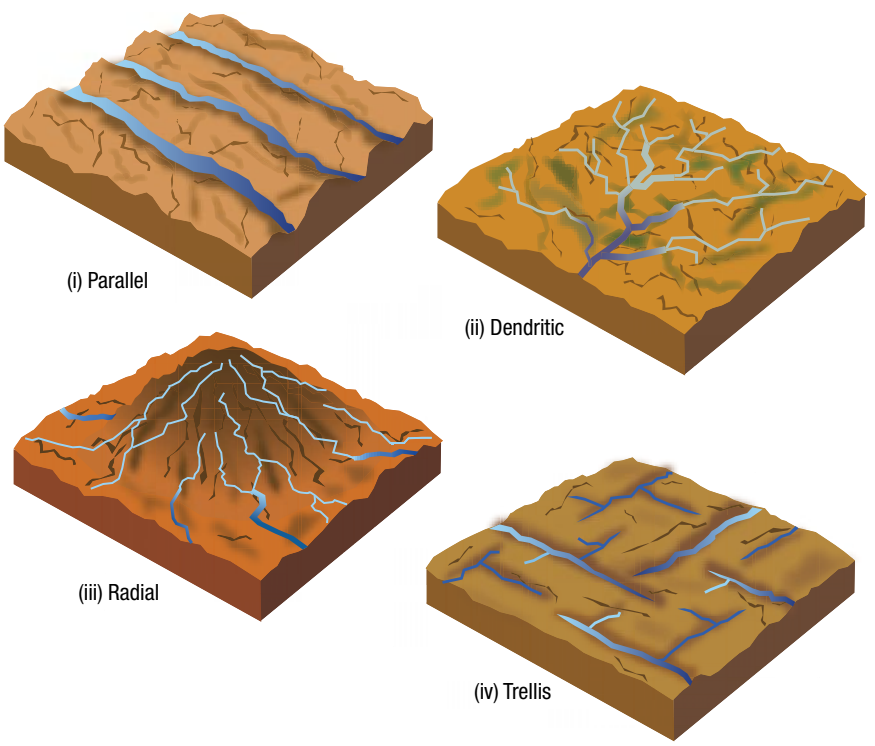

Figure 1.7d Types of drainage patterns.

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SETTLEMENT PATTERNS

Settlements (hamlets, villages, towns and cities) are built-up areas. No two settlements are exactly alike, but many do have certain features in common. One common feature is *site*. This is the place where a settlement was first established. Another common feature is *layout*, which is the arrangement and spacing of buildings within a community.

Settlement pattern is the term used to describe the distribution and layout of buildings within built-up areas. The main settlement patterns are as follows:

- *Nucleated* – settlements that are compact. Specific examples include the grouped hamlet, cluster village and skeleton grid. (See Figure 1.7e (i)–(iii).)
- *Linear* – settlements that are long and narrow. Examples include the string village and linear hamlet. (See Figure 1.7e (iv) and (v).)
- *Dispersed* – scattered rural homesteads. (See Figure 1.7e (vi).)

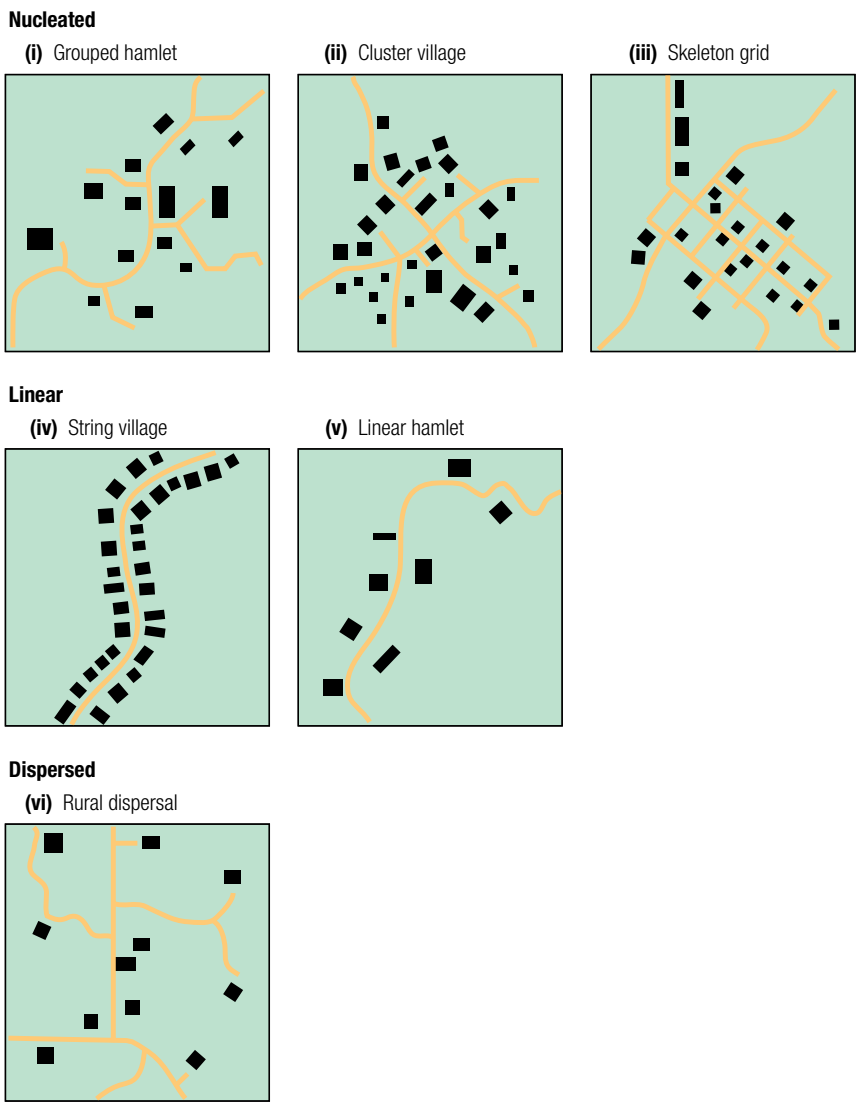

Figure 1.7e Some of the settlement patterns found on maps.

Figure 1.7f Ridge-top grouped hamlet-type village in Papua New Guinea.

Figure 1.7g A linear (string) village in Croatia.

Figure 1.7h A cluster village in rural Germany.

ACTIVITIES

1. Explain why geographers draw precis maps.
2. Outline the purpose of transects.
3. Study the Enard Bay topographic map extract on page 152. Construct a precis map showing the relationship between transport and topography.
4. Study the Popondetta topographic map extract on page 134.
   a. Construct a precis map showing the pattern of vegetation found in the area covered by the map.
   b. Construct a transect from GR 300310 to GR 470310.
5. Study the Mt Ruapehu topographic map extract on page 113. Identify the drainage pattern evident on the map extract.
6. Study the Kokoda topographic map extract on page 131. Identify the general pattern of settlement found on the map.
7. Study the Popondetta topographic map extract on page 134. Identify the settlement type found at AR 3030.
8. Study the Madang topographic map extract on page 128. Identify the settlement type found at AR 6722.

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1.8 Photographs

Figure 1.8a Get the shot!

Geographers use photographs to gather and record information about features of the Earth's surface. Photographic images provide a visual record of a landscape and allow us to note the relationship between the various elements of the physical and built environments. They also provide a convenient way to examine the rate and nature of environmental change. Photographs taken at different times can be compared and analysed. The different types of photographs are shown in Figure 1.8b.

GROUND-LEVEL PHOTOGRAPHS

Ground-level photographs are taken from the ground so that a horizontal view is obtained. Features in the foreground appear larger than those in the background. (See Figure 1.8c.)

AERIAL PHOTOGRAPHS

Aerial photographs are photographic images of part of the Earth's surface taken from an aircraft. Aerial photographs are now widely used to update topographic maps.

TYPES OF AERIAL PHOTOGRAPHS

There are two types of aerial photographs depending on the angle of the camera: oblique and vertical.

Oblique aerial photographs are taken from an aircraft with a camera pointing at an oblique angle to the Earth's surface; that is, at an angle less than 90°. (See Figure 1.8d.) These photographs are often easier to interpret than vertical aerial photographs because:

- the sides of objects as well as the tops of objects can be seen
- they are usually taken at low altitudes.

The main disadvantage of oblique aerial photographs is that there is no consistent scale. Features in the foreground appear larger than those in the background.

Figure 1.8d Oblique aerial photograph of Venice.

Figure 1.8e Vertical aerial photograph of Venice.

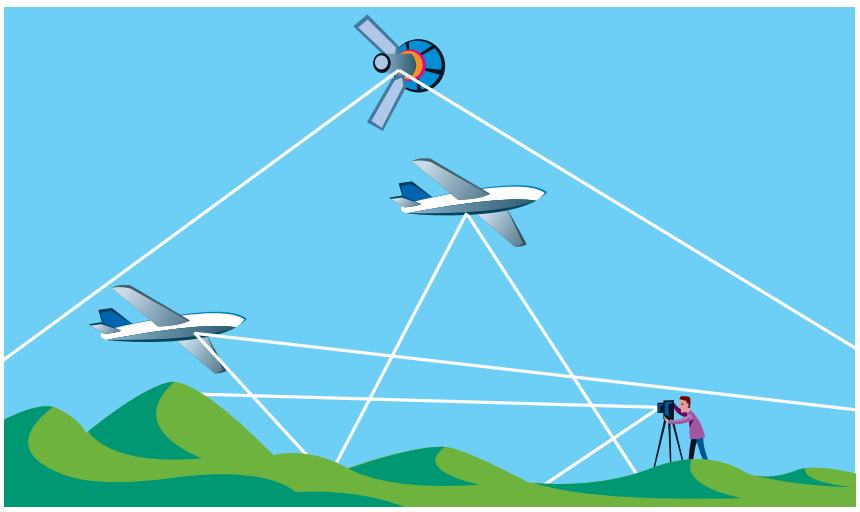

Figure 1.8b Types of photographs.

Vertical aerial photographs are taken from an aircraft with a camera pointing directly towards the Earth's surface; that is, at an angle of 90°. (See Figure1.8e.)

Spatial patterns are clearly visible, but specific features may be difficult to identify because we can see only a plan view of them.

SATELLITE IMAGES

Satellite images are different from the photographs you take with a digital camera because they are created from data collected by satellites that orbit the Earth. (See Figure 1.8f.) Geographers use remote sensing to study the spatial distribution of biophysical, managed and constructed elements of environments. Remotely sensed images are especially important when investigating change over time.

Remotely sensed images are produced from data gathered by satellite-mounted sensors. These sensors are so sensitive that they can record the radiation given off by features on the Earth's surface. These data are then converted into images. Often, these images are referred to as *false-coloured* images, and the observer needs to know what each colour represents

Figure 1.8c Ground-level photograph of Venice's Grand Canal.

Figure 1.8f Satellite image of Venice.

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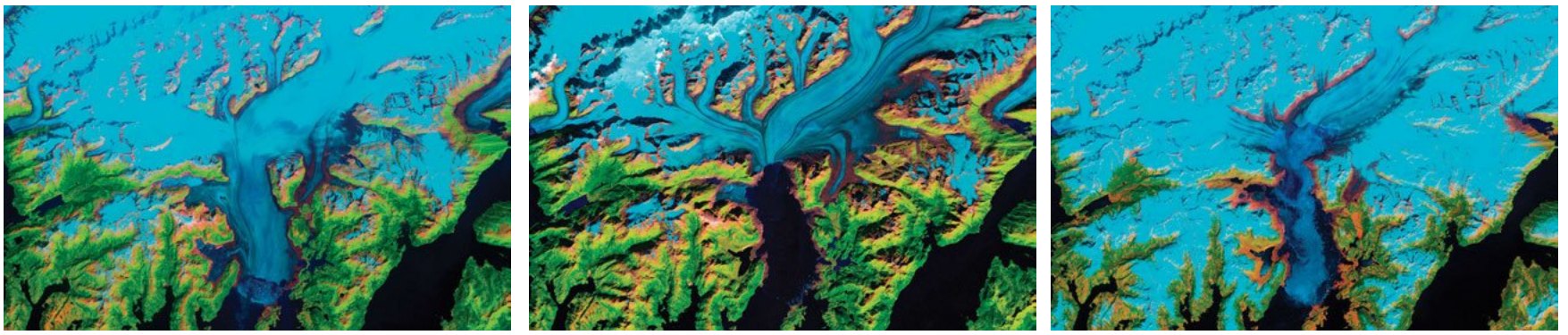

Summer 1986 | Summer 2003 | Winter 2011

Figure 1.8g False-colour satellite images of the Columbia Glacier.

Table 1.8a Colour guide for false-coloured images

Colour	*Feature*
Dark blue–black	Deep water in oceans, lakes and dams
Mauve–steely blue	Urban and industrial areas
Blue–light blue	Arid scrubland; very shallow water
Dark green	Deep muddy floodwaters, clear shallow water
Light green	Moist, ploughed, bare soils; light grass cover
Brown	Dryer vegetation such as eucalypts and arid woodlands; bare rock
Red	Healthy growing vegetation; rainforest (deep red); growing crops and pastures; mangroves (deep red)
Pink–red	Early growth of crops and grasslands; suburban gardens, lawns and parks
Yellow	Areas with little vegetation cover, heavily grazed areas, deserts and sand dunes
White–cream	Bare ground; dry sand and salt areas, dunes and beaches; clouds

in order to interpret the image. The images in Figure 1.8g are examples of *false-coloured* images. Other images look more like photographs because computer programs convert the data received from satellites into *true-colour* images.

The false-colour images in Figure 1.8g, captured by Landsat satellites, show how the glacier and the surrounding landscape has changed since 1986.

As satellites became more sophisticated they were able to capture the data necessary to produce *true-colour* images. These images feature colours as they appear to human eye. We still, however, still need to know what each colour represents (see Table 1.8b).

Figure 1.8h *Perito Moreno Glacier, Patagonia.* True-colour image of the Perito Moreno Glacier in Patagonia, South America. The glacier descends from the Southern Patagonian icefield (2100 m elevation) in the Andes Mountains – down into the water and warmer altitudes of Lago Argentino at 180 m above sea level.

Table 1.8b Colour guide for true-coloured images

Colour	*Feature*
Dark blue–black	Deep, clear water in oceans, lakes and dams
Light blue	Shallow water
Mauve-steely blue	Urban and industrial areas
Brown-light brown	Dry vegetation such as eucalypt and arid woodlands; bare rock
Bright light green	Grassland, growing crops and pastures; suburban parks and gardens
Bright green	Healthy, growing green vegetation; rainforest and mangroves
Light pink–orange–brown	Cleared farming land; early growth in crops and grasslands
White cream	Bare ground; dry sand and salt areas; dunes and beaches; clouds

Interpreting aerial photographs

Interpreting aerial photographs involves the following steps:

1 Determine whether the photograph is a vertical aerial photograph or an oblique aerial photograph.

2 Look for evidence of location and time. Often the caption provides some relevant information about the photograph, especially about the location.

3 Look for a familiar feature of the built environment that will give you some indication of scale.

4 Identify the main features of the photograph. You may find it useful to group them under the following headings.
- Features of the physical environment:
  - landforms; for example, relief and drainage features
  - climate
  - vegetation.
- Features of the built environment:
  - land use
  - transport networks
  - settlements—rural and urban.

5 Ask yourself the following questions.
- Is the area predominantly characteristic of the physical and built environments?
- What is the physical nature of the environment: fluvial, coastal, arid, glacial, mountainous and so on?
- To what extent has the area been modified by human activity?

Using photographs to record information

Photography is often used to record and illustrate geographical information. It allows us to:
- record how a place looks at a particular point in time
- make comparisons between different environments
- show the relationship between geographical phenomena
- study change in an area or environment over time.

Taking a photograph that is of use to geographers involves the following steps:
- Decide what the photograph is going to show.
- Choose what is to be included and excluded.
- Include a generally recognised feature that gives the viewer some indication of scale.
- Choose the appropriate distance between the camera and the object.
- Ensure the technical aspects of the photograph are correct; for example, that the lighting is adequate and the photograph is in focus.

ACTIVITIES

1 Outline how satellite images differ from photographs.

2 Study Figure 1.8b, page 17. Based on your knowledge of the types of photographic images, complete the following tasks:
- **a** Identify the type(s) of images that result in no distortion of the scale of the objects on the ground.
- **b** Identify the type of image that is likely to give the greatest distortion of the features in the foreground.
- **c** Identify the type of image that might block out views of distant features.
- **d** Identify the type of image that is likely to cover the largest area of the Earth's surface.

3 Use the internet to locate examples of ground-level, oblique and vertical aerial photographs.

4 Use Google Earth to explore some of the landscapes featured in the topographic maps in Sections 3 and 5–9 of this text.

5 Study Figure 1.8g. Trace the retreat of the Columbia Glacier.

6 Use NASA's Earth Observatory website (www.cambridge.edu.au/skillsgeo1 weblinks) to locate examples of satellite images that you find interesting. Mount a wall display that shows the diversity of the images available at the site.

1.9 Field sketches, line drawings and sketch maps

Figure 1.9a Hold that look!

Constructing field sketches

To construct a field sketch, follow the steps below:

1. Study the scene or photograph and select the features to be sketched. It may be helpful to use a viewing frame.
2. Using a soft pencil (it makes it easier to erase mistakes) and a blank sheet of paper, draw a frame the same shape as the scene you wish to sketch.
3. Divide the scene you wish to sketch into three parts: the foreground, middle distance and background. (See Figure 1.9b)
4. Sketch in the main features or lines of the scene. This may include the horizon and other prominent landform features.
5. Mark in other prominent features or lines, such as roads, railway lines, rivers or powerlines. These will provide reference points for the addition of detailed features.
6. Add detail if appropriate. Details may include buildings, trees and fences.
7. Use shading and/or colour to highlight the key features of your field sketch. Avoid making your sketch too cluttered.
8. Label the main features shown in your sketch.
9. Give your field sketch a heading and note the date of the observation.
10. Highlight your frame with a black felt-tipped pen.

Figure 1.9b Dividing your frame into foreground, middle distance and background will help you to construct your field sketch.

FIELD SKETCHES AND LINE DRAWINGS

Geographers use *field sketches* and *line drawings* to highlight significant features of a particular landscape. If the drawing is based on observations made during fieldwork it is called a field sketch. If it is drawn from a photograph it is called a line drawing or photo sketch.

Field sketches and line drawings are usually done in pencil, but some students find it useful to 'finish off' the sketch with a black pen and colour. The addition of labels or notes around the borders of the sketch can also be used to draw attention to significant features. (See Figures 1.9e and 1.9f, page 20.)

You do not need to have artistic ability to draw a field sketch or line drawing. Of greater importance is the geographical understanding you develop from identifying and sketching features of a particular landscape.

Once completed, field sketches and line drawings can be used to classify and explain spatial patterns and relationships.

You could, for example, identify the features of the physical and built environments; note the relationship between landforms, settlement patterns and transport networks; and identify the main physical processes shaping the landscape.

Constructing line drawings from photographs

To construct a line drawing from a photograph, follow the steps below:

1. Study the photograph and select the area to be included in the line drawing. (See Figures 1.9c and 19d.)
2. Using a soft pencil and a blank sheet of paper, draw a frame the same shape as the photograph you wish to sketch.
3. When sketching ground-level photographs use soft pencil lines to divide your photograph into three areas: foreground, middle ground and background.
4. Pick out the main features in each area of the photograph and sketch in an outline of their shape.
5. Use shading and/or colour to highlight the key features of your line drawing. Avoid making your line drawing too cluttered.
6. Label the main features shown in your line drawing.
7. Give your line drawing a title and note the source of the image.
8. Highlight your frame with a black felt-tipped pen.

Figure 1.9c Moraine Lake, Banff National Park, Canada.

Figure 1.9d Photo sketch: Moraine Lake, Banff National Park, Canada.

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Figure 1.9e Vogelsang Lake in Yosemite National Park, United States.

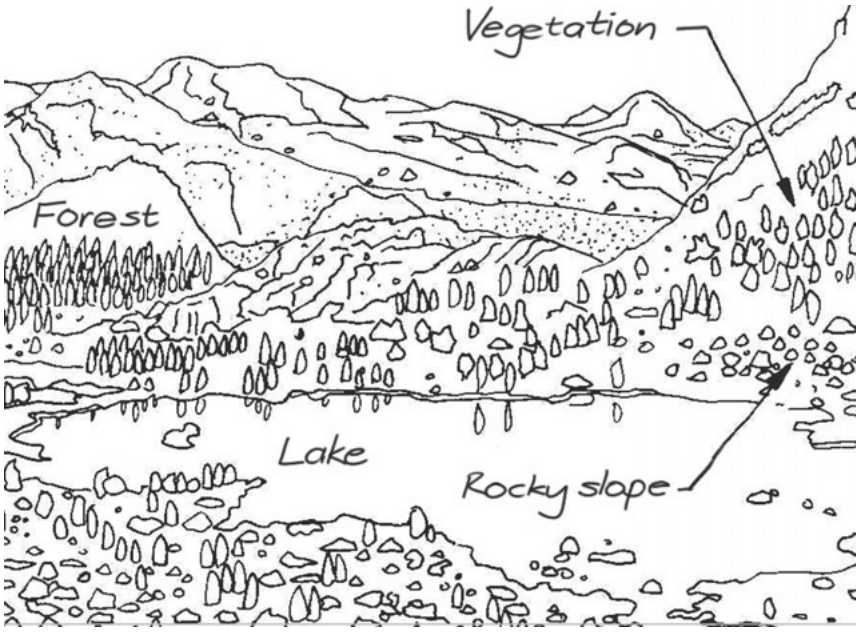

Figure 1.9f A sample field sketch of Vogelsang Lake in Yosemite National Park, United States. Field sketches such as this are a popular way to record information during fieldwork.

SKETCH MAPS

Just as line drawings can be drawn from ground-level and oblique aerial photographs, it is possible to construct *sketch maps* using vertical aerial photographs. Figure 1.9g is a sketch map of Gallipoli, drawn by Private Sydney Callaghan in 1915.

Here are the steps you should follow to make a sketch map from a vertical aerial photograph:

1. Draw a border the same shape as the aerial photograph.
2. Draw in the main features; for example, roads and coastline.
3. Describe the amount of detail required and add these to your sketch map.
4. Label the main features on the sketch. Add colour and shading if appropriate.
5. Complete the sketch by adding a title, scale, north point and, if necessary, legend.

A precis map (see Figure 1.7b, page 15) is a type of sketch map. Precis maps are used to illustrate the relationship between elements a topographic map; for example, landform and settlement patterns.

Figure 1.9g This small, 1 inch: 120 000 inch sketch map of Gallipoli was drawn by Private Sydney Callaghan. Callaghan carried the map in his tunic pocket at the landing at ANZAC Cove on 25 April 1915 [AWM/RC05680]

ACTIVITIES

1. Explain why geographers construct field sketches and line drawings.
2. Distinguish between field sketches and line drawings.
3. Select one of the photographs in Figure 1.9h and construct a photo sketch of the image. Label the principal features of the biophysical or constructed environment.
4. Undertake fieldwork. Construct a field sketch of a landscape. Annotate your sketch, highlighting prominent land-form features and important elements of the biophysical and constructed environments.

Figure 1.9h(i) Matterhorn, Switzerland.

Figure 1.9h(ii) Monument Valley, United States.

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1.10 Climate graphs and weather maps

Figure 1.10a Four seasons in a day.

Table 1.10a Climate data for Sao Paulo, Brazil, elevation 760 m, latitude 23°32'S, longitude 46°37'W

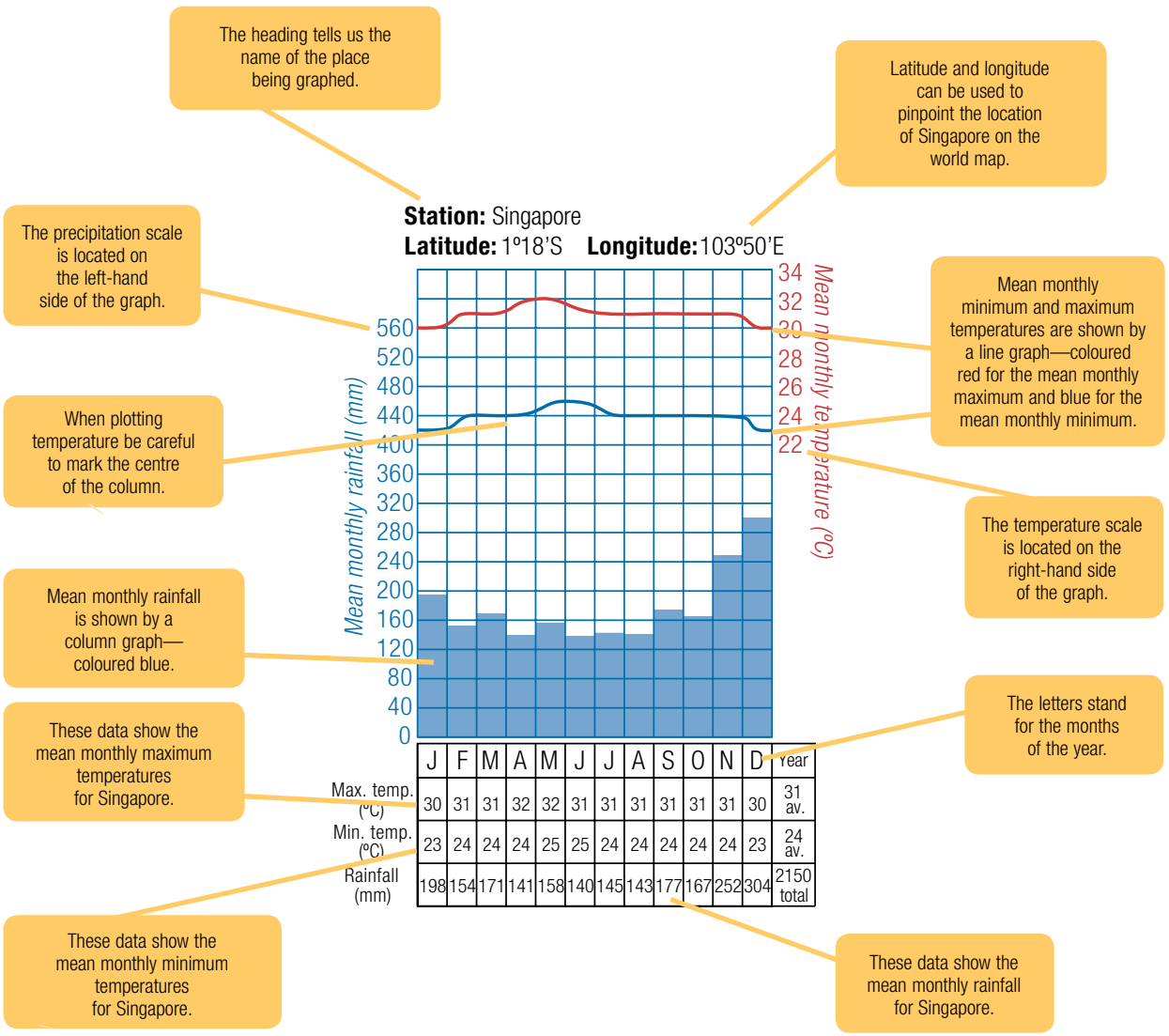
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean min. temperature °C	18.7	18.8	18.2	16.3	13.8	12.4	11.7	12.8	13.9	15.3	16.6	17.7	15.5
Mean max. temperature °C	27.3	28.0	27.2	25.1	23.0	21.8	21.8	23.3	23.9	24.8	25.9	26.3	24.9
Mean total precipitation (mm)	238.7	217.4	159.8	75.8	73.6	55.7	44.1	38.9	80.5	123.6	145.8	200.9	1454.8

CLIMATE GRAPHS

A *climate graph* shows the average temperature and rainfall experienced at a particular place throughout the year. It consists of a line graph showing mean (average) monthly temperature and a simple column graph showing mean monthly rainfall figures.

Climate graphs are constructed using long-term data, such as those collected by the Australian Bureau of Meteorology. The data shown in Table 1.10a are typical of the long-term data that would be plotted on a climate graph. You can use the bureau's website to locate climate data for hundreds of locations throughout Australia. Climate data for international locations can be found at the following websites: World Weather Information Service and WorldClimate (refer to www.cambridge.edu.au/skillsgeo1weblinks for links to these websites).

The main features of a climate graph are shown in Figure 1.10b.



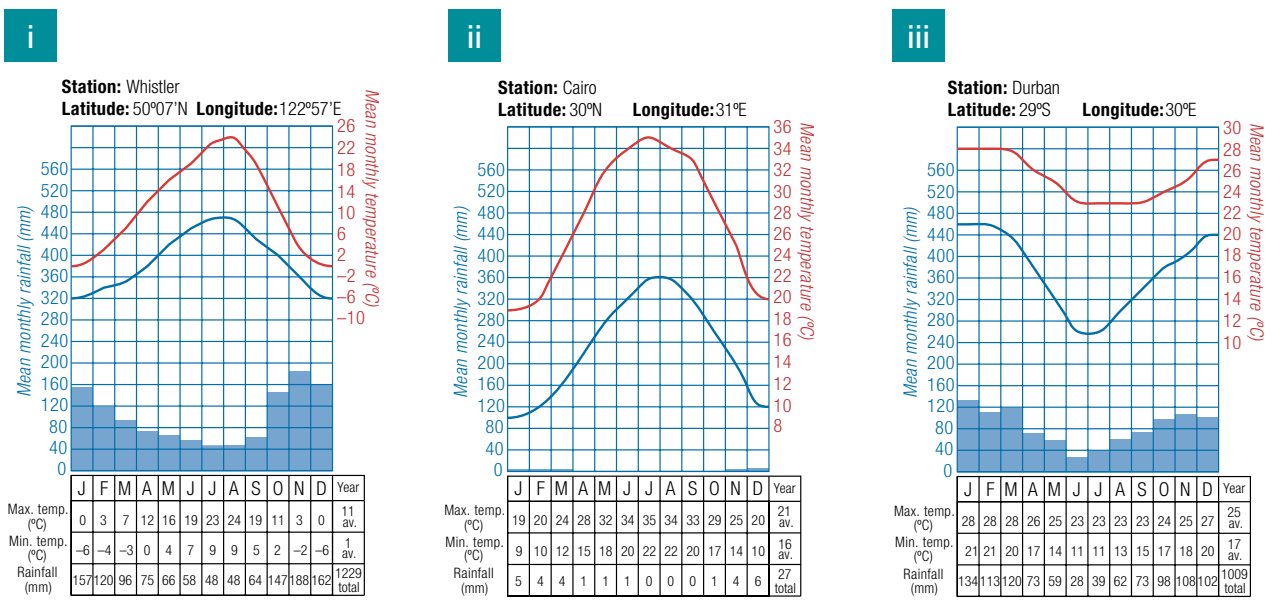
	J	F	M	A	M	J	J	A	S	O	N	D	Year
Max. temp. (°C)	30	31	31	32	32	31	31	31	31	31	31	30	31 av.
Min. temp. (°C)	23	24	24	24	25	25	24	24	24	24	24	23	24 av.
Rainfall (mm)	198	154	171	141	158	140	145	143	177	167	252	304	2150 total

Figure 1.10b Climate graph of Singapore.

Constructing a climate graph

To construct a climate graph, follow the steps below:

1. Transfer the relevant temperature and rainfall data into the table at the base of the climate graph.
2. Study the data to identify the wettest month and the highest and lowest mean monthly temperatures. Use this information to select a suitable scale for both temperature and precipitation.
3. Place the precipitation scale on the right-hand side of the graph and the temperature scale on the left-hand side of the graph.
4. Plot the rainfall figures and then colour the columns blue.
5. Plot the mean temperature data, making sure each dot is placed in the centre of each month. Join the points with a smooth curve.
6. Add a heading that includes the name of the place being graphed together with its latitude and longitude.



	J	F	M	A	M	J	J	A	S	O	N	D	Year
Max. temp. (°C)	0	3	7	12	16	19	23	24	19	11	3	0	11 av.
Min. temp. (°C)	−6	−4	−3	0	4	7	9	9	5	2	−2	−6	1 av.
Rainfall (mm)	157	120	96	75	66	58	48	48	64	147	188	162	1229 total

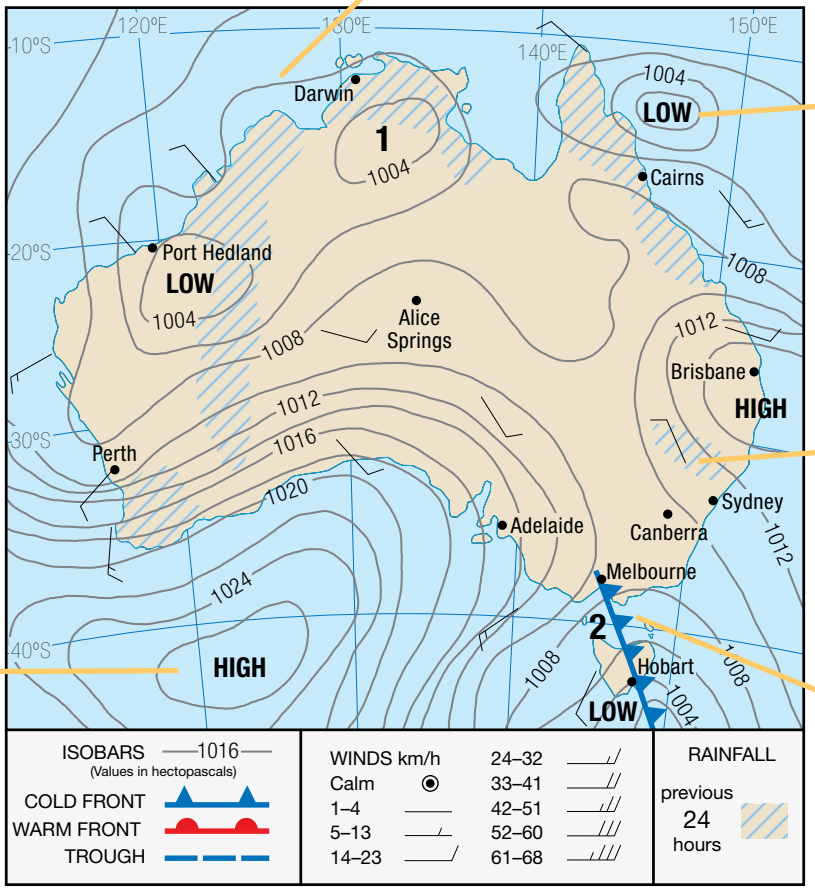
	J	F	M	A	M	J	J	A	S	O	N	D	Year
Max. temp. (°C)	19	20	24	28	32	34	35	34	33	29	25	20	21 av.
Min. temp. (°C)	9	10	12	15	18	20	22	22	20	17	14	10	16 av.
Rainfall (mm)	5	4	4	1	1	1	0	0	0	1	4	6	27 total

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Max. temp. (°C)	28	28	28	26	25	23	23	23	23	24	25	27	25 av.
Min. temp. (°C)	21	21	20	17	14	11	11	13	15	17	18	20	17 av.
Rainfall (mm)	134	113	120	73	59	28	39	62	73	98	108	102	1009 total

Figure 1.10c Climate graphs for Whistler, Canada (i), Cairo, Egypt (ii) and Durban, South Africa (iii).

Isobars are lines that join places of equal atmospheric pressure. Air pressure is measured in hectopascals (hPa). Isobars are usually drawn at intervals of 2 hPa.

Air pressure (also known as atmospheric or barometric pressure) is the weight of air pressing down on the Earth's surface. If air is warmed, it expands, rises and creates a low-pressure area on the Earth's surface. If air is cooled, it contracts, descends and creates an area of high pressure on the Earth's surface. Areas of high and low pressure determine much of the Earth's weather.



Low-pressure systems (or cyclones, as they are sometimes known) form when warm air rises. They are associated with unstable atmospheric conditions: cloudy skies, rain and relatively strong winds. Air pressure decreases towards the centre of the pressure system. Air flows in a clockwise direction towards the centre of the low-pressure system.

Rain: areas that have received rain in the previous 24 hours are shaded.

High-pressure systems (or anticyclones, as they are sometimes known) are areas of stable atmospheric conditions: gentle winds, clear skies and little chance of rain. Air pressure increases towards the centre of the pressure system. Air flows out from the high pressure system in an anticlockwise direction. During summer, southern Australia is generally dominated by high-pressure systems (highs) while the north is dominated by low-pressure systems (lows). These lows and a seasonal reversal of wind direction are responsible for the north's 'Big Wet'.

Cold fronts form when a mass of cold air overtakes a slower-moving mass of warm air. As a cold front passes over an area, the temperature is likely to fall, rain may occur and the wind direction changes. (See Figure 1.10e.)

Figure 1.10d A weather map (or synoptic chart).

WEATHER MAPS

A *weather map*, or synoptic chart, is a record of the weather conditions being experienced across part of the Earth's surface at a particular point in time. (See Figure 1.10d.) It provides information about air pressure, wind speed and direction, and the distribution of rainfall. It enables us to predict the weather we are likely to experience over the forthcoming two or three days. Being able to read weather maps is an important skill to master. Farmers, for example, use weather maps to help them plan their farming activities. It also enables people to plan their recreational activities, such as going to the beach and playing sport.

When interpreting weather maps it is important to remember that weather systems tend to move from west to east across southern Australia and from east to west across northern Australia.

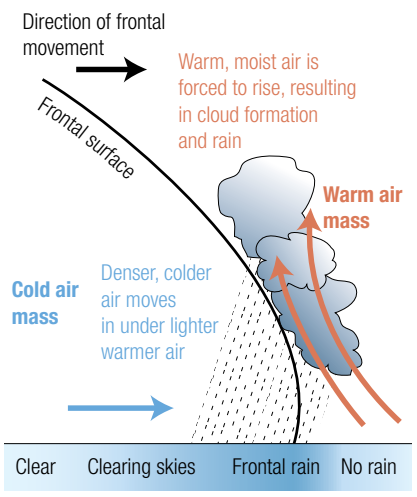


Figure 1.10e Cold front.

Predicting weather using a synoptic chart

HOW WARM WILL IT BE?

Seasonality is the main factor affecting temperature. It is, on average, warmer in summer than it is in winter. Other factors to take into account include:

- extent of cloud cover
- frontal activity
  - after the passing of a cold front, the temperature falls
- wind direction
  - winds blowing from the south usually bring cooler weather
  - winds blowing from the north generally bring warmer conditions
- proximity to large bodies of water, which has a moderating effect on temperature; that is, results in a smaller diurnal range.

Diurnal range is the difference between the highest and lowest temperature experienced during the day.

WILL IT RAIN?

- Areas in which rainfall has occurred in the previous 24 hours are shaded.
- Low-pressure systems and fronts are associated with rising air. As it rises it cools and condenses. This may produce precipitation.
- Highs tend to be associated with sinking air. As the air sinks it becomes warmer and is better able to retain moisture.
- Winds blowing from central Australia bring dry conditions.
- Winds blowing onshore are more likely to bring rain.

WILL IT BE WINDY?

- The closer the isobars, the stronger will be the wind.
- Strong winds are normally associated with low-pressure systems.
- To determine wind direction:
  - Draw a dotted line through the place, parallel to the adjacent isobars.
  - Place a faint arrowhead on this line, indicating an anticlockwise direction if a high is influencing weather conditions, or clockwise if a low is present.
  - Deflect the arrow (10–20 degrees away from a high, or 10–30 degrees towards a low) and draw a new, clearer arrow to give an indication of wind direction.

ACTIVITIES

1. What types of graphs are featured on a climate graph?
2. What elements of climate do climate graphs typically show?
3. Study Figures 1.10b and 1.10c (page 21) and then answer the following questions:
   - **a** Which station has the highest mean monthly maximum temperature?
   - **b** Which station has the lowest mean monthly temperature?
   - **c** Which station has the greatest annual range in mean maximum temperature?
   - **d** Which station has the smallest annual range in mean maximum temperature?
   - **e** What is the warmest month in Whistler?
   - **f** What is the coldest month in Cairo?
   - **g** Which station is located in the Southern Hemisphere?
   - **h** Which station has the highest mean annual precipitation?
   - **i** Which station has the lowest mean annual precipitation?
   - **j** Which station has the greatest seasonal variability in precipitation?
   - **k** Which station has the smallest seasonal variability in precipitation?
4. Study Figure 1.10d and then complete the following tasks:
   - **a** Identify the synoptic features labelled 1 and 2.
   - **b** What is the atmospheric pressure at Adelaide?
   - **c** What is the atmospheric pressure at Cairns?
   - **d** What is the wind speed and direction at Perth?
   - **e** What is the wind speed and direction at Port Hedland?
   - **f** What weather conditions is Darwin experiencing?
   - **g** State the season of which this weather map is typical.
   - **h** Describe the likely weather conditions being experienced in Melbourne.
   - **i** Describe the weather Perth is likely to experience over the following day or so.

1.11 Graphs

Figure 1.11a Now that's a trend!

LINE GRAPHS

Simple *line graphs* provide an effective way to show values that change over time. Figure 1.11b, for example, shows the annual (actual and projected) rate of growth of the world's population between 1950 and 2050.

Constructing line graphs

To construct a line graph, follow the steps below:

1. Select the set of information or variable you wish to plot on the horizontal axis. The variable that causes the change (usually in time) is generally plotted on the horizontal axis.
2. Select the variable to plot on the vertical axis. In most cases this will be the variable that changes over time.
3. Note the highest value to be shown on each axis and work out an appropriate scale.
4. Rule up the horizontal and vertical axes and mark on the appropriate divisions.
5. Neatly label each axis and give the graph a title.
6. Plot each value on the graph and then join these points with a straight ruled line or a continuous hand-drawn curve.

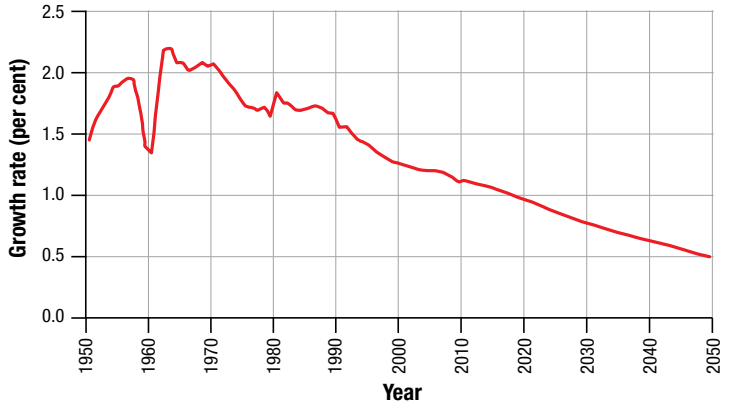


Figure 1.11b Simple line graph showing the annual growth rate in the world's population between 1950 and 2050.

BAR AND COLUMN GRAPHS

Bar graphs use horizontal bars to make comparisons. Simple column graphs use vertical bars to make comparisons. Figure 1.11c shows a simple bar graph, while Figure 1.11d is an example of a simple *column graph*.

Constructing bar and column graphs

To construct a simple bar or column graph, follow the steps below:

1. Select the set of information to be represented on the horizontal axis; for example, the year, country or age group in the case of column graphs, or the quantifiable variable in the case of bar graphs. (See Figures 1.11c and 1.11d.)
2. Select the variable to be plotted on the vertical axis. For column graphs this is usually the data that have a quantitative value and tend to rise and fall. For bar graphs is it usually the non-quantifiable data; for example, the year, country or age group.
3. Decide on the width and spacing of the bars or columns to be located along the horizontal or vertical axis.
4. Draw the horizontal and vertical axes, ensuring they can accommodate the range of data to be graphed. Label each axis and give the graph a title.
5. Draw in the bars or columns in pencil, making sure the value of each is accurately plotted.
6. Colour each bar or column and label each if appropriate.

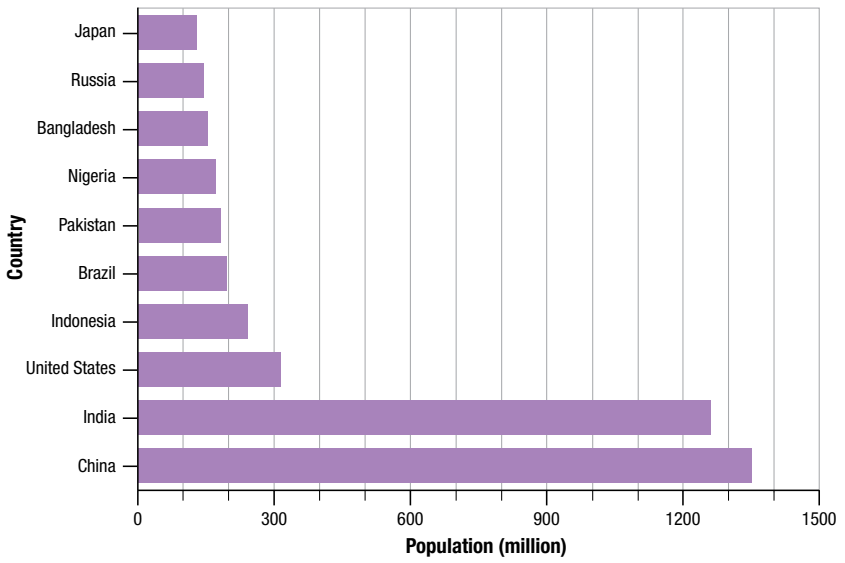


Figure 1.11c Simple bar graph showing the population of the world's 10 most populous countries, 2012.

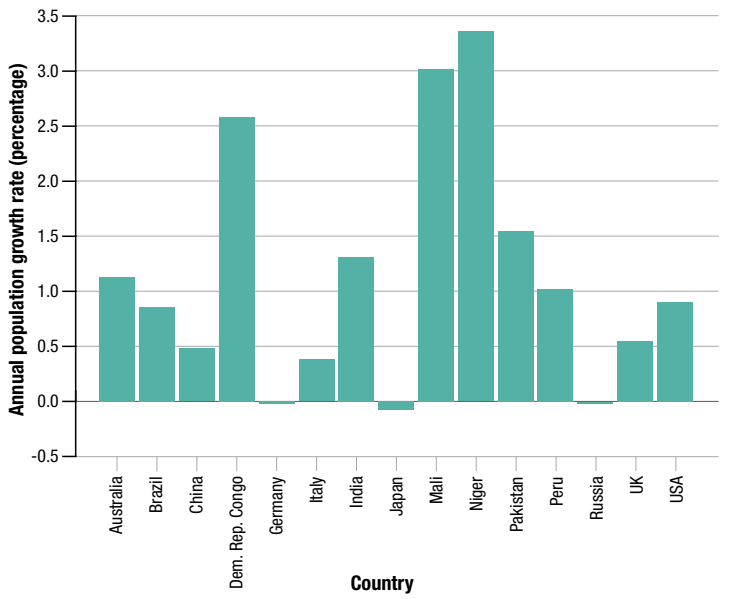


Figure 1.11d Simple column graph showing the annual population growth rate for selected countries, 2011.

PROPORTIONAL GRAPHS

Proportional graphs provide an effective way to present geographical data. They have good visual effect and are easy to interpret. They can be analysed to obtain a more detailed understanding of the data presented. The two main types of proportional graphs are pie graphs and proportional circles.

PIE GRAPHS

Pie graphs are also known as divided circles, pie diagrams or sector graphs.

In a pie graph, a circle is divided into segments by radiating out from its centre.

Each segment of the graph is proportional to the value the segment represents. (See Figure 1.11e, page 24.)

A complete pie graph (360°) represents 100 per cent. Therefore, each percentage point equals 3.6°. Knowing this statistic will help you to construct and interpret pie graphs.

Constructing pie graphs

To construct a pie graph, follow the steps below:

1. Draw a circle and then extend a line from its centre to the 12 o'clock position.
2. Convert the percentage value of each value or variable to degrees by multiplying it by 3.6. For example, if the percentage was 20%, this would represent 72° on the pie graph; that is, 20 x 3.6 = 72°.
3. List your converted values from the largest to the smallest. Place categories such as 'others' at the end of your list.
4. Starting at 12 o'clock, mark in each segment using a protractor. Work in a clockwise direction, starting with the largest segment.
5. Shade in and label each segment. It may be useful to provide a legend. If a legend is included it is not necessary to label the segments.
6. Add an appropriate title.

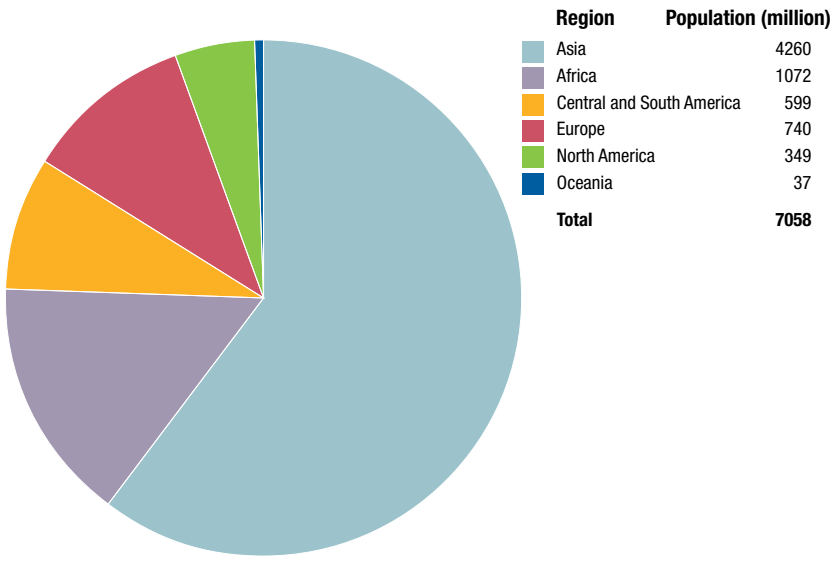


Figure 1.11e Pie graph showing the distribution of the world's population, 2012.

PROPORTIONAL CIRCLES

Proportional circles are used to show the relative size of selected data; for example, the relative size of the Earth's continents.

In Figure1.11f, the values represented are proportional to the area of the circle. Therefore, the greater the value, the larger the circle.

Constructing proportional circles

To construct proportional circles, follow the steps below:

1 Rank the values being represented from the largest to smallest. For example:
   – the area of Asia: 44 614 000 km^2
   – the area of Africa: 30 319 000 km^2
   – the area of North and Central America: 24 247 000 km^2.
2 Calculate the square root of each value*. For example:
   – Asia: the square root of 44 614 000 = 6679
   – Africa: the square root of 30 319 000 = 5506
   – North and Central America: the square root of 24 247 000 = 4924.

   *You can use an internet-based square root calculator to complete this step.
3 Determine a scale that allows the circles to be a suitable size. In this example 1 mm = 100 units.
4 Use the scale to determine the radius of each circle. For example:
   – Asia: 6679/100 = 66.8 mm
   – Africa: 5506/100 = 55.1 mm
   – North and Central America: 4924/100 = 49.2 mm.
5 Draw three circles that have a radius of 66.8 mm, 55.1 mm and 49.2 mm.
6 You can, of course, scale down your graph. For example, by dividing each value in step 5 by two you significantly reduce the space occupied by the graph.
7 Label each circle and record the actual area of each continent in brackets next to each name.
8 Give your graph an appropriate title.

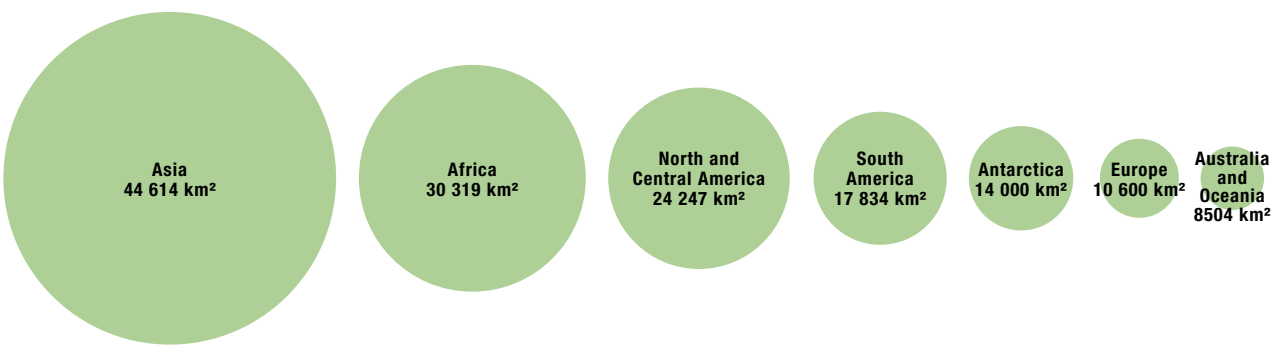


Figure 1.11f Proportional circles showing the relative size of the Earth's continents (in '000s).

PICTURE GRAPHS

Picture graphs are used to present information in a way that is both visually appealing and informative. Each symbol represents a particular value or quantity.

To find totals you need to multiply the total number of symbols by the value each symbol represents. For example, half symbols represent half the value.

When reading such graphs it is important to read the legend. When a legend is not provided, the size of the symbol may give an impression of the total amount. Figure 1.11g shows the proportion of the population living in urban centres by continent in 2012.

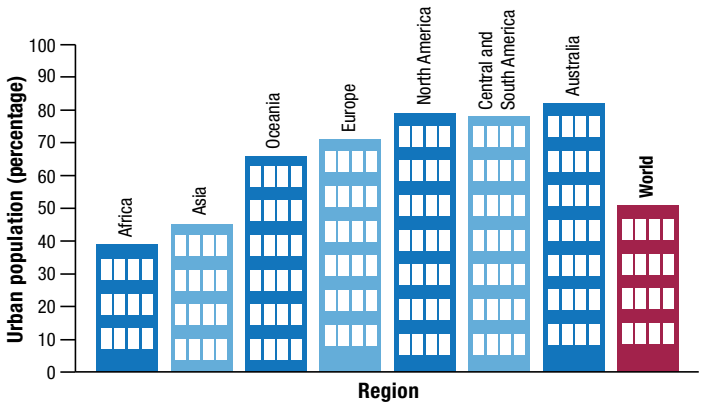


Figure 1.11g Picture graph showing the percentage of the population living in urban centres by continent, 2012.

POPULATION PYRAMIDS

Population pyramids are bar graphs used to show the age and sex structure of a population. The vertical axis of the graph represents the various age groups of the population. The horizontal axis shows either the actual number or the proportion of the population for both males and females.

Each population pyramid represents 100 per cent of a particular population. This allows comparisons to be made with the population pyramids of other populations.

To assist in these comparisons, population pyramids can be drawn on top of each other. This enables us to compare the population structure of a population with another or the changes that occur in a population over time. Figure 1.11h (page 25) compares the structure of the German population in 2005 and 2050.

The shape of the pyramid is also important because it tells us a lot about the particular population. For example:

- If the base of the pyramid is wide, then the population is said to be 'young'. An example is Figure 4.3l on page 88.
- If the upper part is relatively wide, then the population is said to be 'old' or 'aging'. An example is Figure 4.3l on page 88.
- Events such as war, famine, diseases or large-scale emigration may explain why there are fewer people in a particular age group.
- The effects of a 'baby boom' and/or immigration may explain why there are more people than expected in a particular age group.

Figure 1.11i (page 25) shows a series of pyramid shapes with an explanation of the conditions under which such population structures develop.

Interpreting statistical data: percentage

When analysing statistics it is often useful to compare a new value with the original value. This is called the percentage (or proportional) change. To calculate the percentage change, apply the following formula.

$$\text{Percentage change} = \frac{\text{Difference}}{\text{Original}} \times \frac{100}{1}$$

(Difference: the difference between the two values; Original: the original value)

EXAMPLE

In 1950, the world's population was 2.55 billion. In 2013, it was 7.08 billion. Calculate the percentage increase between 1950 and 2013.

Difference: 7.08 billion – 2.55 billion = 4.53 billion

Original value: 2.55 billion

$$\text{Percentage change: } \frac{4.53}{2.55} \times \frac{100}{1}$$

$$= 178\%$$

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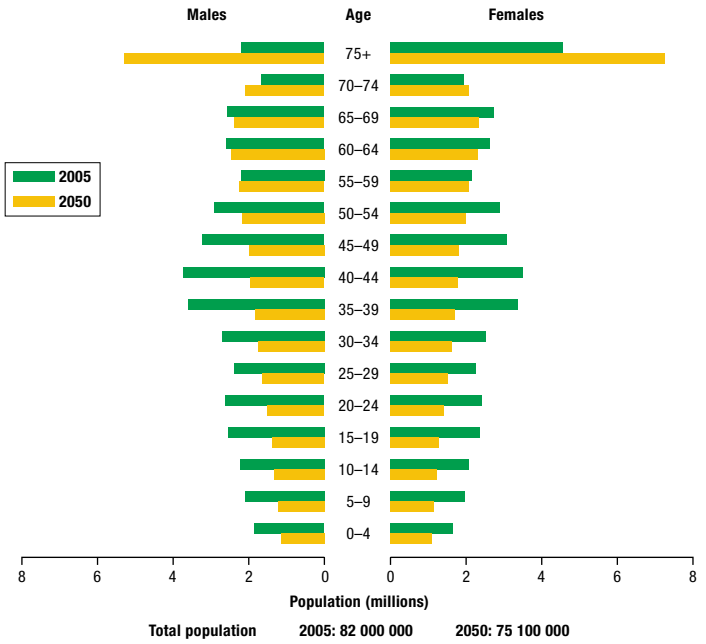

Figure 1.11h Population pyramid comparing the age and sex structure of the German population in 2005 and the projected structure for 2050.

Populations are often divided into broader age groups based on their level of independence. The dependent parts of the population are usually defined as the 14 years and under age group and the 65 years and over age group. The changing proportion of the population in each of these age groups provides us with valuable information about future population trends.

If the proportion of the population aged 65 years and over is growing, the population is said to be ageing. If the proportion of the population aged 14 years and under is decreasing, we can conclude that the birth rate is declining, as is the rate of population increase.

Note: Sometimes the horizontal scale shows the actual number of people in each age group. Before you try to interpret a graph always check the units of measurement used.

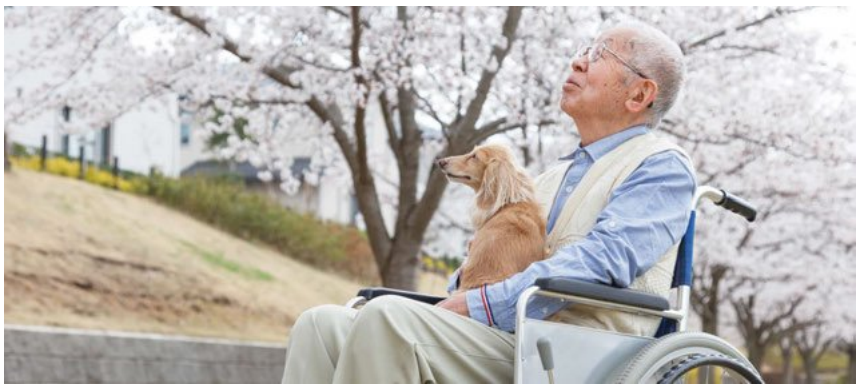

Figure 1.11i Japan has the highest proportion of people aged 65 and over in the world.

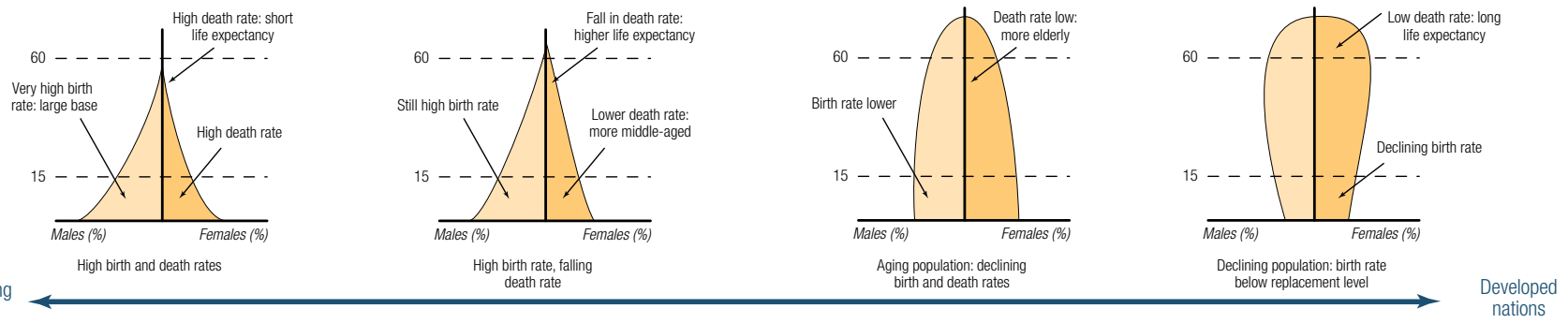

Figure 1.11j Common population pyramid shapes and the conditions under which they develop.

ACTIVITIES

1. Name the graph best suited to showing values that change over time.
2. Distinguish between bar and column graphs.
3. Name the two types of proportional graphs.
4. Outline the key features of a pie graph.
5. Explain what proportional circle graphs are used to show.
6. Outline why picture graphs are commonly used to present information.
7. State what population pyramids show.
8. Explain what the shape of a population pyramid tells us about a population.
9. Study Figure 1.11b (page 23) and then complete the following tasks:
   - **a** State the year in which the annual rate of world population growth rate peaked.
   - **b** Identify the trend in the annual rate of world population increase since the late 1980s.
10. Study Figure 1.11c (page 23) and then complete the following tasks:
    - **a** State the population of China.
    - **b** Estimate the number by which the population of China exceeded that of India in 2012.
11. Study Figure 1.11d (page 23) and then complete the following tasks:
    - **a** Name the country with the greatest annual rate of population increase.
    - **b** Name the countries with a negative annual rate of population increase.
12. Study Figure 1.11e (page 24) and then complete the following tasks:
    - **a** State the proportion of the world's population found in Asia.
    - **b** State the number of people living in Africa.
13. Study Figure 1.11f (page 24) and then complete the following tasks:
    - **a** State which has the larger area: South America or Antarctica.
    - **b** State the area of Asia.
14. Study Figure 1.11g (page 24). Identify the continents with the percentage of their population living in urban centres below and above the world's average.
15. Study Figure 1.11h and then complete the following tasks:
    - **a** Estimate the number of Germans under the age of 15 years in 2005 and 2050.
    - **b** Estimate the number of Germans aged 75 years and over in 2005 and 2050.
    - **c** Estimate the proportion of the German population under the age of 15 years in 2005 and 2050.
    - **d** Estimate the proportion of the German population aged 75 years and over in 2005 and 2050.
16. Use the data in Table 1.11a to construct a line graph showing the growth in the world's population since 1800.
17. Use the data in Table 1.11b to construct a bar graph showing the projected population of the world's most populous countries in 2050.
18. Use the data in Table 1.11c to construct a column graph showing the rate of natural population increase for selected countries in 2012.
19. Use the data in Table 1.11d to construct a pie graph showing the proportion of the world's population living in the developed and developing worlds in 2012.

Table 1.11a World population actual and projected, 1800–2050

Year	Population (billion)
1800	1.00
1850	2.55
1900	1.60
1950	2.55
2000	6.00
2050	9.20

Table 1.11b Projected population of the world's five most populous countries, 2050

Country	Population (millions)
India	1628
China	1437
United States	420
Nigeria	299
Pakistan	295

Table 1.11c Rate of natural population increase for selected countries, 2012

Country	Rate of natural increase (%)
Australia	0.7
Germany	–0.2
India	1.5
Mali	3.2
Russia	–0.1
World	1.2

Table 1.11d Number of people living in developed and developing worlds, 2012

Region	Population (Billion)
More developed	1243
Less developed	5814
Least developed	876
Total	7058

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1.12 Specialist maps

Figure 1.12a Some assembly required!

CHOROPLETH MAPS

Choropleth maps use shading, symbols and colour to show the average density, or concentration, of features such as population and rainfall. Figure 1.12b, for example, shows the population density of Indigenous Australians in 1788 using four shades of the one colour.

When drawing choropleth maps, each area that falls within a particular range is allocated the appropriate colour or shade until the overall pattern is revealed.

Shadings should be graded from the deepest colour for the highest value down to the lightest colour for the lowest value.

Usually, shades of one colour are used; for example, dark red down to light red.

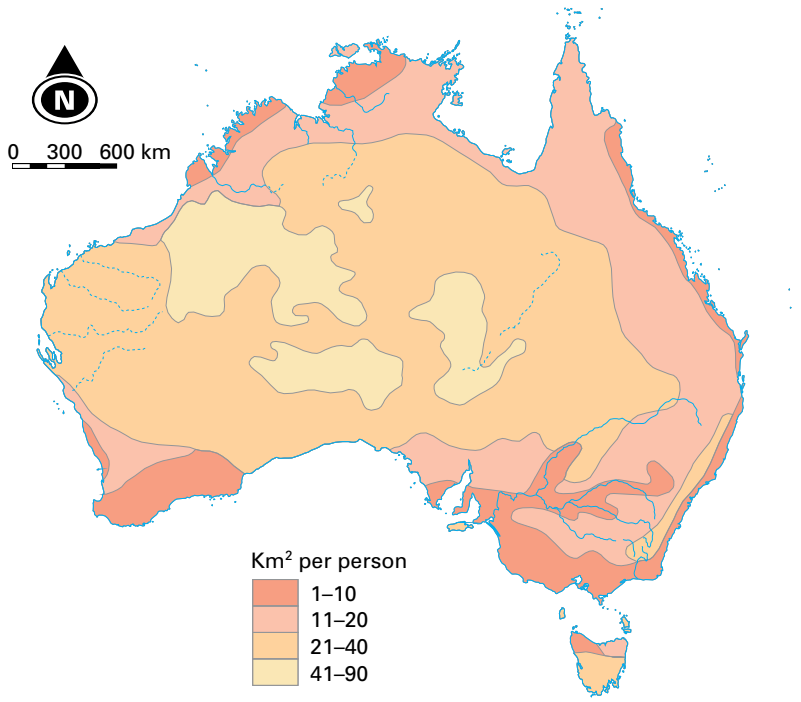

Figure 1.12b Choropleth map showing the population density of the Indigenous Australian population, 1788.

Steps in constructing choropleth maps

To construct a choropleth map, follow the steps below:

1. Examine the data and decide on the categories that you will use. Make sure that they are logically spaced; for example, 1–10, 11–20, 21–30.
2. Make sure that you have at least three categories of data.
3. Select a different shade of the one colour for each of your categories.
4. Colour in your map.
5. Include a legend that shows the value range for each colour used.

When interpreting choropleth maps it is important to remember that considerable differences can exist within an area, even though areas may have the same colour or type of shading. World maps, for example, usually present data for particular countries. National borders often become the boundaries between different ranges of values, resulting in generalisations and the neglect of localised variations in the feature being mapped.

DOT MAPS

Dot maps are used to illustrate the distribution and density of a particular feature.

Figure 1.12c shows the distribution of Indigenous Australians at the 2011 Census. The map consists of a number of dots representing a specific value (1 dot = 100 people). It is also possible to have dots of different sizes representing different values or quantities.

FLOWLINE MAPS

Flowline maps show the movement of information, goods and people between places, and the quantity of such movements. Movements are shown by lines or arrows that link the place of origin with the destination. The quantity moved between places is indicated by the width of the line or arrow. The map's legend indicates the value of the flowlines.

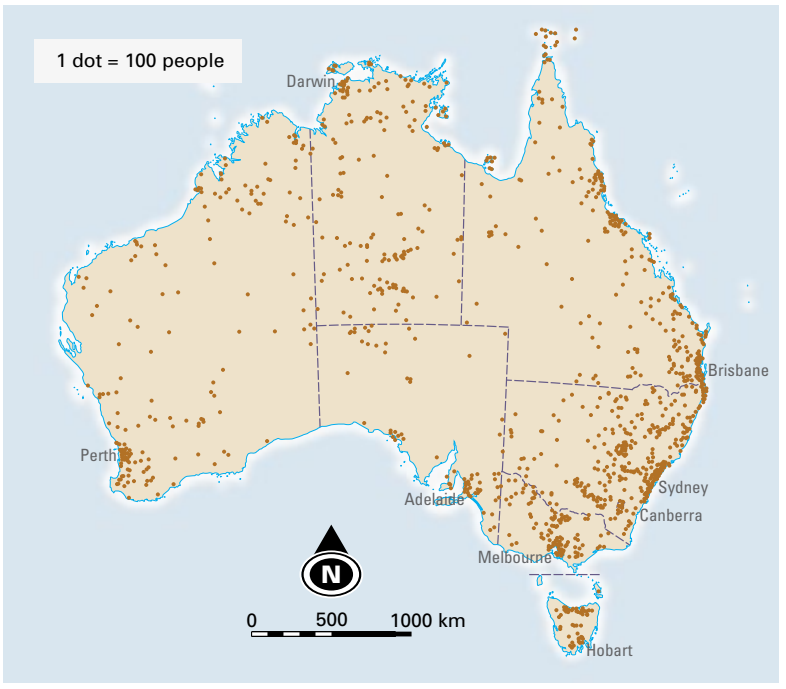

Figure 1.12c Dot map showing the population distribution of Indigenous Australians, 2011.

Steps in constructing flowline maps

To construct a flowline map, follow the steps below:

1. Arrange the data from the largest to smallest units.
2. Select suitable categories and use a ruler to draw lines of varying thicknesses; one line for each category of data. The thickness of the line should reflect the quantity that it represents; for example, use a 2-mm thick line for 0–20 units, a 4-mm thick line for 21–40 units, a 6-mm thick line for 41–60 units, and so on.
3. Using a pencil, mark on the information you are mapping.
   Make sure that the thickness of the line represents the category of data being mapped.
4. Make any adjustments to the position of your lines to avoid them crossing over and being too close to one another.
5. Add arrow heads if necessary.
6. Go over your lines, or arrows, in ink and add colour if considered necessary.
7. Add suitable labels and give your map a title.

CARTOGRAMS

A *cartogram* (value-by-area map) is a special kind of thematic map that resizes each territory according to the variable being mapped. Figure 1.12d shows population by country. The map illustrates the relative sizes of the populations of the countries of the world by scaling the area of each country in proportion to its population; the shape and relative location of each country is kept to as large an extent as possible, but inevitably a large amount of distortion occurs.

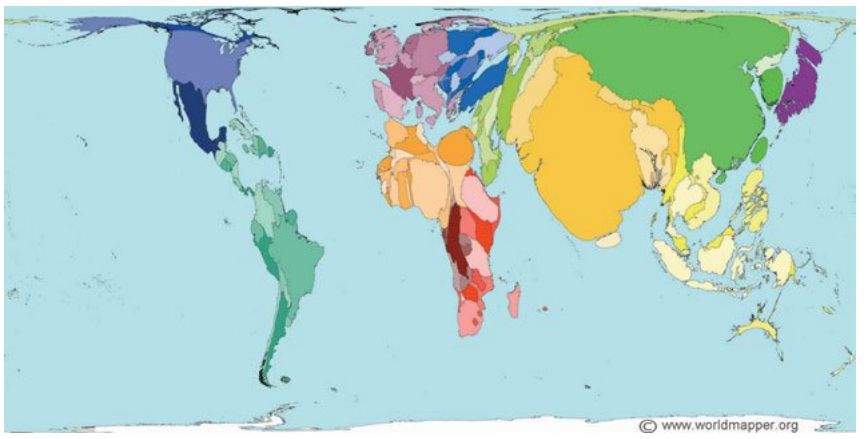

Figure 1.12d Worldmapper cartogram: population by country.

ACTIVITY

Distinguish between choropleth, dot and flowline cartogram maps. Using the internet, find examples of each type of map featured on this page.

THEMES IN AUSTRALIAN GEOGRAPHY

2.1 Australia's place and space

Geographical dimensions

Distance north to south
Cape York, Queensland to South East Cape,Tasmania: 3580 km

Distance north to south (mainland)
Cape York to Wilsons Promontory, Victoria: 3180 km

Distance east to west
Cape Byron, New South Wales to Steep Point, Western Australia: 4000 km

Figure 2.1a Physical map of Australia.

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Figure 2.1b Political map of Australia.

Table 2.1a Areas of Australian states and territories

State/territory	*Area*
New South Wales	801 600 km^2
Victoria	227 600 km^2
Queensland	1 727 200 km^2
South Australia	984 000 km^2
Western Australia	2 525 500 km^2
Tasmania	67 800 km^2
Northern Territory	1 346 200 km^2
Australian Capital Territory	2 400 km^2
Australia	*7 682 300 km^2*

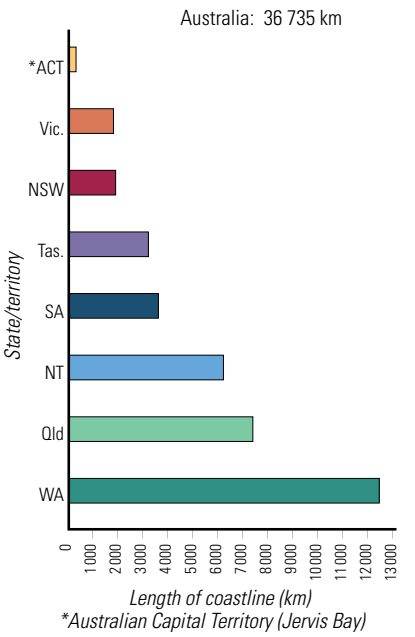

Figure 2.1c Length of Australia's coastline by state and territory.

ACTIVITIES

Study the physical map of Australia (Figure 2.1a) and complete the following activities.

1. In which Australian state or territory would you find the following features of the physical environment?
   - a Macdonnell Ranges
   - b Flinders Ranges
   - c Barkly Tableland
   - d Mount Bogong
   - e Tanami Desert
   - f Carnarvon Range
   - g Musgrave Ranges
   - h Lake Torrens
   - i Cape York Peninsula
   - j Gibson Desert
2. Name the strait separating mainland Australia from Tasmania.
3. Name the strait separating Cape York Peninsula from Papua New Guinea.
4. The Timor and Arafura seas form part of which ocean?
5. Into which gulf do the Flinders and Gilbert rivers flow?
6. Name the sea lying to the south-east of the continent.
7. Name the sea in which the Great Barrier Reef is located.
8. Name the island located at:
   - a lat. 39°52'S long. 143°45'E
   - b lat. 34°45'S long. 137°00'E
   - c lat. 25°30'S long. 153°00'E.
9. Name the landform feature located at:
   - a lat. 17°20'S long. 145°45'E
   - b lat. 25°21'S long. 131°02'E
   - c lat. 28°15'S long. 138°08'E
   - d lat. 36°27'S long. 148°16'E.
10. Name the river that flows through Perth.
11. Name a river that drains the Arnhem Land Plateau in the Northern Territory.
12. Name the river that flows into Western Australia's Shark Bay.
13. Name a river that has its headwaters in the Kimberleys region of Western Australia.
14. Name two waterways that drain into Lake Eyre in South Australia.
15. Name a tributary of the Murrumbidgee River.
16. Into what river system do the waters of the Macquarie River flow?
17. Name the river that separates New South Wales and Victoria.
18. Name the desert located in the south-west corner of Queensland.
19. Name the desert located in both Queensland and the Northern Territory.
20. Name the desert located in both Western Australia and South Australia.
21. Name the landform feature found to the south of the Nullarbor Plain.
22. What is the elevation of South Australia's Lake Eyre?
23. What is the depth of the ocean 300 km east of Sydney?
24. Locate the following places on the physical map of Australia:
   - a Cape Byron: the mainland's most easterly point
   - b Steep Point: the continent's most westerly point
   - c Cape York Peninsula: the mainland's most northerly point
   - d Wilsons Promontory: the mainland's most southerly point
   - e South East Cape: Tasmania's most southerly point

To complete the following activity, refer to Table 2.1a.

25. Construct a proportional pie graph showing the area of Australia's states and territories.

Study the political map of Australia (Figure 2.1b) and complete the following activities.

26. Which is the only mainland state to share a common border with all other mainland states?
27. Which is the only Australian state or territory completely surrounded by another state or territory?
28. What number is given to the highway linking Sydney and Melbourne?
29. What number is given to the coastal highway linking Darwin, Perth, Adelaide, Melbourne, Sydney, Brisbane and Cairns?
30. Which two state capitals are linked by highway 94?
31. How many cities in New South Wales have a population greater than 100 000?
32. What is the direction of:
   - a Sydney from Melbourne
   - b Melbourne from Adelaide
   - c Darwin from Brisbane
   - d Hobart from Melbourne?
33. What is the straight-line distance between:
   - a Sydney and Adelaide
   - b Sydney and Melbourne
   - c Sydney and Brisbane
   - d Sydney and Perth
   - e Sydney and Hobart?
34. Name the towns and cities you would pass through on a trip by road from Melbourne to Brisbane via the inland route.
35. Name the towns and cities you would pass through on a trip by road from Melbourne to Darwin via Adelaide.

Study Figure 2.1c and answer the following questions.

36. What is the length of Western Australia's coastline?
37. What is the length of the New South Wales coastline?

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2.2 Australia's landforms and deserts

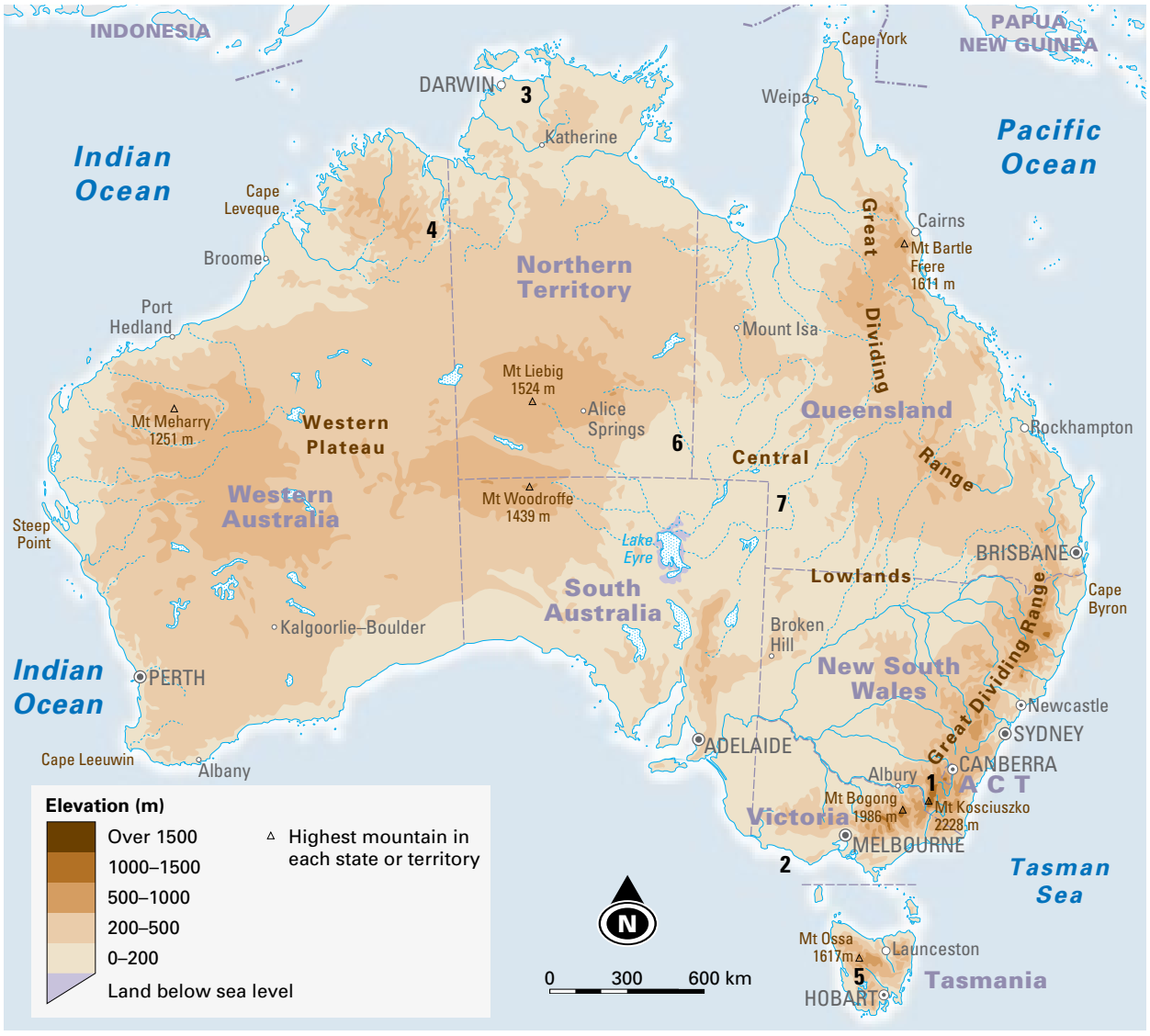


Figure 2.2a Australia's elevation.

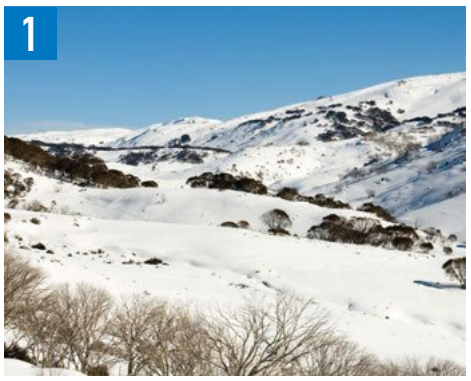


Figure 2.2b
The Snowy Mountains (Australian Alps).

Figure 2.2c The Twelve Apostles.

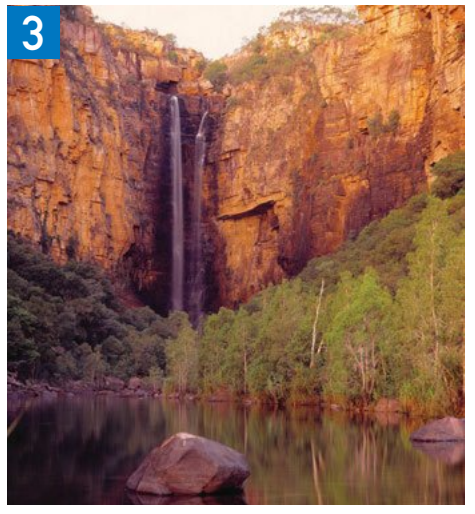
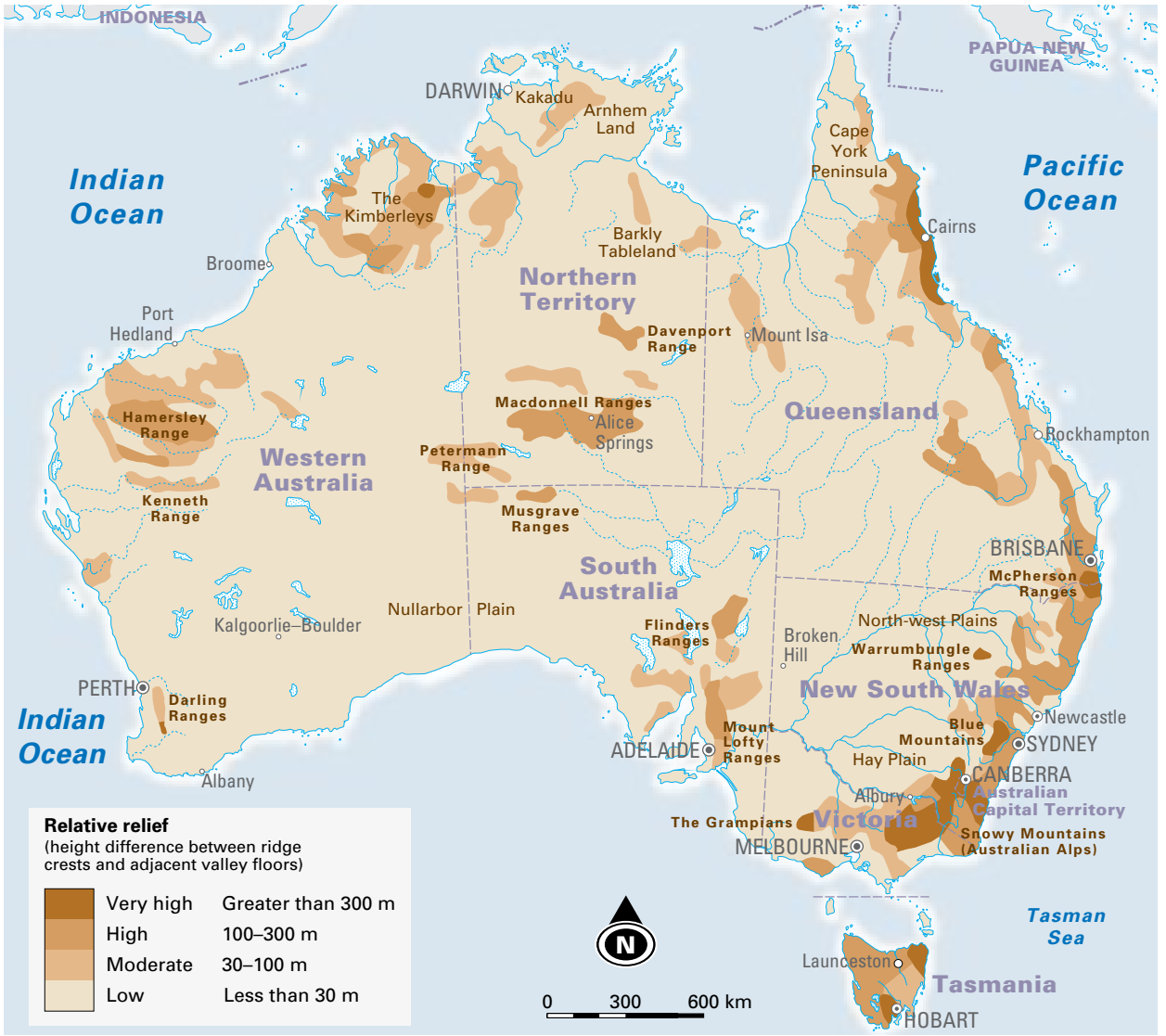


Figure 2.2d Kakadu's Jim Jim Falls.

Figure 2.2e Bungle Bungle Range.

Figure 2.2f
Australia's relative relief.



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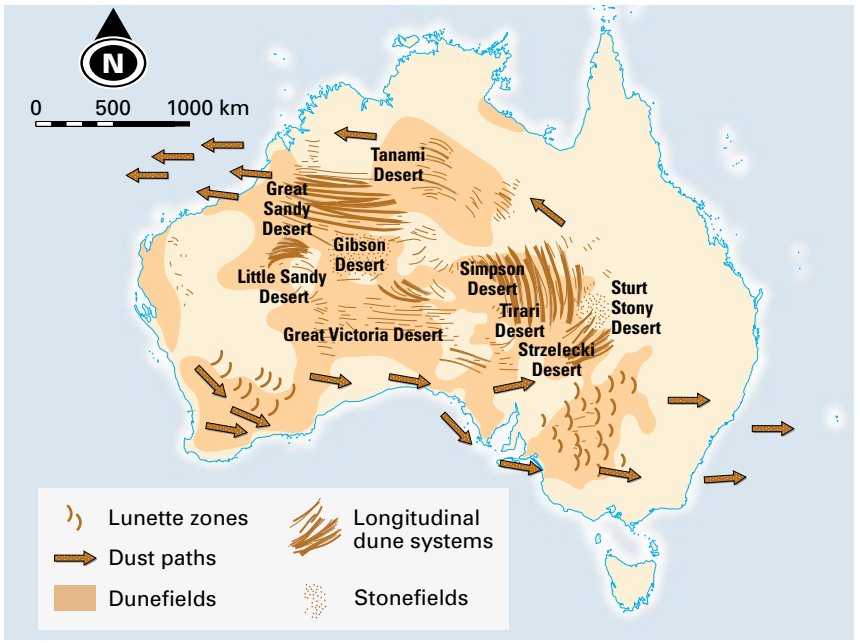

Figure 2.2g Australia's deserts: the alignment of dunes and the major dust paths.

Figure 2.2i Sand dunes of the Simpson Desert.

Figure 2.2h Franklin River.

Figure 2.2j Sturt Stony Desert.

ACTIVITIES

1. Study Figure 2.2a (page 29) and complete the following tasks:
   - **a** Name the three main landform divisions of Australia.
   - **b** Compare Figure 2.2a with an atlas map of the world. What evidence is there to support the observation that Australia is the 'flattest' of the continents?
2. Study Figures 2.2b to 2.2e (page 29) and 2.2h to 2.2j. For each photo, identify the agent of erosion most responsible for the formation of the landscape shown.
3. Study Figure 2.2f (page 29). What is meant by the term 'relative relief'? With reference to Figure 2.2a (page 29), where is relative relief the greatest?
4. Study Figure 2.2g and Table 2.2b and answer the following questions:
   - **a** Where are Australia's deserts found?
   - **b** Which is Australia's largest desert?
   - **c** In which direction are the dunes aligned in the Great Sandy Desert?
   - **d** In which direction are the dunes aligned in the Simpson Desert?
   - **e** Which deserts are dominated by stonefields?
5. Select two photographs of contrasting landscapes. Construct photo sketches of the contrasting landscapes.
6. Study Figure 2.2k and complete the following tasks:
   - **a** What is the highest mountain in the state or territory in which you live?
   - **b** Calculate the difference in elevation between Mount Kosciuszko and the highest mountain in the state or territory in which you live. Calculate the difference in elevation between Victoria's highest peak and Mount Kosciuszko.
   - **c** By how much does the elevation of Mawson Peak on Heard Island exceed that of Mount Kosciuszko?
7. Study Table 2.2a. Construct a bar graph showing the relative size of Australia's plains.
8. Study Table 2.2b. Construct a bar graph showing the relative size of Australia's deserts.

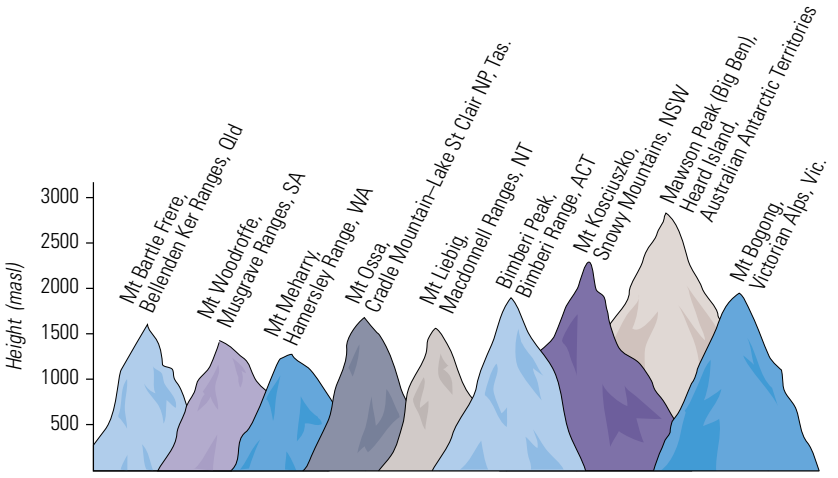

Figure 2.2k The highest mountain in each Australian state and territory.

Table 2.2a Australia's plains

Plain	*Area*
Lake Eyre Peneplain, Qld–SA–NT	1 170 000 km^2
Nullarbor Plain, SA–WA	270 000 km^2
Barkly Tableland, Qld–NT	240 000 km^2
North-west Plains, NSW–Qld	145 000 km^2
Hay Plain, NSW	70 000 km^2

Table 2.2b Australia's deserts, by size

Name	*Surface type*	*Area*
Great Sandy Desert, WA–NT	Longitudinal dunes	414 000 km^2
Great Victoria Desert, SA–WA	Longitudinal dunes	325 000 km^2
Tanami Desert, WA–NT	Sandplain	310 000 km^2
Simpson Desert, Qld–SA–NT	Longitudinal dunes	170 000 km^2
Little Sandy Desert, WA	Longitudinal dunes	30 000 km^2
Sturt Stony Desert, Qld–SA	Stony	20 000 km^2
Gibson Desert, WA	Stony	20 000 km^2
Strzelecki Desert, NSW–SA	Longitudinal dunes	5 000 km^2
Tirari Desert, SA	Sand dunes	5 000 km^2

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2.3 Australia's vegetation

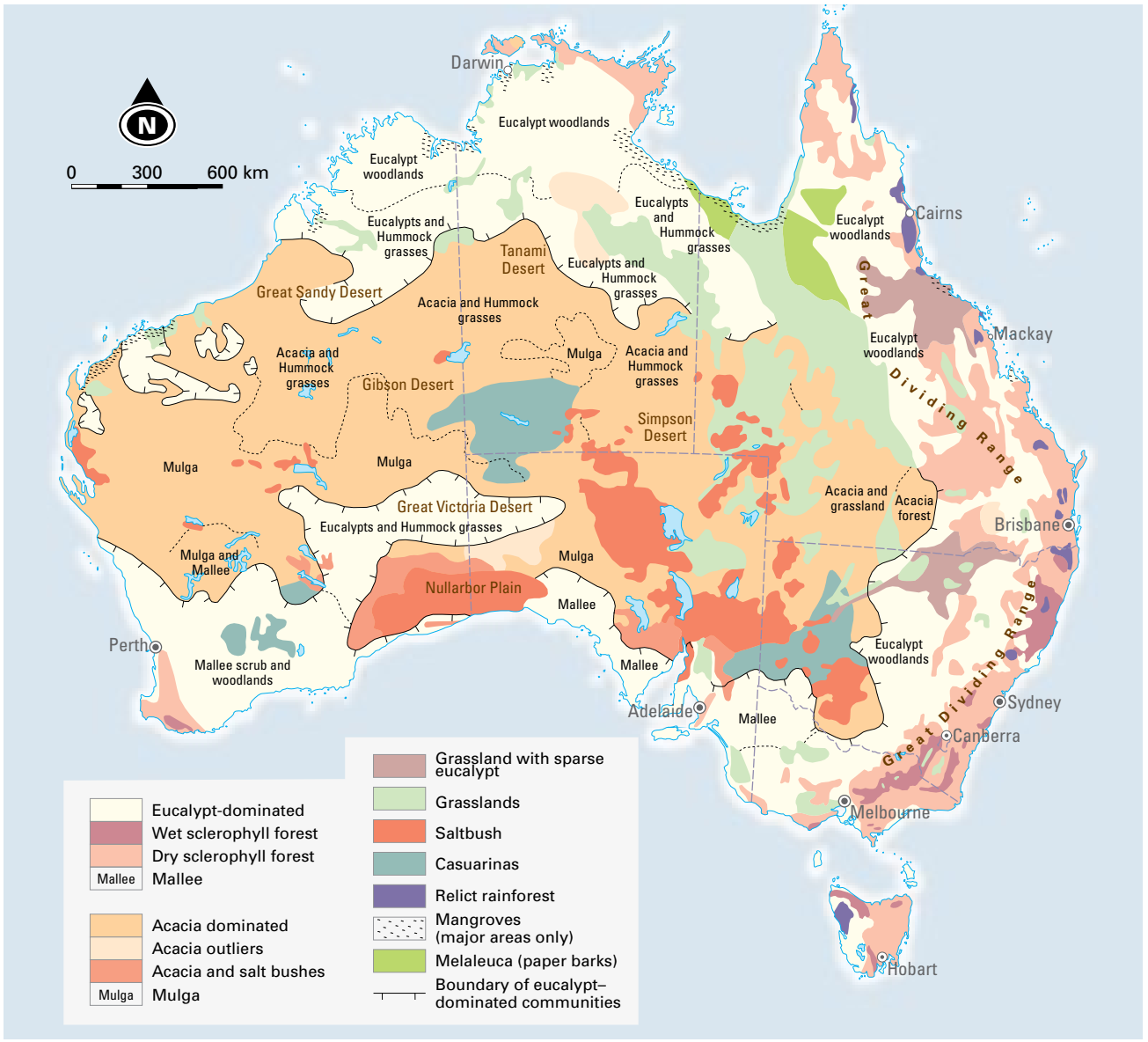

Figure 2.3a Australia's natural vegetation.

ACTIVITIES

1. Study Figure 2.3a. In what parts of Australia are the major areas of mangroves located?
2. Using Figure 2.3a, describe the distribution of the vegetation types shown in Figures 2.3b to 2.3g.
3. Using the information on Australia's climate in Unit 2.4 (pages 33–5), comment on the type of climate conditions under which the vegetation types shown in the photographs develop.
4. Undertake library or internet research and complete the following tasks:
   - **a** Explain the difference between wet and dry sclerophyll forests.
   - **b** Describe the distribution of Australia's wet and dry sclerophyll forests. With reference to Figure 2.4i (page 35), state how this pattern relates to the distribution of rainfall.
5. Study Table 2.3a. Construct a pie graph showing the area of native forest types in Australia.

Figure 2.3b Mallee.

Figure 2.3c Acacia (wattle).

Figure 2.3d Mulga.

Figure 2.3e Grassland.

Figure 2.3f Saltbush (foreground).

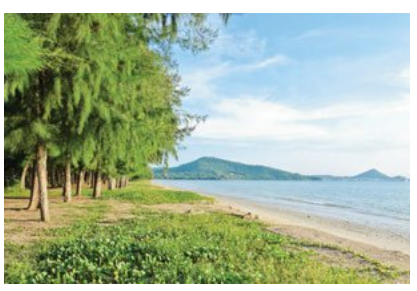

Figure 2.3g Casuarinas.

Table 2.3a Area of native forest in Australia

Forest type	*Area ('000 ha)*
Eucalypt	124 463
Acacia	12 298
Rainforest	3 583
Mangrove	1 045
Other	14 445
Total	*155 834*

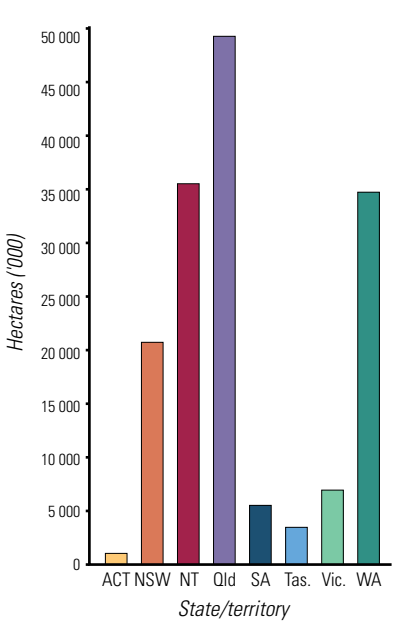

Figure 2.3h Area of native forest in Australia, by state and territory ('000 ha), 2004.

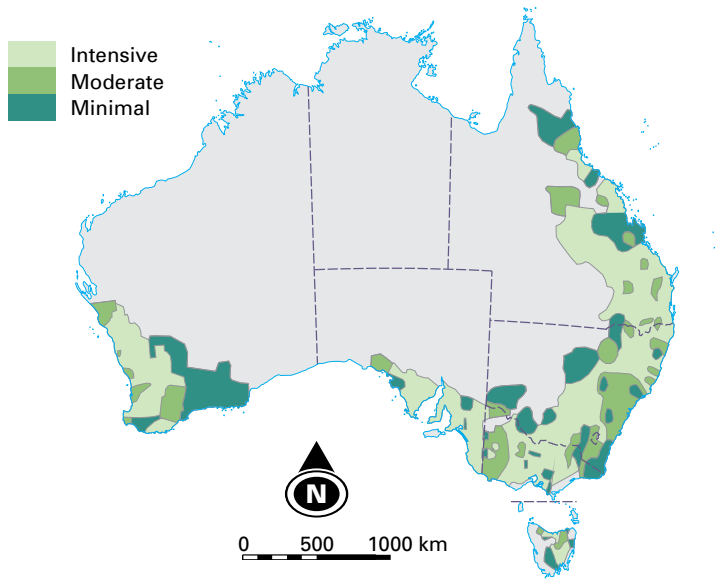

Figure 2.3i Extent of land clearing in Australia since 1788.

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Figure 2.3j Area of deforestation and forest regrowth in Australia, by state and territory, 2001 to 2004.

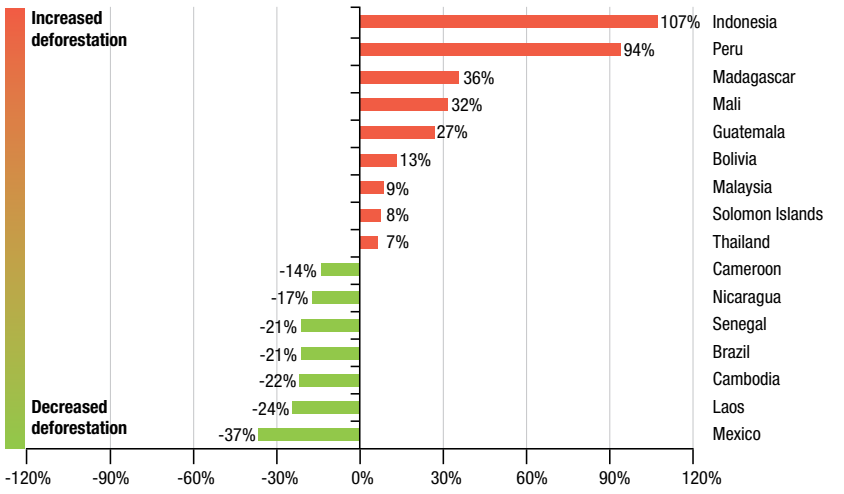


Figure 2.3k Change in annual deforestation rate 2000–05 versus 2005–10.

6 Study Figure 2.3h (page 31) and answer the following questions:
- **a** What is the approximate area of native forest in Queensland and Western Australia?
- **b** Which state or territory has approximately 21 000 ha of native forest?

7 Study Figures 2.3i (page 31) and 2.7b (page 39). Comment on the relationship between land clearing and the distribution of Australia's population.

8 Refer to Figures 2.3a (page 31) and 2.3i. Which vegetation types have been most affected by land clearing?

9 Study Figure 2.3j and then complete the following tasks:
- **a** Rank the states and territories according to the extent of deforestation in 2004.
- **b** Rank the states and territories according to the extent of regrowth in 2004.
- **c** Identify the states and territories with declining trend rates of deforestation and those with increasing rates. Identify the state or territory with the greatest increase in deforestation in 2003–04.

10 Study Figure 2.3k and then complete the following tasks:
- **a** Which two countries experienced the greatest increase in the rate of deforestation in the latter half of the 2000s?
- **b** Which two countries experienced the greatest reduction in the rate of deforestation in the latter half of the 2000s?
- **c** Overall, has there been an increase or decrease in the rate of deforestation in the group of countries included in the graph?

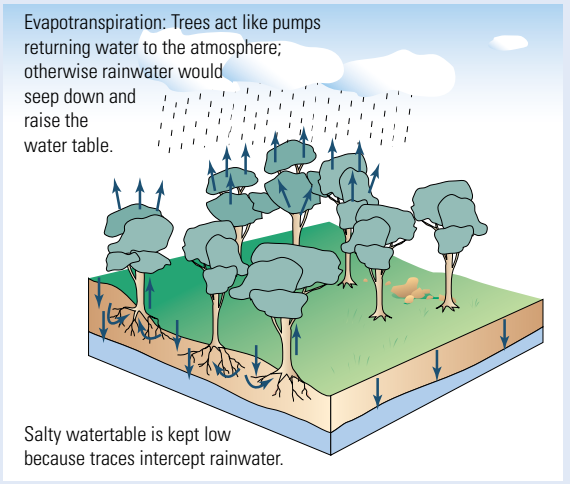
11 In groups, brainstorm the likely effects of such large-scale land clearing. Share the main points raised in your group's discussion with the rest of the class.

12 As a class, list the activities of people that contribute to land degradation.

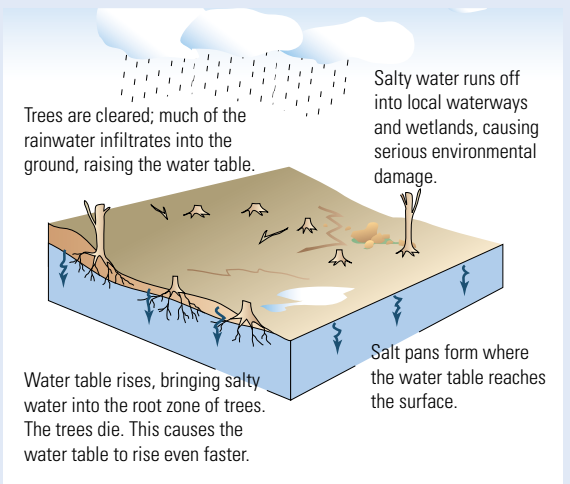
13 Construct a photo sketch of Figure 2.3l.

Figure 2.3l Land clearing in Tasmania.

Salinity



(i) Before land clearance.



(ii) After land clearance.

Figure 2.3m The effects of land clearance on salinity. The removal of deep-rooted native vegetation results in rising water tables and the salinisation of soils.

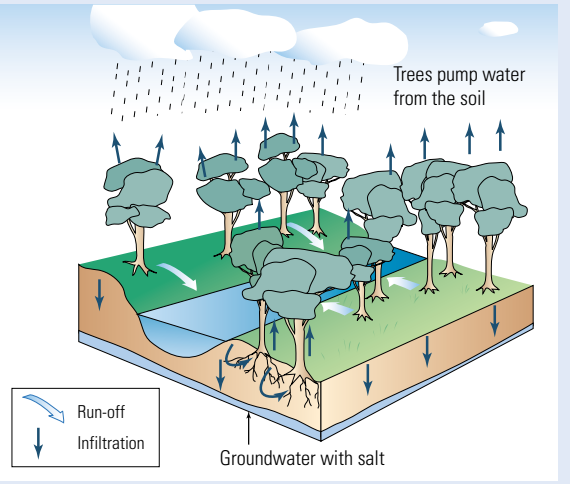
ACTIVITIES

1 Study Figure 2.3m. Write an explanation outlining the effects of land clearance on salinity.

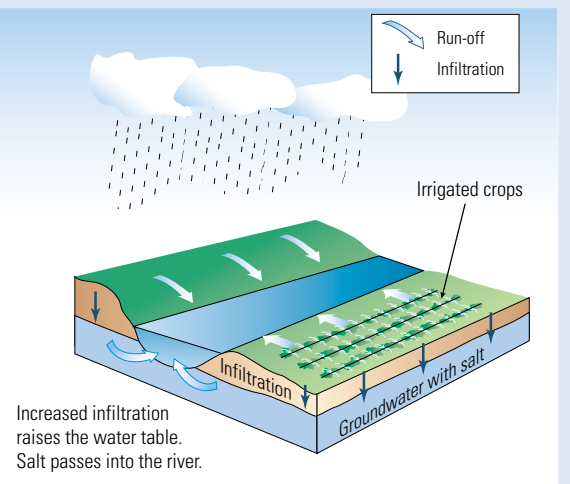
2 Study Figure 2.3n. Write an explanation outlining how irrigation can affect the level of salinity in river systems.

3 Undertake library and/or internet-based research. Investigate alternative methods of irrigation that minimise the amount of water added to the water table.

4 Undertake library and/or internet-based research. Investigate strategies to manage rising water tables and protect water quality in local river systems.



(i) Before irrigation.



(ii) After irrigation.

Figure 2.3n The effects of irrigation on salinity. Irrigation water causes the water table to rise, bringing dissolved salts to the surface.

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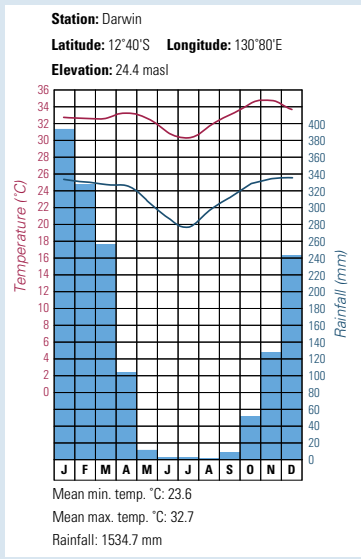
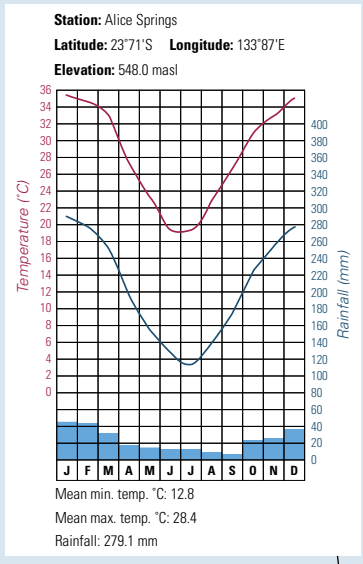
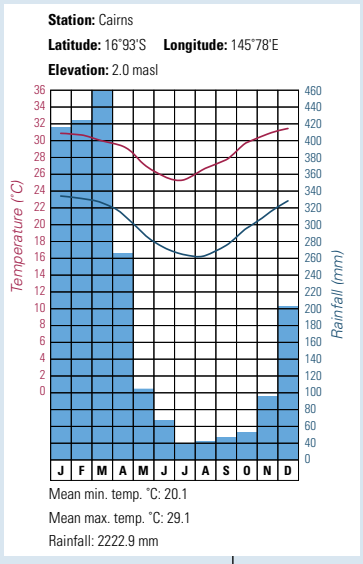
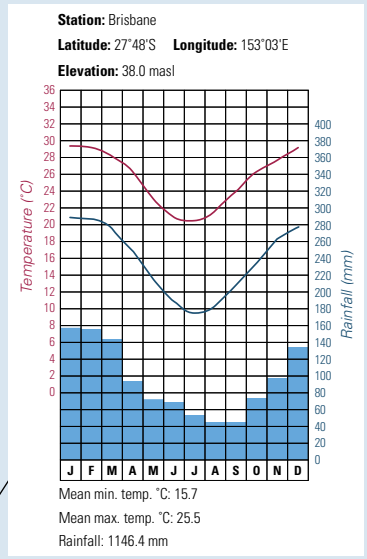
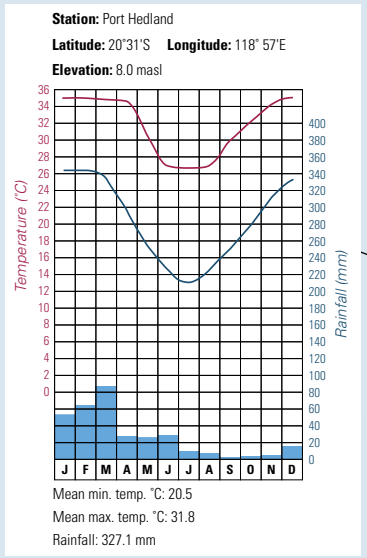
2.4 Australia's climate

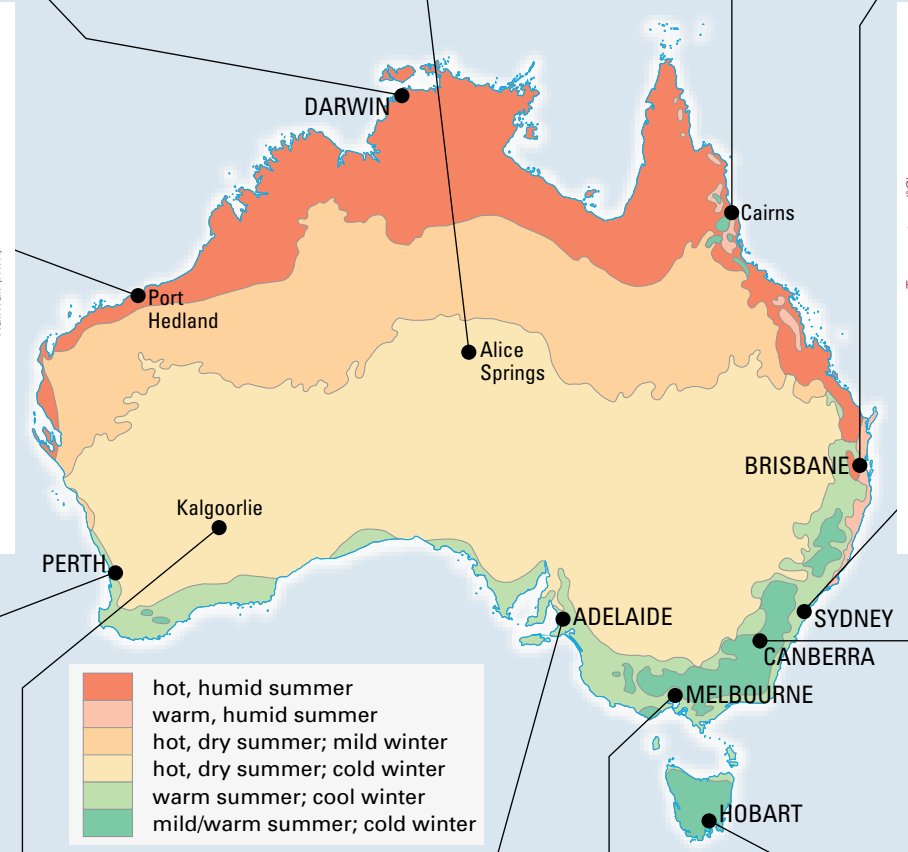


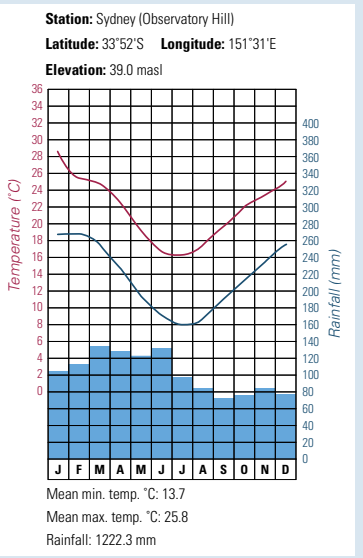


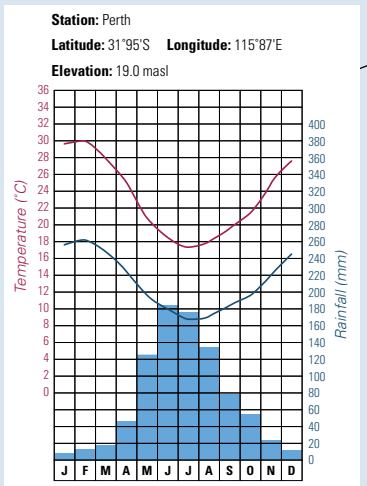


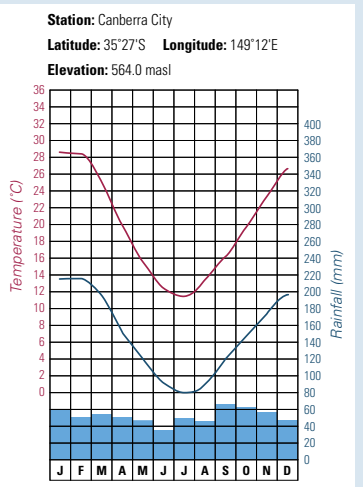


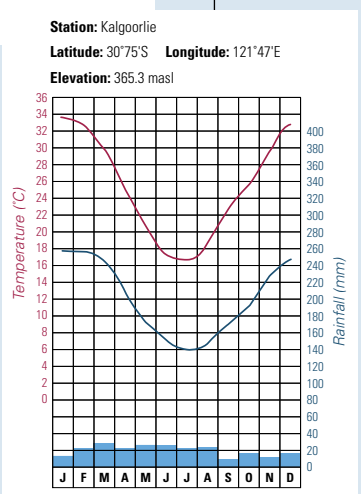


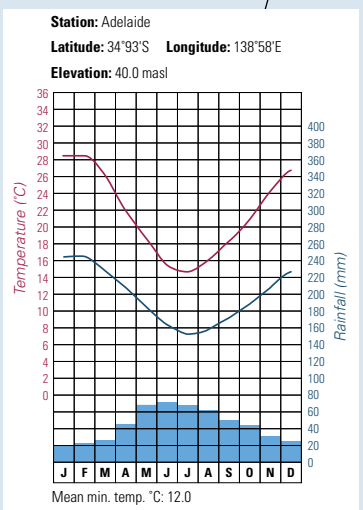


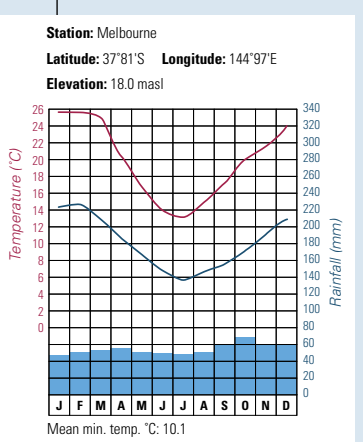












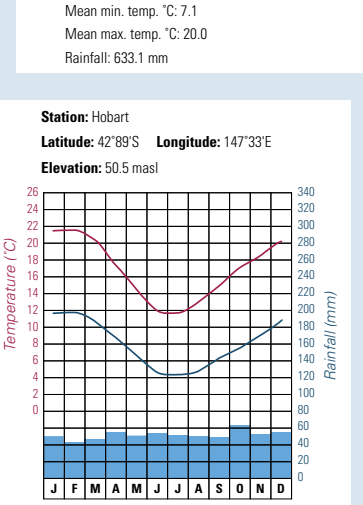


Figure 2.4a Main climatic zones of Australia (based on temperature and humidity).

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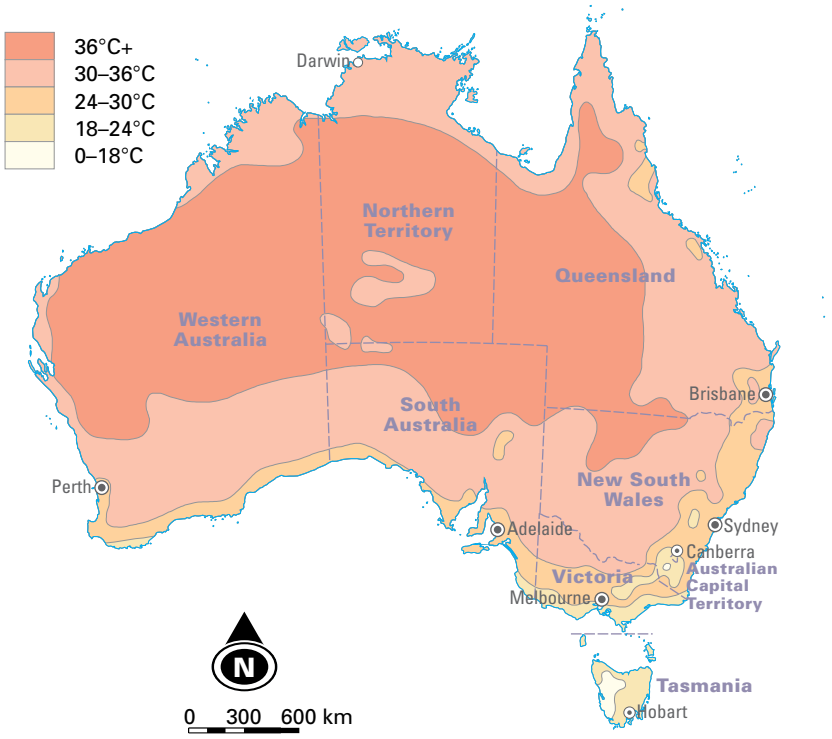

Figure 2.4b January maximum temperatures in Australia.

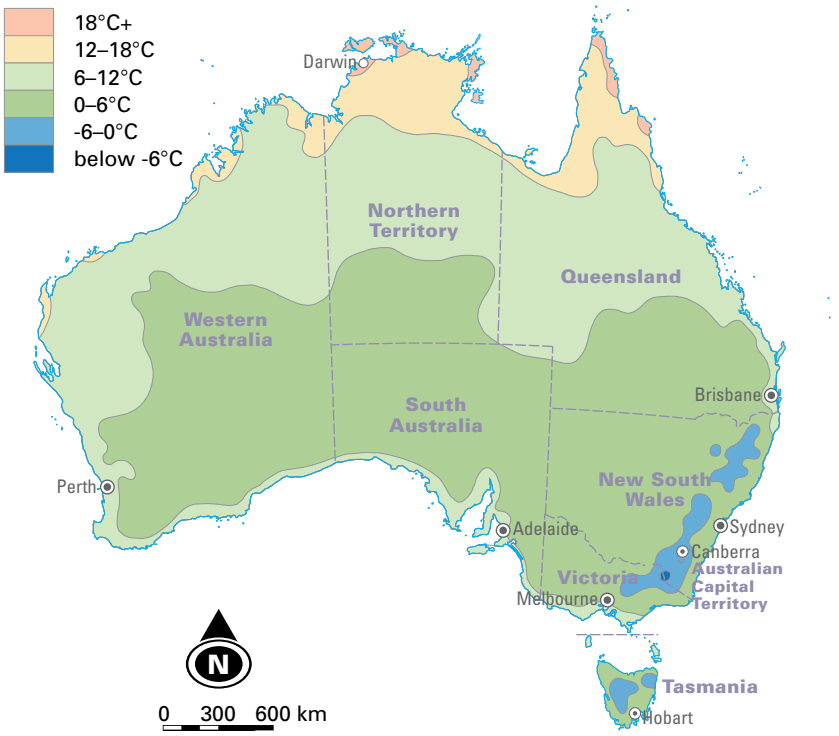

Figure 2.4c July minimum temperatures in Australia.

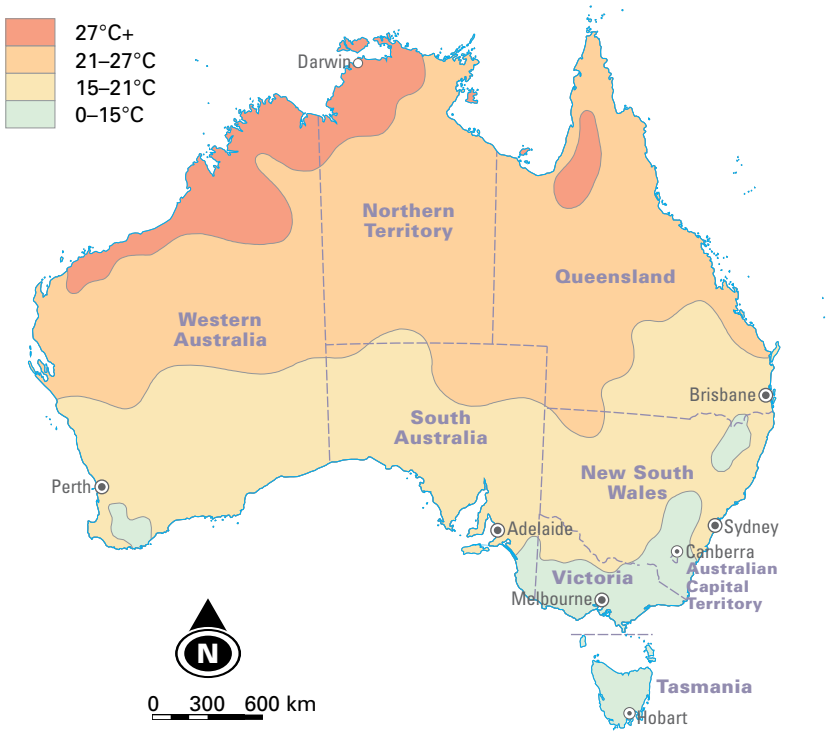

Figure 2.4d Mean temperatures in Australia.

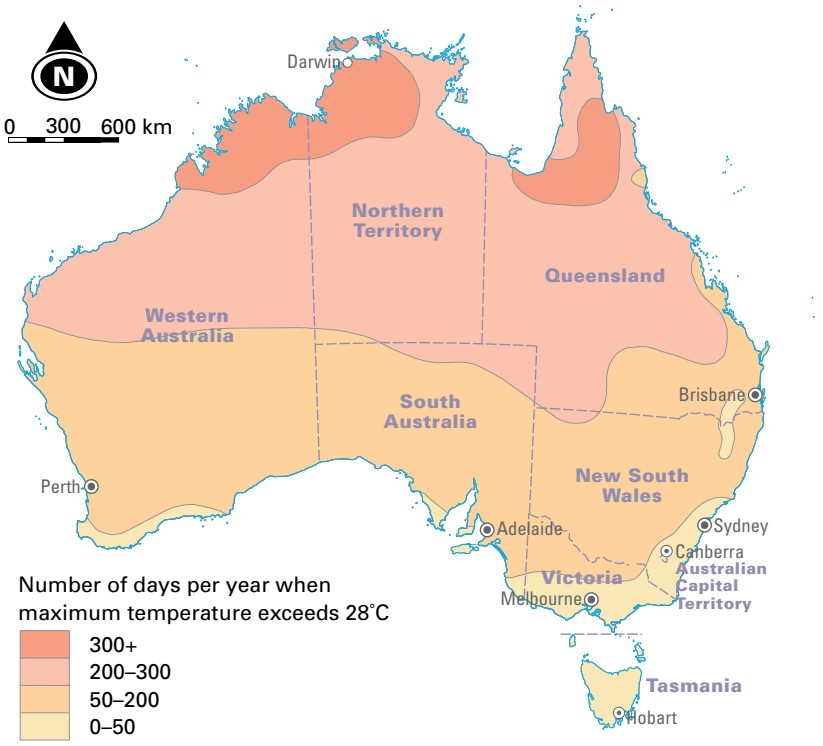

Figure 2.4e Hot days in Australia.

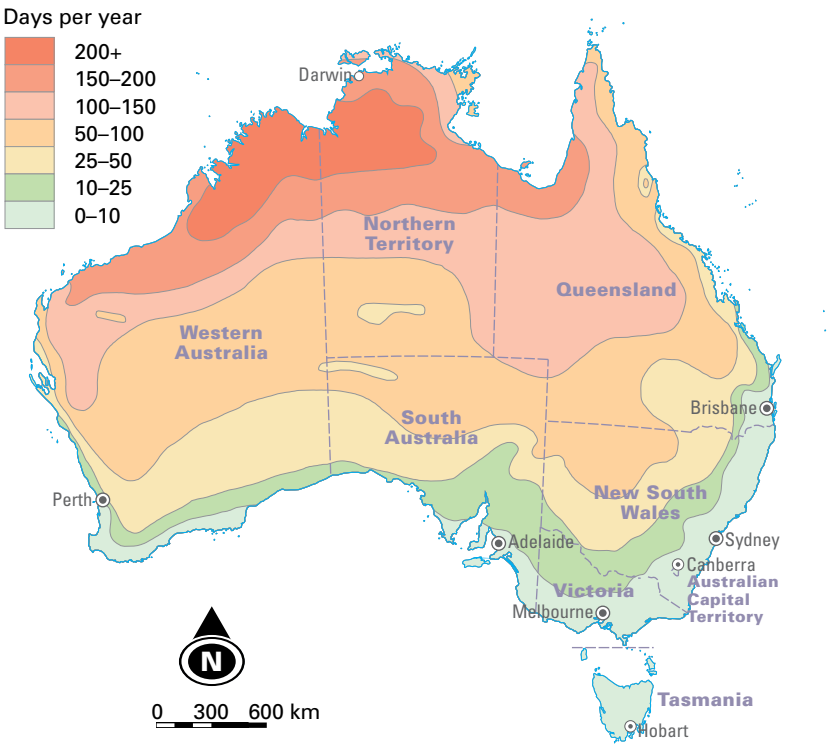

Figure 2.4f Heat discomfort in Australia.

ACTIVITIES

1. Study Figure 2.4a (page 33) and complete the following tasks:
   - **a** On an outline map of Australia, draw the boundaries of each climatic zone. Annotate your map with a brief description of the climate experienced in each zone.
   - **b** With the aid of Figure 2.4a (page 33), describe the distribution of the following climatic zones:
     - **i** hot, humid summers
     - **ii** warm, humid summers
     - **iii** hot, dry summers and mild winters
     - **iv** hot, dry summers and cold winters
     - **v** warm summers and cool winters
     - **vi** mild/warm summers and cold winters.
2. Study Figures 2.4a (page 33), 2.4d and 2.4i (page 35). Describe the different climates you would experience on a road journey from Darwin to Adelaide.
3. Study the climate graphs in Figure 2.4a and complete the following tasks:
   - **a** Which location has the highest daily maximum temperature?
   - **b** Which location has the lowest daily minimum temperature?
   - **c** Which location has the largest range of mean daily maximum temperatures?
   - **d** Which location has the smallest range of mean daily maximum temperatures?
   - **e** Which location has the highest mean annual rainfall?
   - **f** Which location has the lowest mean annual rainfall?
   - **g** Estimate the average July temperature experienced by Darwin, Alice Springs, Adelaide and Hobart. Comment on the pattern evident.
   - **h** Describe the seasonal distribution of rainfall in Cairns and Darwin.
   - **i** Describe the seasonal distribution of rainfall in Perth and Adelaide.

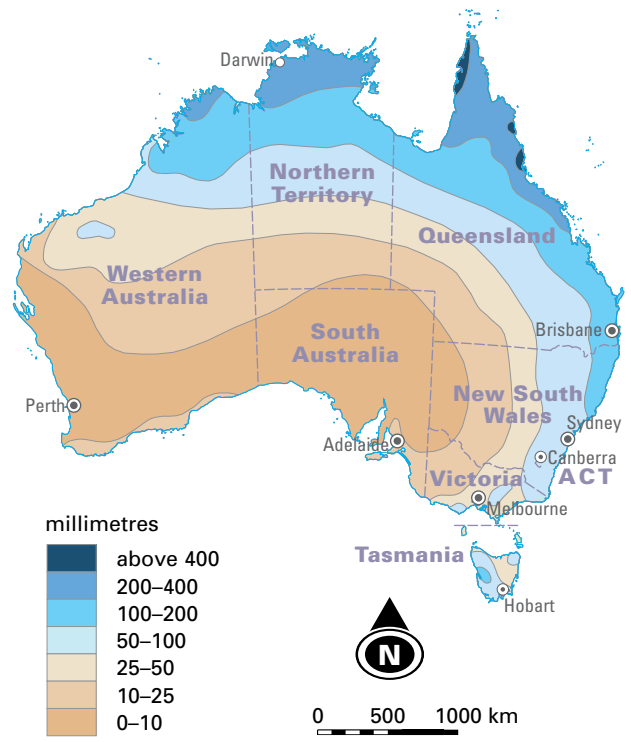

Figure 2.4g January rainfall in Australia.

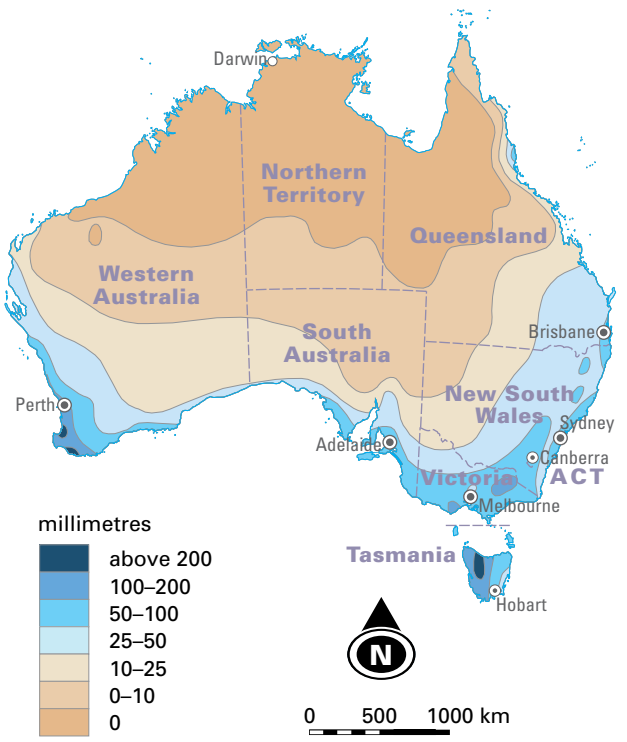

Figure 2.4h July rainfall in Australia.

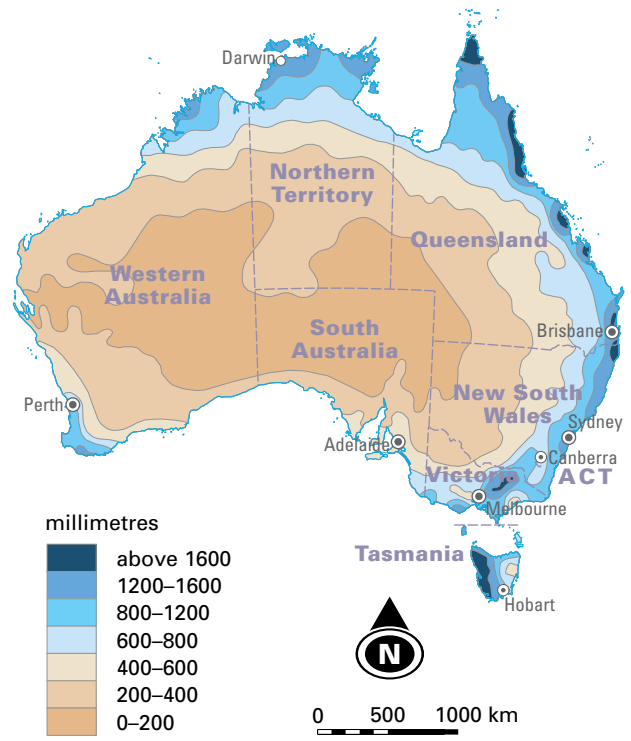

Figure 2.4i Median annual rainfall in Australia.

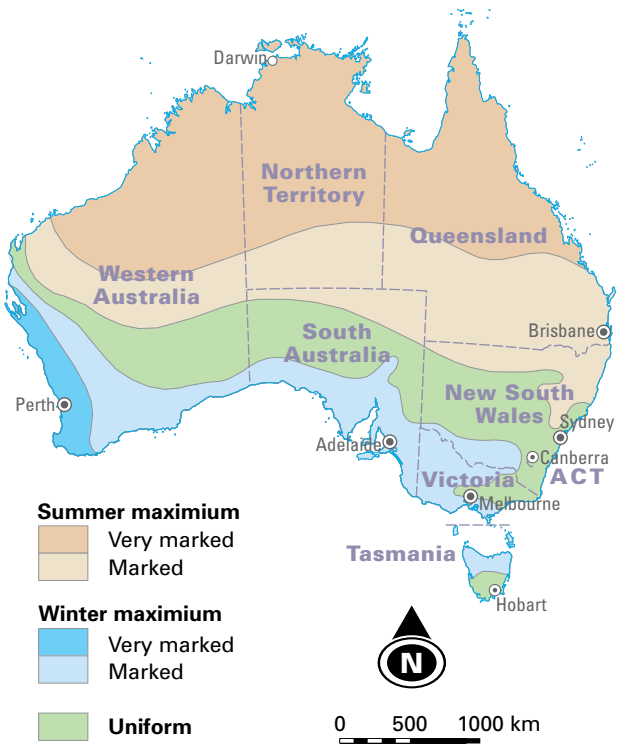

Figure 2.4j Seasonal rainfall in Australia.

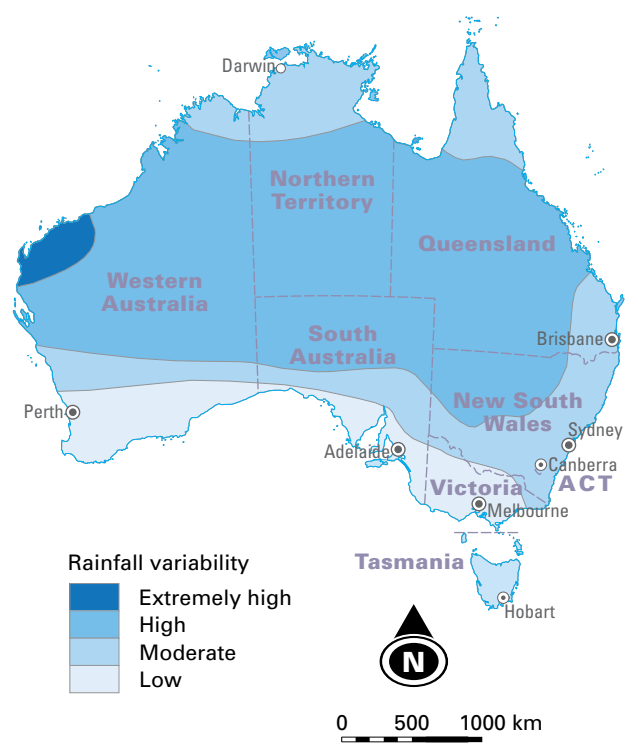

Figure 2.4k Rainfall variability in Australia.

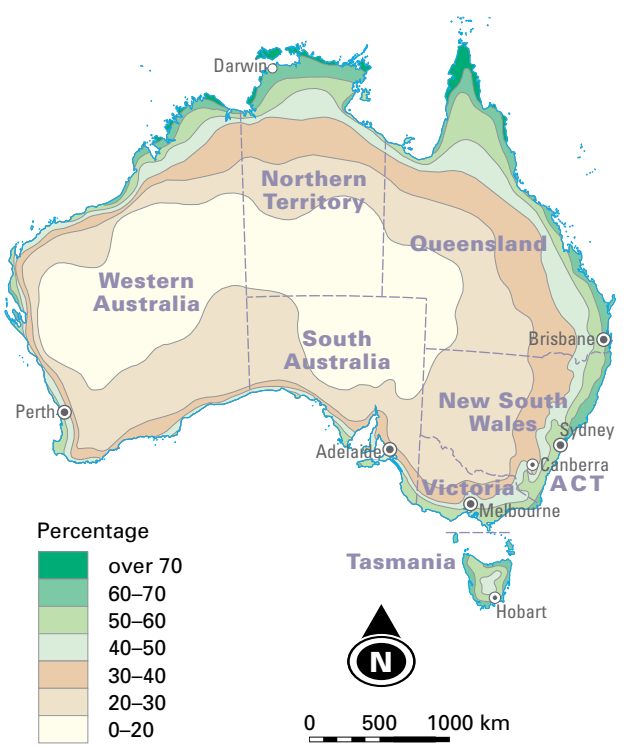

Figure 2.4l Relative humidity in Australia.

j List the locations that:
- **i** receive most of their rainfall in summer
- **ii** receive most of their rainfall in winter
- **iii** have rainfall evenly distributed throughout the year.

4 Study Figure 2.4b and answer the following questions:
- **a** Which part of Australia experiences the highest January maximum temperature?
- **b** Which parts of Australia experience the lowest January maximum temperature?
- **c** What is Darwin's mean January maximum temperature?

5 Study Figure 2.4c and answer the following questions:
- **a** Which parts of Australia experience July minimum temperatures in excess of 12°C?
- **b** Which part of Australia experiences the lowest July minimum temperatures?

6 Study Figure 2.4d and describe the pattern of mean temperatures.

7 Study Figure 2.4e and answer the following questions:
- **a** Which part of Australia has fewer than 50 days when the maximum temperature exceeds 28°C?
- **b** How many days does Darwin have when the maximum temperature exceeds 28°C?

8 Study Figure 2.4f and answer the following questions:
- **a** Which part of Australia experiences the greatest heat discomfort?
- **b** What is the general pattern evident on the map?

9 Study Figure 2.4g and complete the following tasks:
- **a** Describe the general pattern of January rainfall.
- **b** What is the January rainfall experienced by the following capital cities?
  - **i** Adelaide
  - **ii** Sydney
  - **iii** Darwin

10 Study Figures 2.4b, 2.4f and 2.4g. What factors contribute to the high levels of heat discomfort in north-west Australia?

11 Study Figures 2.4i and 2.4j. Describe the seasonal distribution of rainfall in northern Australia.

12 Study Figure 2.4h. Describe the general pattern of July rainfall.

13 Study Figure 2.4i. Describe the pattern of median annual rainfall.

14 Study Figure 2.4j and answer the following questions:
- **a** Which Australian capital cities have a uniform seasonal rainfall pattern?
- **b** Which Australian capital cities receive most of their rainfall in summer?
- **c** Which Australian capital cities receive most of their rainfall in winter?

15 Study Figure 2.4k and answer the following questions:
- **a** Which parts of Australia have the most reliable rainfall?
- **b** Which parts of Australia have the least reliable rainfall?

16 Study Figure 2.4l. What locational factor appears to be the most important influence on relative humidity?

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2.5 Australia's natural hazards

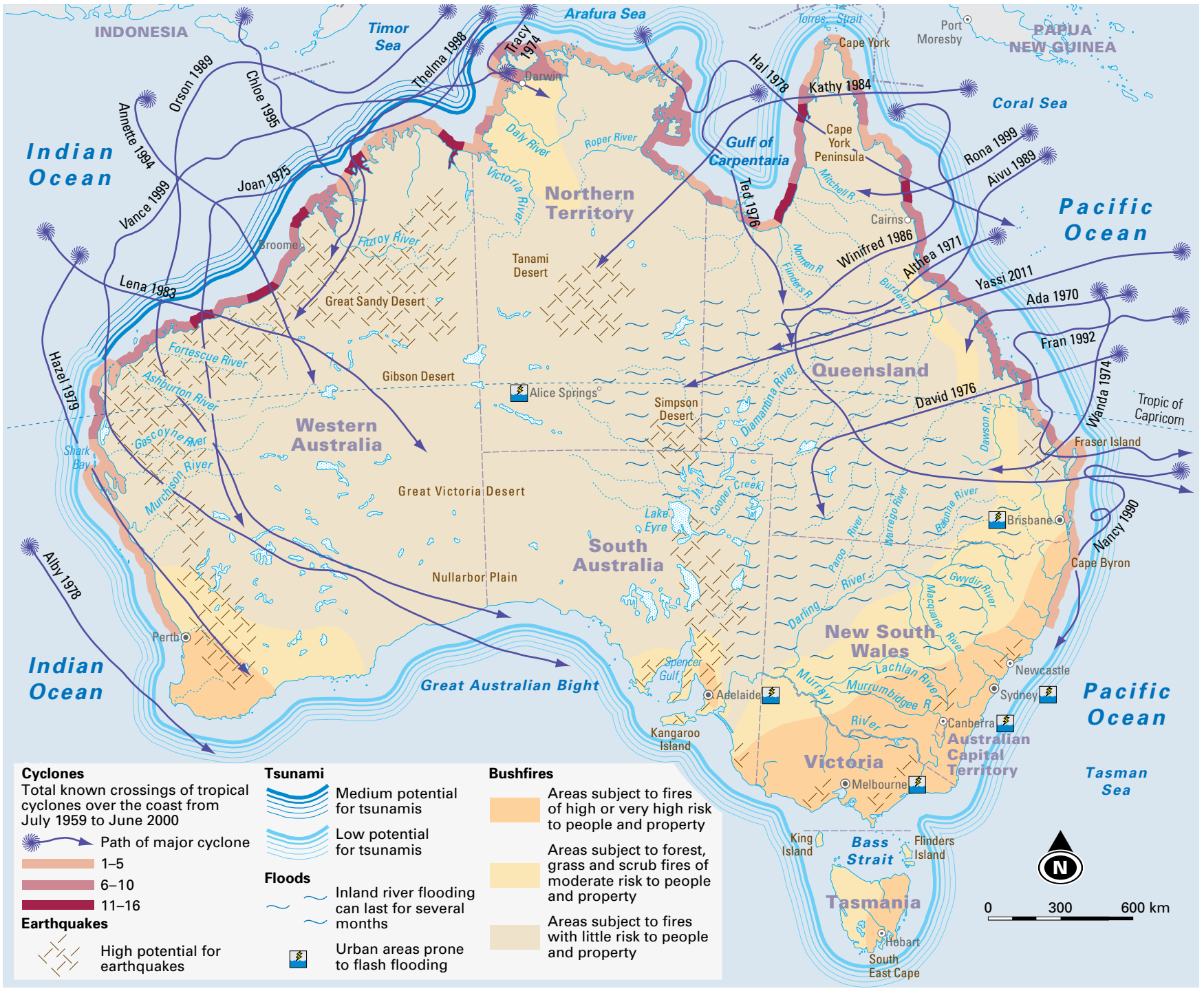

Figure 2.5a Natural hazards in Australia.

ACTIVITIES

Study Figure 2.5a and complete the following tasks:

1. a Name the seas over which the majority of Australia's cyclones develop.
   b Describe the paths generally taken by the cyclones that develop over these three water bodies.
2. Outline the areas of Australia that have a high potential for earthquakes.
3. Identify the parts of Australia's coastline that have a medium potential for tsunamis.
4. With the aid of Figure 2.2a (page 29), identify the landform division that is subject to inland flooding.
5. Identify the urban areas subject to flash flooding.
6. Identify those areas of Australia where bushfires pose a high or very high risk to people and property.
7. From which types of hazards is your community at risk?
8. Select one of the natural hazards shown on the map. Investigate the actions you could take to protect life and property.

Figure 2.5b Storm damage.

Figure 2.5c Bushfire.

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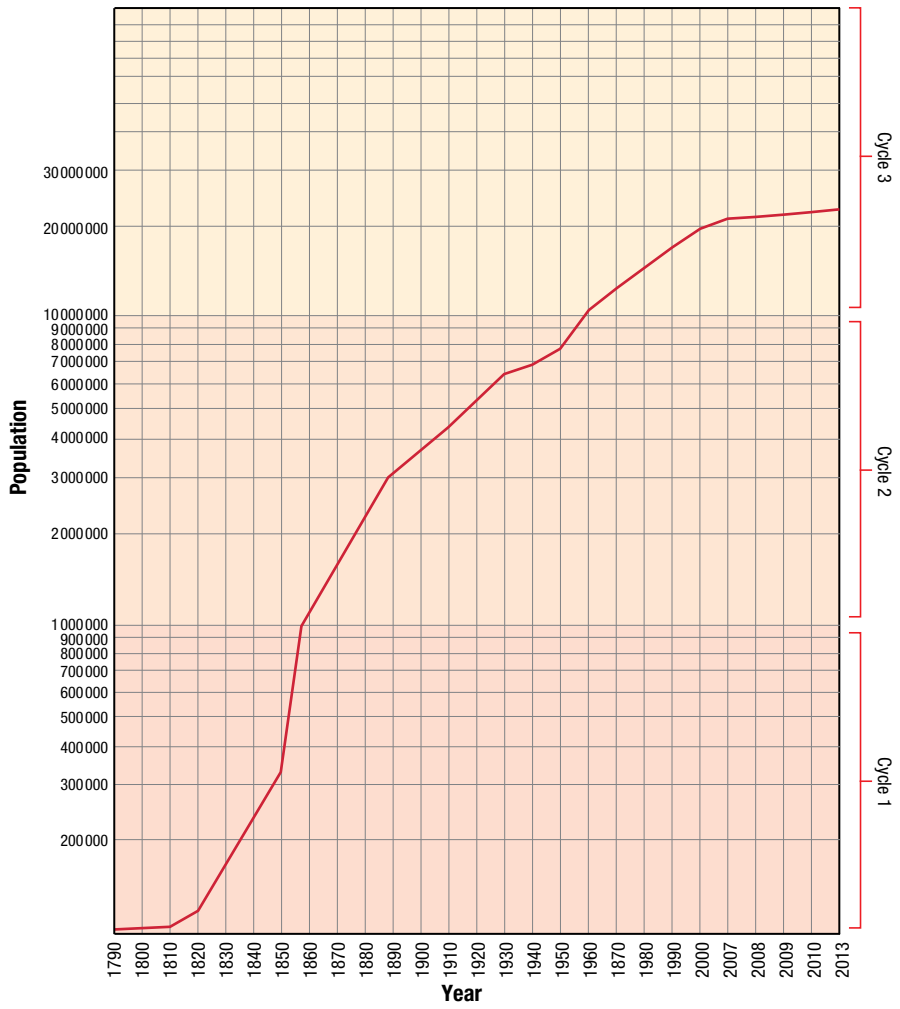
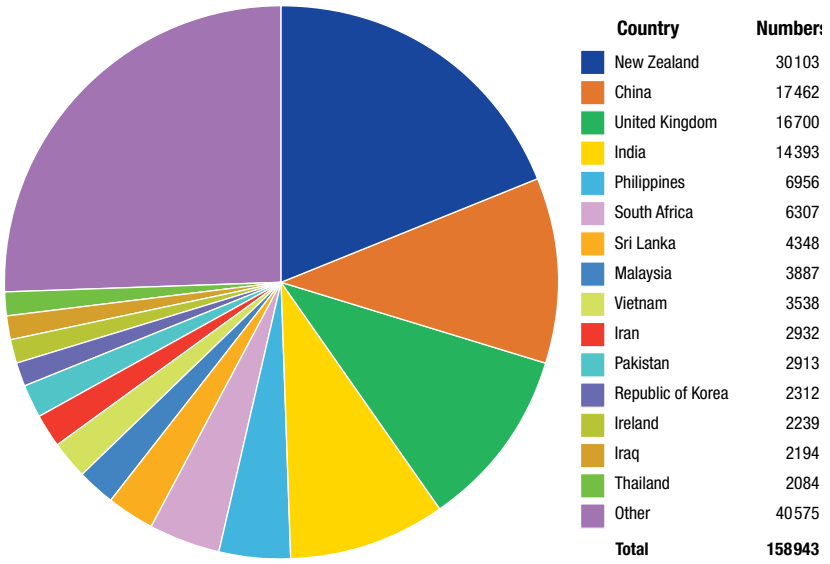
2.6 Australia's population



Note: Indigenous Australians were not included in official population statistics until 1967.

Figure 2.6a A semi-logarithmic graph showing the growth in the Australian population, 1790–2012.



Country	Numbers
New Zealand	30103
China	17462
United Kingdom	16700
India	14393
Philippines	6956
South Africa	6307
Sri Lanka	4348
Malaysia	3887
Vietnam	3538
Iran	2932
Pakistan	2913
Republic of Korea	2312
Ireland	2239
Iraq	2194
Thailand	2084
Other	40575
Total	**158943**

Figure 2.6c Immigrants to Australia by top 15 countries, 2011–12.

Figure 2.6d A lion dance at the annual Moon Festival in Cabramatta, NSW.

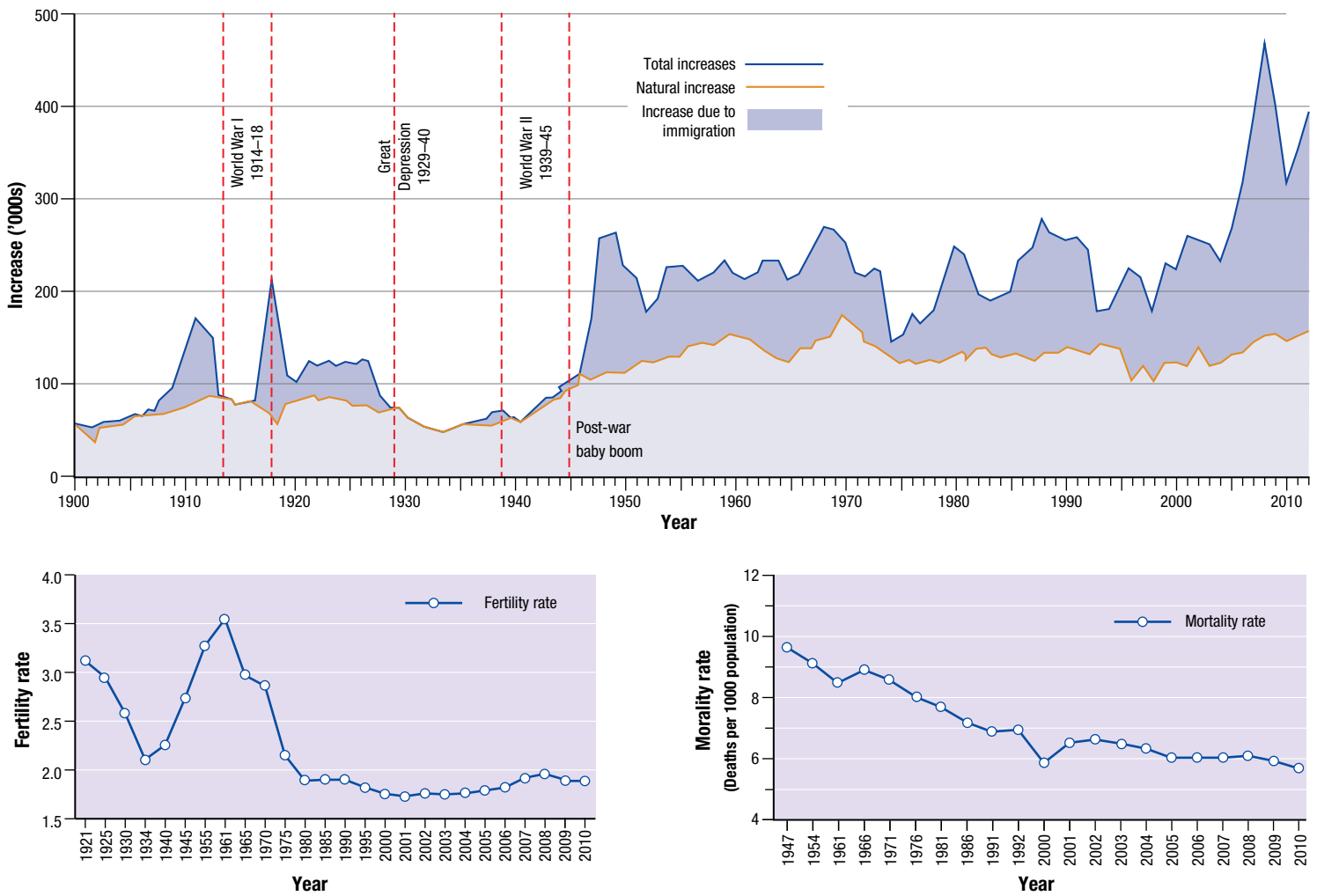


Figure 2.6b Components of Australia's population growth, 1991 to 2010: Australia's fertility rate, 1921 to 2010; Australia's mortality rate, 1947 to 2010; and components of the immigration program, 2001–02 to 2011–10.

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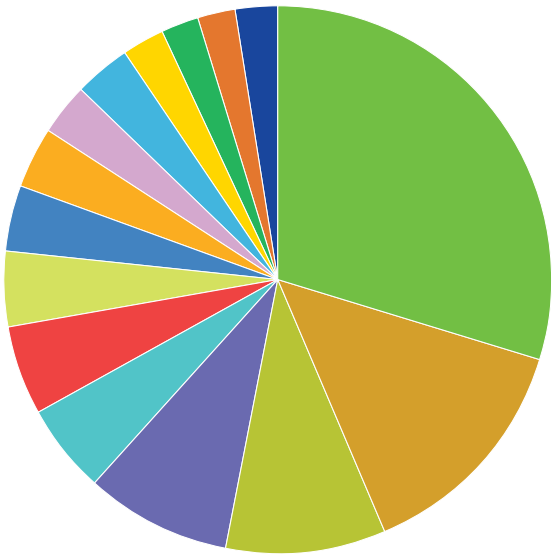

Country	'000
United Kingdom	1192.9
New Zealand	544.2
China	379.8
India	340.6
Italy	216.3
Vietnam	210.8
Philippines	177.4
South Africa	155.7
Malaysia	135.6
Germany	128.6
Greece	127.2
South Korea	100.3
Sri Lanka	92.2
Lebanon	90.4
Hong Kong	90.3
Total overseas-born	**5994**
Australian born	**16334.9**
Total population	**22328.9**

Figure 2.6e Birthplace of overseas-born residents of Australia, top 15 countries, 2010.

In April 2013, Australia's population reached 23 million. This is nearly three times the population of 1950 and five times the population in 1900. The main drivers of population increase are natural increase and net migration. *Natural increase* is the difference between the birth rate and the death rate. *Net migration* is the difference between the number of permanent departures from Australia and the number of people arriving to live in Australia on a permanent basis.

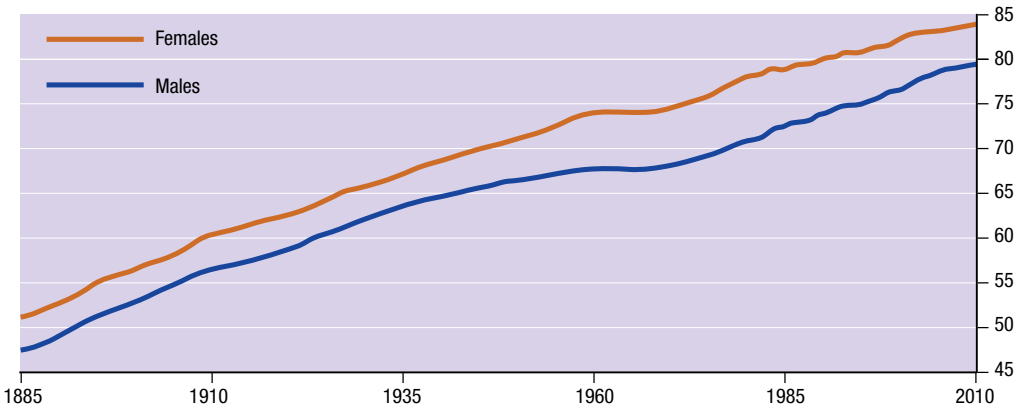

Figure 2.6f Life expectancy 1906–2010.

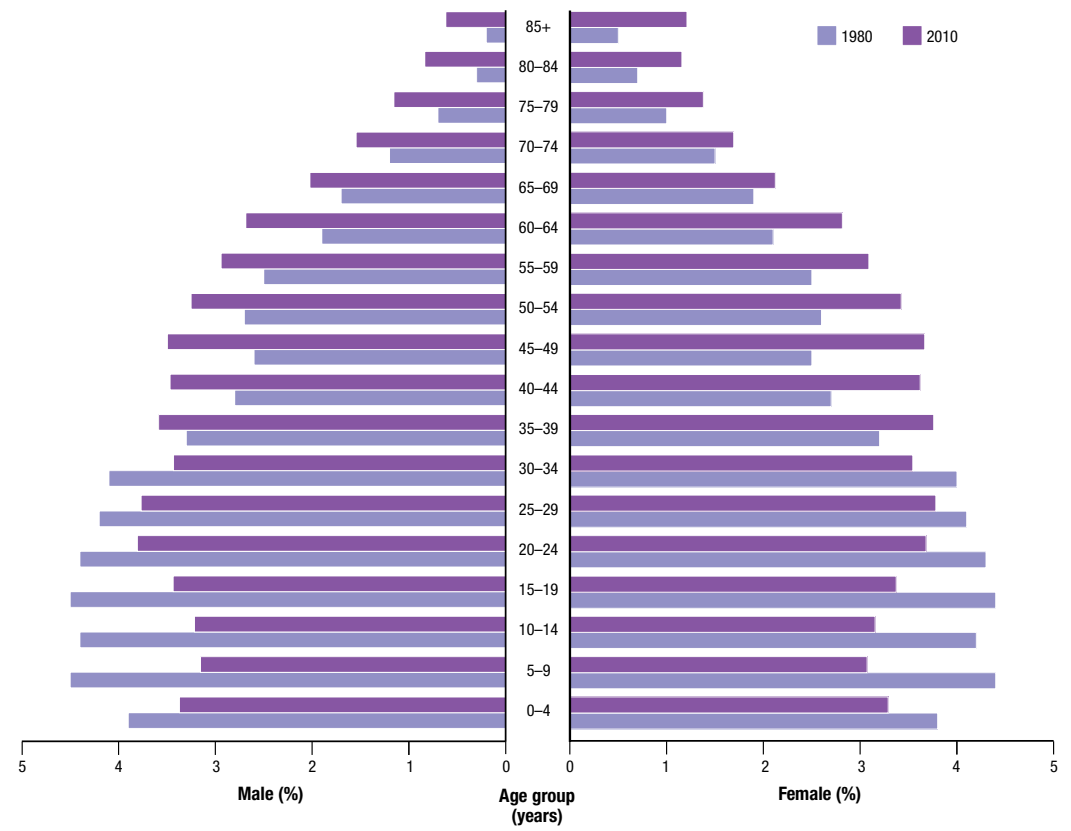

Figure 2.6g Population structure of Australia, by age and sex, 1980 and 2010.

ACTIVITIES

1 Study Figure 2.6a (page 37) and then answer the following questions:
- **a** What was the population of Australia in:
  - **i** 1850
  - **ii** 1900
  - **iii** 1950?
- **b** Which decade experienced the most rapid population growth?
- **c** Which decade of the 20th century experienced the slowest rate of population growth?

2 Study Figure 2.6b (page 37) and then answer the following questions:
- **a** In which year did the rate of natural increase peak?
- **b** What effect did the World Wars and the Great Depression have on population growth? What was affected more: natural increase or immigration?
- **c** Explain why there was a significant increase in population growth in 1918 and 1946.
- **d** Estimate the contribution made by immigration to total population growth in 1980.
- **e** In what year did Australia's fertility rate exceed 3.5?
- **f** Describe the trend in fertility rates since 1961.
- **g** By how much has Australia's mortality rate declined since 1947?
- **h** Undertake library research. Investigate the reasons for the declines experienced in Australian fertility and mortality rates in the periods shown in Figure 2.6b.
- **i** What category of Australia's immigration program makes up the largest percentage of immigrants?
- **j** What percentage of migrants entered Australia under the skilled migration program in 2011–12?
- **k** In what year did the family reunion category make the largest percentage of migrants?
- **l** What has been the overall trend in skilled migration since 2001–02?

3 Study Figure 2.6c (page 37) and then answer the following questions:
- **a** What is the most common birthplace of overseas-born Australian residents in 2010?
- **b** What percentage of immigrants came from China?
- **c** What number of immigrants originated from China in 2011–12?
- **d** What percentage of immigrants came from the UK in 2011–12?

4 Study Figure 2.6e and then answer the following questions:
- **a** What was the most common birthplace of overseas-born residents in Australia in 2010?
- **b** What percentage of Australian residents were born in New Zealand in 2010?
- **c** How many Chinese-born Australian residents were there in 2010?
- **d** What percentage of Australian residents were born in on either China or India?
- **e** How many Australian residents were born in either China or India in 2010?
- **f** What percentage of the Australian population was born in either China or India?

5 Study 2.6f. By how much has life expectancy for Australian males and females increased since 1910?

6 Study Figure 2.6g and then complete the following tasks:
- **a** Estimate the number of Australians under the age of 15 years in 1980.
- **b** Estimate the number of Australians under the age of 15 years in 2010.
- **c** Calculate the percentage of Australians under the age of 15 years in 1980.
- **d** Calculate the percentage of Australians under the age of 15 years in 2010.
- **e** Estimate the number of Australians over the age of 65 years in 1980.
- **f** Estimate the number of Australians over the age of 65 years in 2010.
- **g** Calculate the percentage of Australians over the age of 65 years in 1980.
- **h** Calculate the percentage of Australians over the age of 65 years in 2010.
- **i** What effect did the high rate of natural increase in the 1950s and 1960s have on the population in 2010?
- **j** What do the figures suggest about the changing structure of the Australian population?
- **k** What other evidence is there that Australia has an ageing population?

2.7 Australia's population movements

The distribution of Australia's population is changing. Economic change (especially the decline of manufacturing and the growth in mining), immigration, the ageing of the population and the lifestyle choices made by individuals are the main drivers of this change.

THE 'TYRANNY OF DISTANCE' IS DEAD

Distance is no longer the barrier it once was. Developments in communications and transport technologies have brought Australia closer to the Northern Hemisphere's centres of business and culture. Australians can now interact with others no matter where they live.

THE FLIGHT TO THE SUBURBS

During the 1960s to 1980s, Australians abandoned the inner city for the suburban lifestyle. This was the era of the single, detached suburban home with the Holden Kingswood or Ford Falcon in the driveway.

TURNING OUR BACK ON THE SUBURBAN DREAM

Since the 1990s the number of people choosing to live in the inner suburbs of all Australia's large cities has increased significantly. Attracted by benefits of inner-city living, these people (mainly young professionals and older 'empty nesters') have created a demand for new high-rise apartments within walking distance of the central business district or major public transport nodes.

FILLING THE GAPS

Urban infill is the development of land in already-developed areas, either by building housing on land that was previously vacant or used for non-residential purposes, or by replacing low-density housing (detached single homes) with higher-density dwellings (townhouses, villas or appartments). Infill development is becoming more common on transport corridors, near major commercial centres, in suburbs where there are older houses on large blocks of land, and on former inner-city industrial sites. The process is commonly known as urban consolidation.

DESERTING THE BUSH

The share of the population living in rural areas is declining. As a result, many small rural communities are struggling to survive.

HEADING TO THE BEACH

Australians' love affair with the beach continues. Towns along Australia's coastline have grown as retirees, families and singles seeking a lifestyle change, and those in search of more affordable housing, move from the capital cities to beach-side communities.

Queensland's Gold Coast has been the most popular destination for Australians on the move over the past 20 years. The Gold Coast barely existed in 1945. By 2000 it had 404 000 residents. By 2010 the population had grown to 540 000.

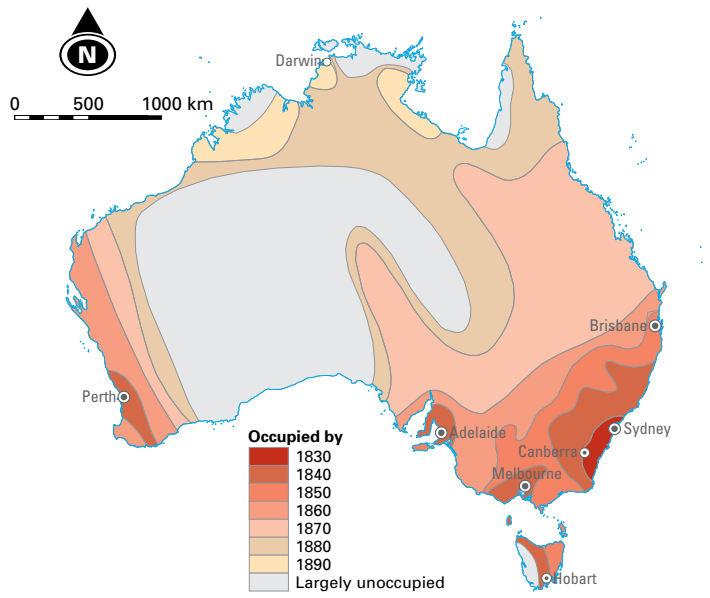

Figure 2.7a Spread of European settlement in Australia since 1788.

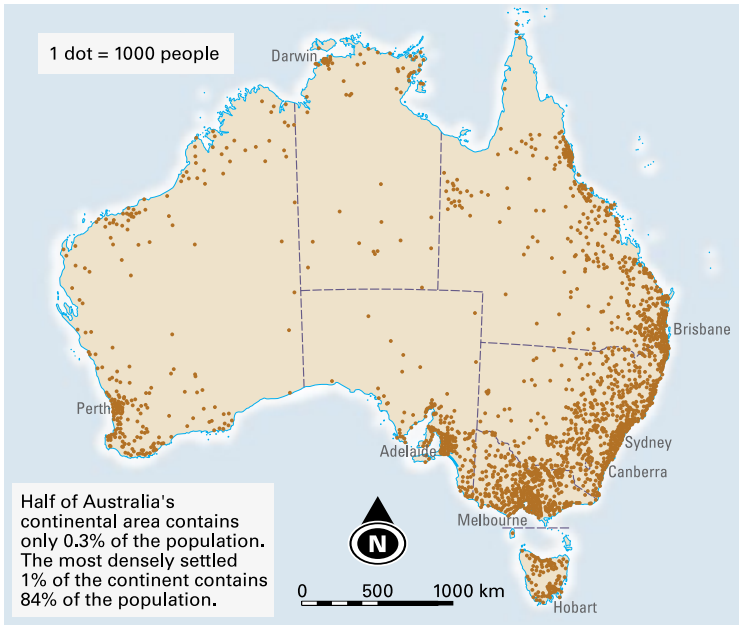

Figure 2.7b Dot map showing the distribution of the Australian population, 2010.

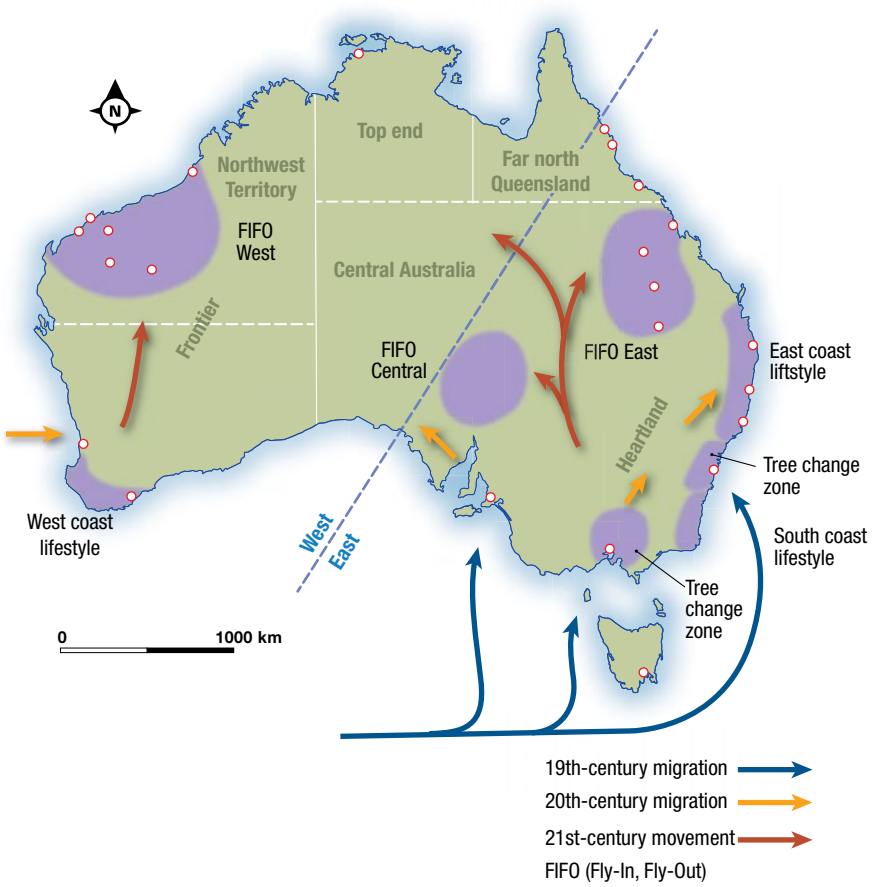

Figure 2.7c Population density, 2010.

REGIONAL CENTRES BACK IN FAVOUR

Cities such as Dubbo, Tamworth and Wagga Wagga in New South Wales, Horsham in Victoria, as well as Narrogin in Western Australia have grown in recent years, attracting people from smaller, surrounding rural communities.

THE NEW FRONTIER

Australia's mining boom – fuelled by the rapid economic growth being experienced by China – is attracting people to those parts of Australia where the minerals are found and mining developments are taking place. The use of 'fly-in, fly-out' and 'drive-in, drive-out' labour means that the growth of communities in remote parts of Australia may not be as great as experienced in earlier mining booms.

MOVING INTERSTATE

The proportion of people living in the Australian Capital Territory, Victoria, Western Australia and Queensland has increased, while the proportion living in New South Wales and the Northern Territory has declined.

The attractions of Queensland's south-east include jobs, climate and lifestyle.

NEW ARRIVALS, OLD CHOICES

In 2009–10, net overseas migration added 66 000 to the population of New South Wales, followed by Victoria (60 400) and Queensland (39 700). The Northern Territory received just 1300 persons. Sydney is using immigrants to replace departing residents.

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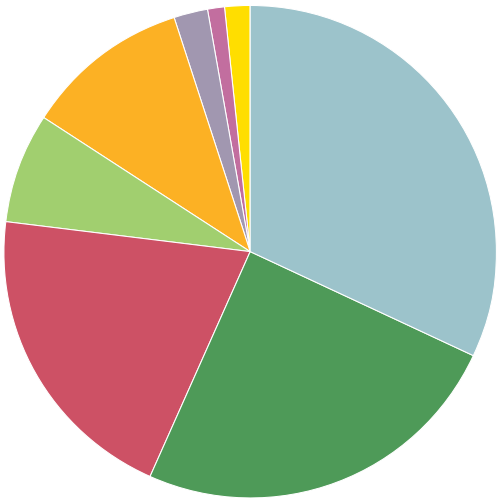


Region	Population at end September quarter 2012 '000
New South Wales	7314.1
Victoria	5649.1
Queensland	4584.6
Western Australia	2451.4
South Australia	1658.1
Tasmania	512.2
Australian Capital Territory	376.5
Northern Territory	236.3
Australia[a]	**22785.5**

(a) Includes other Territories comprising Jervis Bay Territory, Christmas Island

Figure 2.7d Distribution of Australia's population by state and territory, 2012.

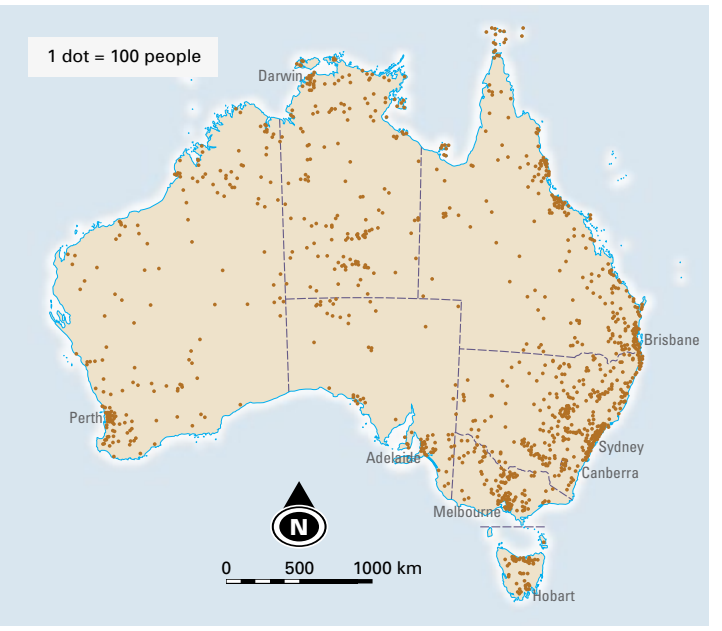


Figure 2.7f Dot map showing the distribution of Indigenous Australians.

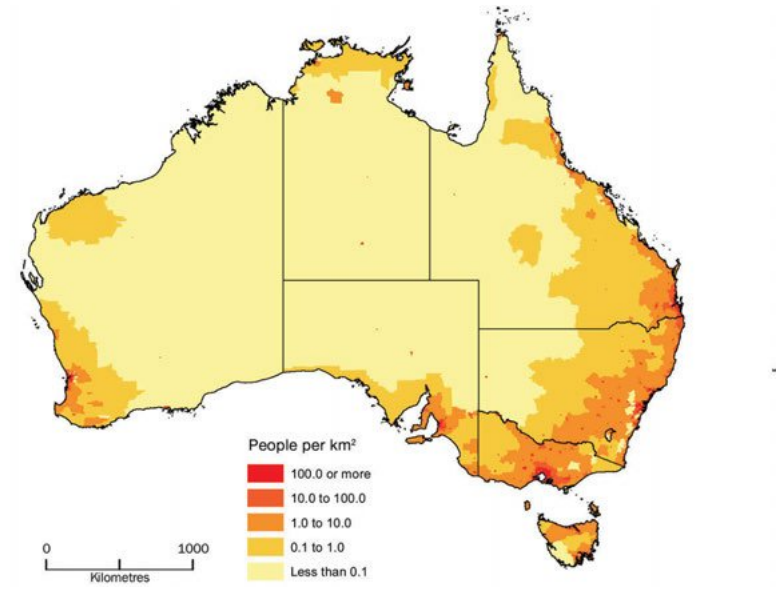
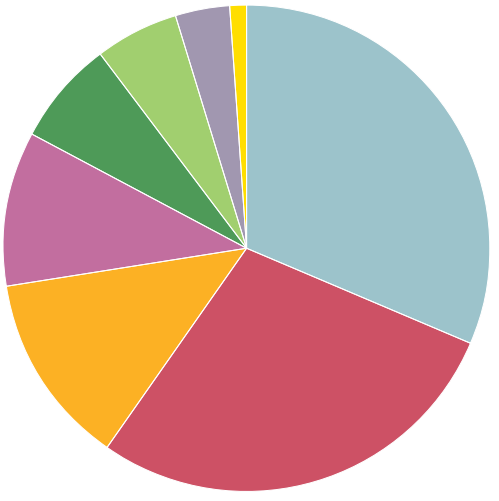


Figure 2.7e Population density, 2010.



Region	Total
New South Wales	172624
Queensland	155825
Western Australia	69665
Northern Territory	56779
Victoria	37991
South Australia	30431
Tasmania	19625
Australian Capital Territory	5184
Australia[a]	**548370**

(a) Includes other Territories comprising Jervis Bay Territory, Cocos (Keeling) Islands and Christmas Island

Figure 2.7g The distribution of Indigenous Australian by state and territory, 2011 Census.

ACTIVITIES

1. Study Figure 2.7a (page 39). Write a paragraph describing the spread of European settlement since 1788.
2. Study Figure 2.7b (page 39). Describe the distribution of the Australian population. Working in groups, brainstorm the reasons for the pattern identified.
3. Study Figure 2.7c (page 39) and answer the following questions:
   - **a** Where are population densities the highest?
   - **b** Which parts of Australia have population densities of 1.0 to 10.0 people per square kilometre?
4. Study Figure 2.7d and then answer the following questions:
   - **a** What percentage of Australia's population lives in New South Wales?
   - **b** How many people live in Victoria?
   - **c** Which state has the smallest share of Australia's population?
5. Study Figures 2.7e and 2.7f. Write a paragraph describing the distribution and density of the Aboriginal population before 1788.
6. Study Figures 2.7b (page 39) and 2.7e. What similarities and differences are there between the population distribution of Australia's current population compared to the distribution of Aboriginal Australians before 1788?
7. Study Figure 2.7g and then answer the following questions:
   - **a** What percentage of Indigenous Australians live in:
     - **i** New South Wales
     - **ii** Queensland
     - **iii** Northern Territory?
   - **b** How many Indigenous Australians live in:
     - **i** Northern Territory
     - **ii** Queensland
     - **iii** Victoria?
8. Write an extended response outlining the nature of internal migrations taking place within Australia.
9. Study Table 2.7a and Table 2.7b and describe how the distribution of the Australian population changed between 1901 and 2010.
10. Study Table 2.7b. Construct a column graph to illustrate the population change by state and territory, 2006–11. Account for the population growth experienced by Western Australia and Queensland.
11. Write an extended response outlining the principal movements of Australia's population.

Indigenous Australia

In 1788, Australia's population was thought to be about 315000, divided into 250 nations. While most parts of the continent were occupied, population densities were greater in areas where water and food were more widely available.

Each Indigenous nation had its own traditional lands, with which its people had a deep spiritual bond. Each nation also had its own language and traditions. Each nation was typically divided into several clans, with as many as 30 or 40 members. Today, Australia's Indigenous population is concentrated in northern and central parts of Australia. Twenty-six per cent of Indigenous Australians live in semi-remote and remote areas (compared with just 1.7 per cent of the total population).

Table 2.7a Changing distribution of the Australian population

	1901	*2010*
Rural	52%	18%
Inner city	25%	5%
Suburbia	15%	58%
Coastal	8%	19%

Table 2.7b Population change by state and territory, 2006–11

State/Territory	*Total population (2011 Census)*	*Percentage increase 2006–11*
Queensland	4332737	+11.0
Western Australia	2239171	+14.3
Victoria	3999980	+9.7
ACT	356586	+10.3
Tasmania	495351	+4.0
Northern Territory	211941	+9.9
South Australia	1596570	+5.4
New South Wales	6917656	+5.6

AUSTRALIAN TOPOGRAPHIC MAPS

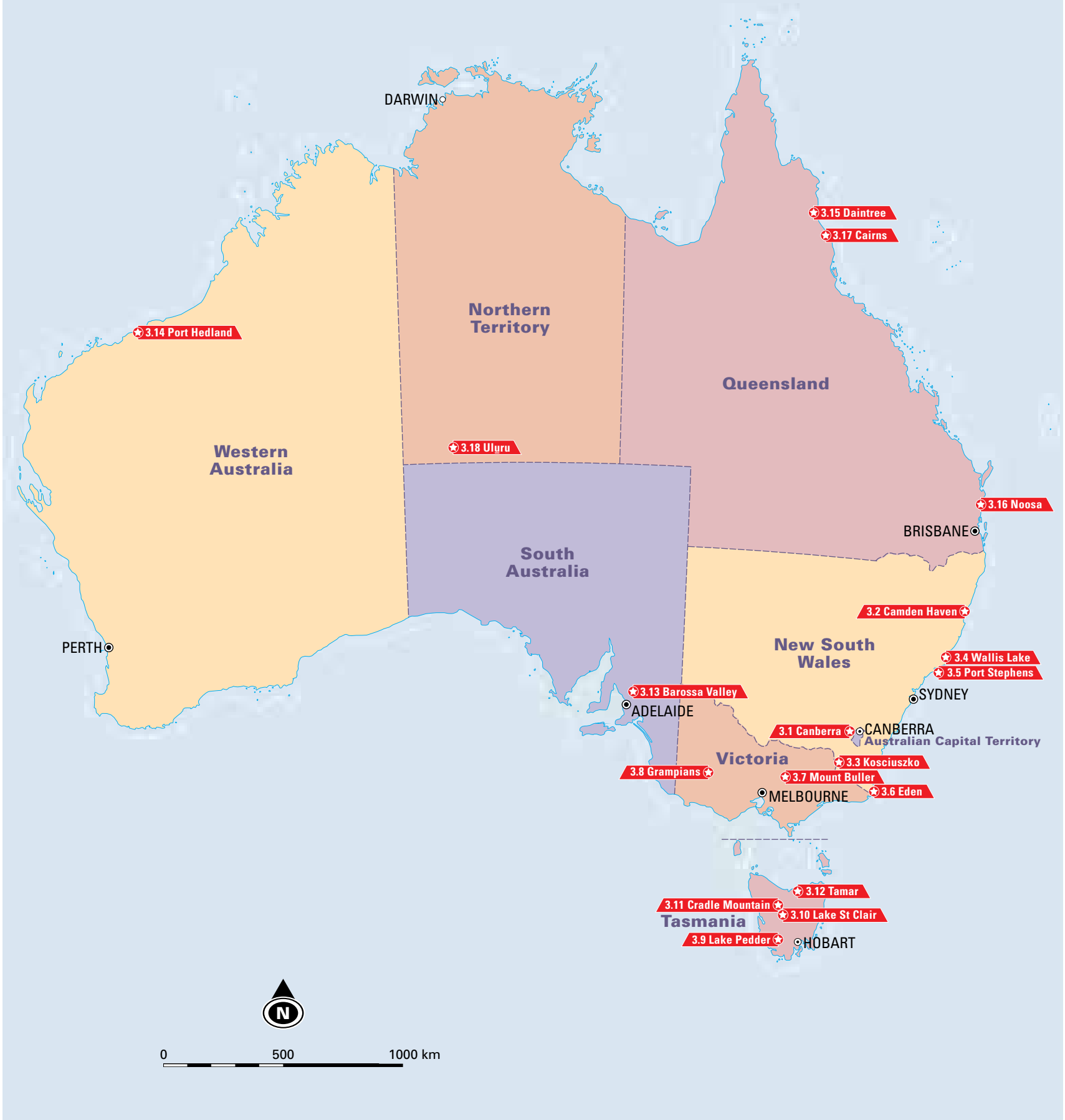


Figure 3 Location of map extracts in Section 3.

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3.1 Canberra (ACT) topographic map extract

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Using the map extract and Figure 3.1a, identify the features labelled a to l on the aerial photograph of Canberra.
4. Identify the feature of the biophysical environment located at:
   - **a** GR 985985
   - **b** GR 848834
   - **c** GR 860790
   - **d** GR 878951.
5. Identify the feature of the constructed environment located at:
   - **a** GR 904983
   - **b** GR 948918
   - **c** GR 883918
   - **d** GR 912974.
6. Give the grid reference of five recreational activities found on the map extract.
7. What river has been dammed to form Lake Burley Griffin?
8. What type of vegetation is found in AR 8489?
9. What type of land use is found at GR 893937?
10. Identify the feature of the built environment located 5.2 km to the south-west of the summit of Mount Ainslie (GR 964949).
11. What is the direction of Black Mountain (GR 908946) from Parliament House (AR 9390)?
12. What is the aspect of the slope in AR 9193?
13. What is the bearing of Parliament House from the Australian War Memorial (AR 9593)?
14. What is the length of the north–south runway at Fairbairn Airport?
15. What is the straight-line distance between Parliament House and the Australian War Memorial?
16. Estimate the distance by road from the showground (GR 956994) to Parliament House.
17. Calculate the time it would take to travel from the showground to Parliament House at an average speed of 60 km/h.
18. Estimate the density of buildings in AR 9880.
19. What is the height of the landform feature at GR 994033?
20. Estimate the height of the landform feature at GR 979034.
21. What is the difference in elevation between Black Mountain and Mount Ainslie?
22. What is the difference in elevation of Mount Majura (GR 984984) and Mount Arawang (GR 859844)?
23. What is the local relief in AR 9678?
24. Is Red Hill (AR 9288) visible from the summit of Mount Ainslie?
25. Is Majura (AR 9994) visible from the summit of Black Mountain?
26. Calculate the gradient of the slope between GR 965785 and GR 968795.
27. What evidence is there that Canberra is a planned city?
28. Undertake library research. When was Canberra founded? Outline the process involved in the selection of the site. Who was Walter Burley Griffin? What role did he play in the development of Canberra?
29. Working in groups, brainstorm the advantages and disadvantages of living in a planned city such as Canberra. Share your group's findings with the rest of the class.

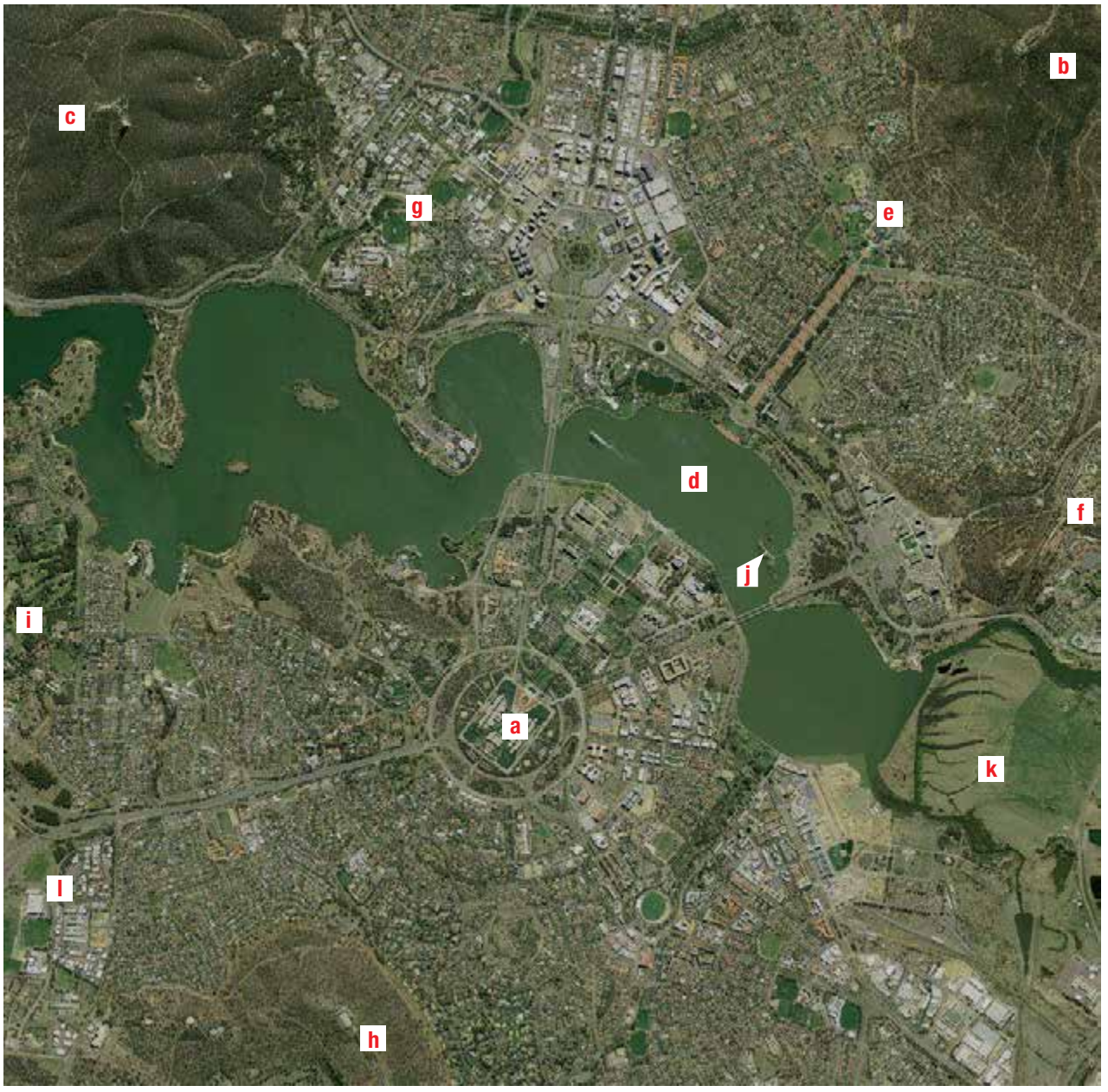
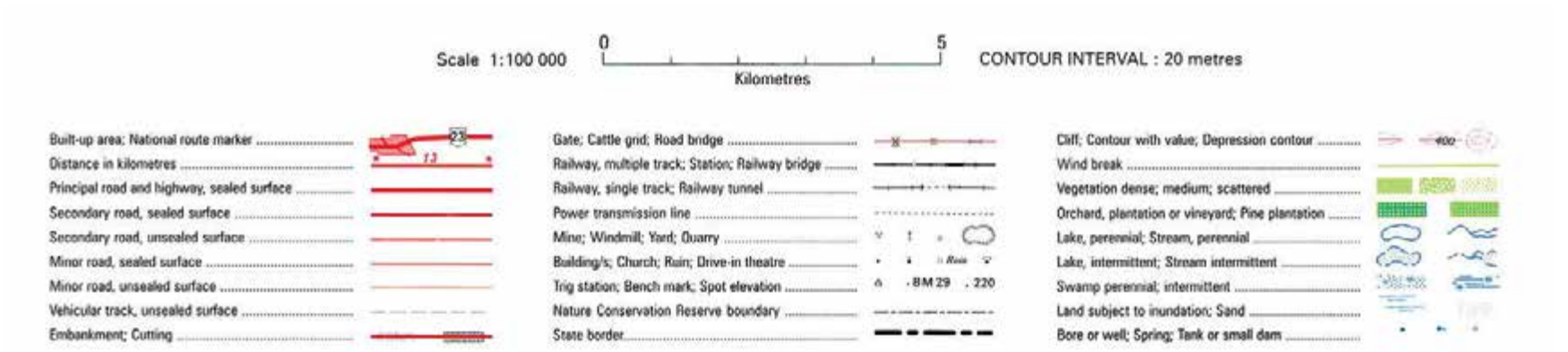


Figure 3.1a Aerial photograph of central Canberra.



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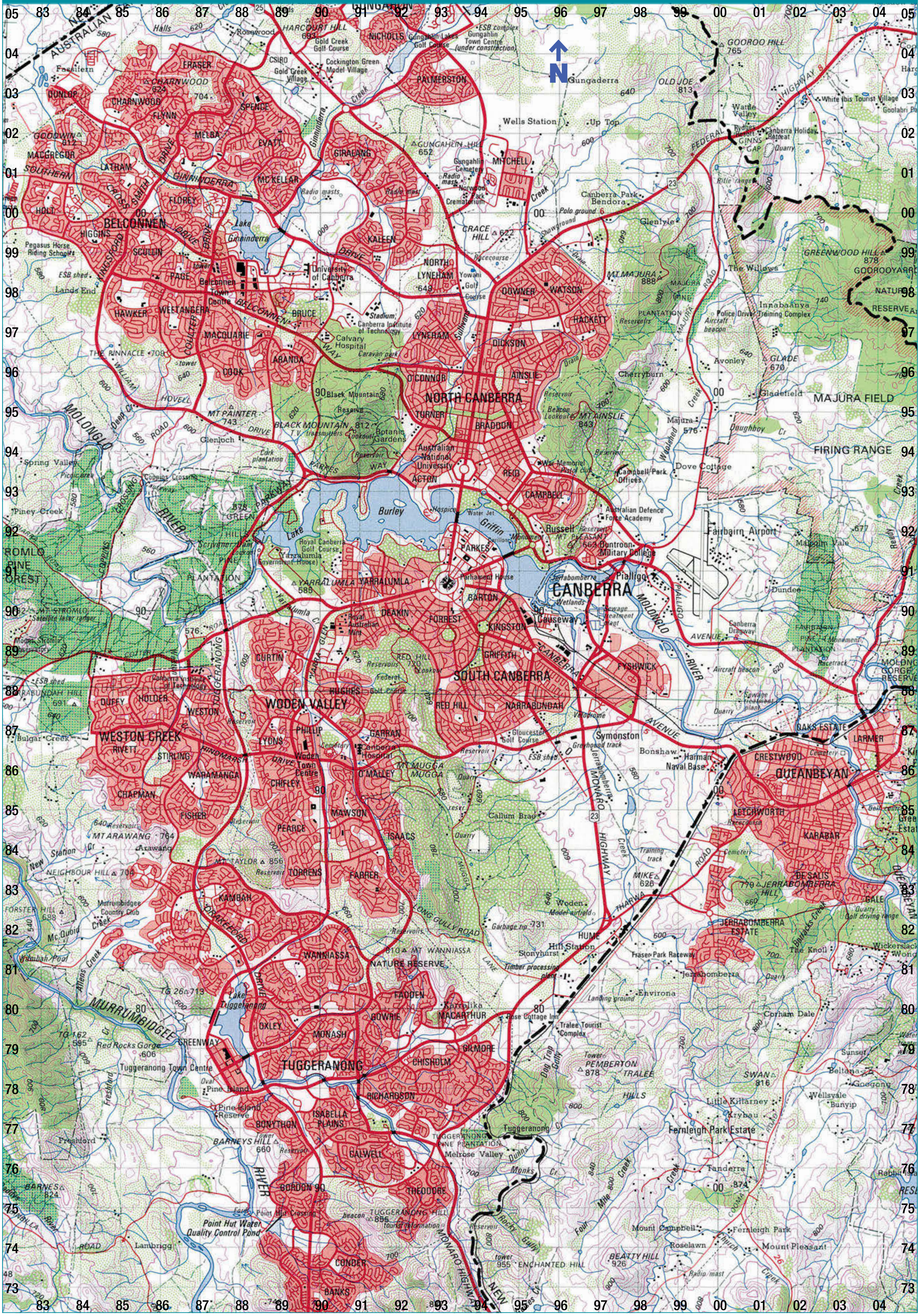
Canberra topographic map extract (Canberra: latitude 35°17´S, longitude 149°08´E)



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3.2 Camden Haven (NSW) topographic map extract

You be the judge

A group of developers wishes to convert Gogleys Lagoon into a canal estate and resort complex. The canal estate will have 300 building sites with water frontages. The resort will include a 110-room hotel, a marina and a retail complex housing shops and restaurants. When completed, the resort will create 160 permanent jobs. Local environment groups have objected to the development on the grounds that it will destroy the environmentally sensitive lagoon ecosystem. The pro-development council has approved the development. Those opposed to the development have gone to the Land and Environment Court in an effort to have the development stopped. You are the judge of the Land and Environment Court. Will you allow the development to go ahead?

Figure 3.2a A sample of community views.

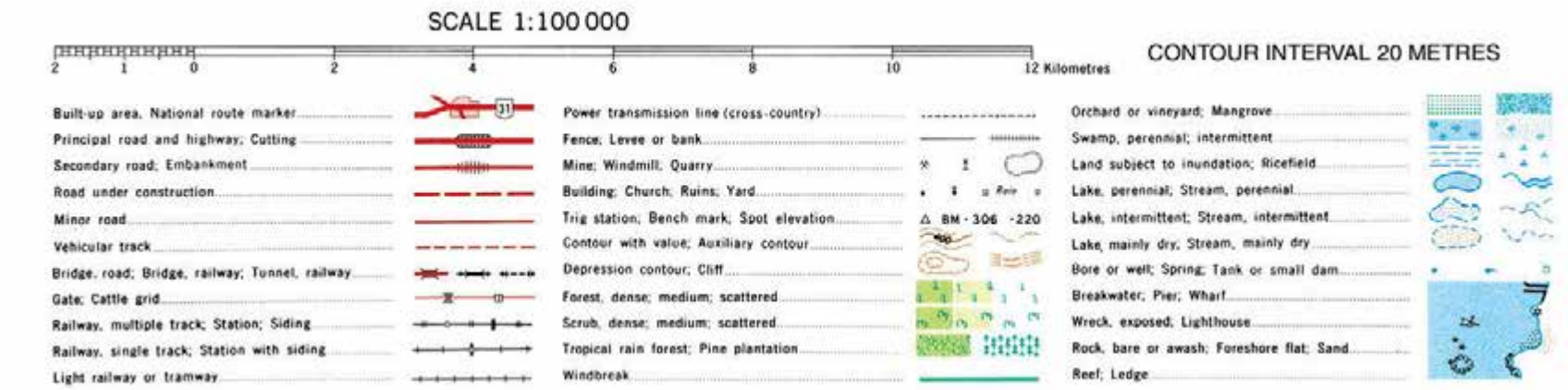
ACTIVITIES

Read each of the statements made by members of the Laurieton community and then complete the following tasks:

1. List the statements that are in favour of building the resort and its facilities. Make a separate list of the statements that are not in favour of the development going ahead.
2. Which set of views do you agree with?
3. In small groups of four or five students, discuss the different views about the proposed development. Study the map extract and evaluate the suitability of the site. Reach agreement on what you think should happen. Be prepared to defend your group's point of view when you report back to the class.
4. Examine both sides. Have the people on each side of the discussion in Activity 3 present the case for the other side, using exact arguments.
5. Discuss in class the statement: 'The resort should go ahead'.
6. At the end of the debate, conduct a secret ballot to determine whether the class will recommend that the resort should go ahead.
7. Write an exposition outlining the arguments you would use to justify your point of view on the issue.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 855991
   - **b** GR 685877
   - **c** GR 847087
   - **d** GR 785940.
4. Identify the feature of the constructed environment located at:
   - **a** GR 709021
   - **b** GR 827082
   - **c** GR 843043
   - **d** GR 842052.
5. What creek flows into the sea at GR 865092?
6. What type of vegetation is found at AR 8408?
7. What type of vegetation is found in AR 7486?
8. What type of land use is found in AR 7608?
9. Name the type of biophysical feature found in GR 835985.
10. Identify the feature of the biophysical environment located 14 km to the north-east of South Brother Mountain (AR 6887).
11. What is the direction of Kew (AR 7399) from Lake Cathie township (AR 8609)?
12. In what direction does Herons Creek flow in AR 7503?
13. Is the mouth of the Camden Haven River visible from the summit of Middle Brother Mountain (GR 695924)?
14. What is the settlement pattern found in AR 7499?
15. What is the aspect of the slope in AR 7996?
16. What is the bearing of South Brother Mountain (GR 685877) from North Brother Mountain (GR 790971)?
17. Estimate the straight-line distance between Diamond Head trig station (GR 811899) and Camden Head trig station (GR 848984).
18. Estimate the distance by road from Kew (GR 738999) to the bridge at GR 714905.
19. Calculate the time it would take to travel from Kew (GR 738999) to the bridge at GR 714903 at an average speed of 60 km/h.
20. Estimate the area of Queens Lake.
21. What is the density of buildings in AR 7599?
22. Estimate the height of the landform feature at GR 774028.
23. What is the difference in elevation of North Brother Mountain (GR 970971) and South Brother Mountain (GR 685877)?
24. Estimate the local relief experienced on a traverse from GR 736951 to GR 790971.
25. Estimate the local relief in AR 8189.
26. Calculate the gradient of the slope between GR 790971 and GR 790954.
27. Undertake research. Identify the type of delta formed by the Camden Haven River. Explain how deltas such as this develop.
28. The section of coast shown on the map extract is dominated by depositional landform features. What evidence is there to support this view?
29. Write a report describing how landform has affected the area's drainage pattern and its settlement and communications patterns.
30. What types of functions would be provided by a settlement such as Kew? How may these be different from those offered by Laurieton (GR 805980)?



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Camden Haven topographic map extract (Laurieton: latitude 31˚65′S, longitude 152˚80′E)

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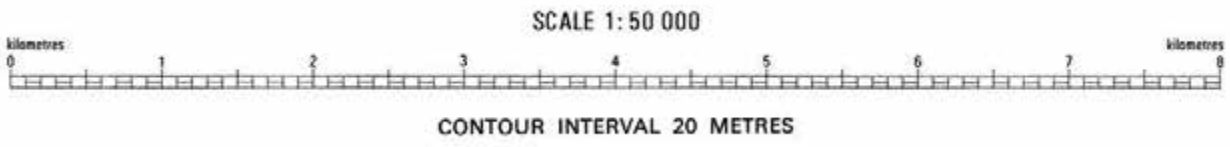
3.3 Kosciuszko (NSW) topographic map extract

Figure 3.3a Thredbo in NSW.



ACTIVITIES

When completing these activities refer to the legend on page 42.

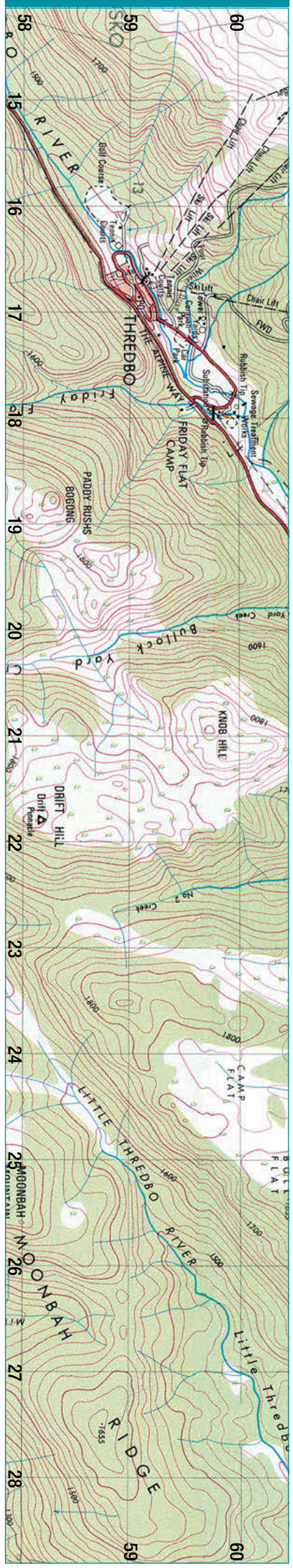
1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 253668
   - **b** GR 157692
   - **c** GR 275687
   - **d** GR 250715.
4. Identify the feature of the constructed environment located at:
   - **a** GR 214712
   - **b** GR 280710
   - **c** GR 148652
   - **d** GR 196648.
5. What type of land use is found in AR 1659?
6. What is the grid reference of the following landform features?
   - **a** Mount Twynam
   - **b** Mount Kosciuszko
   - **c** Lake Otapatamba
   - **d** Mount Perisher
7. Name the tributary that joins the Snowy River at GR 158645.
8. What is the direction of Blue Lake (AR 1770) from the summit of Mount Kosciuszko (AR 1364)?
9. In which direction does the Snowy River flow in AR 1968?
10. What is the feature of the physical environment located 1 km to the south of Mount Kosciuszko?
11. What is the aspect of the slope in AR 2263?
12. What is the bearing of Mount Clarke (AR 1567) from Mount Kosciuszko?
13. What is the straight-line distance between the summit of Mount Kosciuszko and Mount Townsend (GR 1268)?
14. What is the length of the walk from GR 151605 to the summit of Mount Kosciuszko via the walking trail and road?
15. Estimate the area of Blue Lake.
16. What is the height of Mount Kosciuszko?
17. Estimate the height of the following landform features:
   - **a** Mount Clarke (AR 1567)
   - **b** Mount Perisher (AR 2469)
   - **c** Porcupine Rocks (GR 252670).
18. What is the difference in elevation between Mount Kosciuszko and Mount Townsend?
19. Can Mount Clarke (AR 1567) be seen from the summit of Mount Guthrie (AR 1967)?
20. Calculate the average gradient of Lubra Creek from its source at GR 272677 to where it enters the Thredbo River (GR 271655).
21. Construct the cross-section from Duncan geodetic station (GR 257676) to the peak at GR 255635.
22. Calculate the vertical exaggeration of the cross-section that you constructed in activity 21.
23. Undertake library research. Investigate how alpine lakes, such as Blue Lake, are formed.
24. Working in groups, identify possible sources of environmental damage in the fragile alpine ecosystem of the Snowy Mountains area. Share the points raised in your group's discussion with the rest of your class. Brainstorm ways in which the impact of people could be minimised.
25. Use Tables 3.3a and 3.3b to construct the climate graphs for Thredbo Village and Crackenback Station. These two stations have a horizontal separation of just 2.2 km. Account for the difference in climate experienced.

Table 3.3a Climate data for Thredbo (Village), elevation 1380 m, latitude 36˚51´S, longitude 148˚30´E

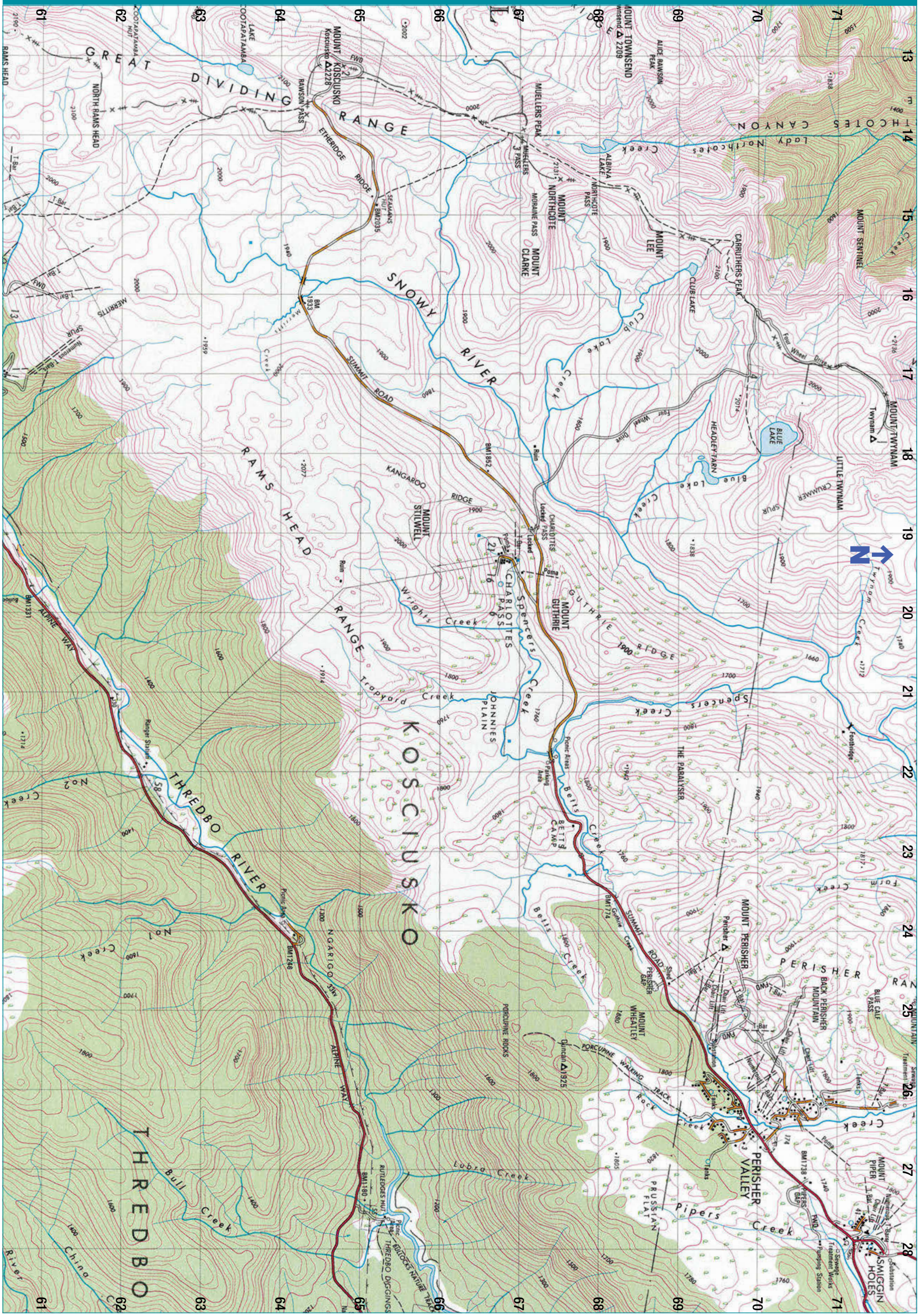
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean min. temp. (C˚)	6.5	6.7	4.3	1.7	–0.5	–2.9	–3.9	–2.4	–0.8	1.3	3.2	5.1	2.0
Mean max. temp. (C˚)	20.7	20.6	18.0	13.7	10.0	6.3	5.1	6.2	9.5	13.0	15.7	18.8	14.0
Mean rainfall (mm)	115.6	84.2	113.4	119.3	172.4	160.1	161.3	185.6	207.7	207.4	158.6	119.1	1804.6

Table 3.3b Climate data for Thredbo (Crackenback Station), elevation 1957 m, latitude 36˚49´S, longitude 148˚29´E

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean min. temp. (C˚)	6.0	7.1	5.2	1.7	–1.6	–3.6	–5.5	–5.0	–3.5	–0.5	1.5	4.7	–0.4
Mean max. temp. (C˚)	15.4	16.4	13.5	9.3	4.6	2.0	0.1	0.4	2.8	7.2	10.3	14.0	6.9
Mean rainfall (mm)	103.0	91.9	124.1	118.3	141.2	85.8	130.2	134.0	150.8	168.3	162.4	111.1	1521.0



Kosciuszko topographic map extract (Thredbo: latitude 36°51′S, longitude 148°30′E)



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3.4 Wallis Lake (NSW) topographic map extract

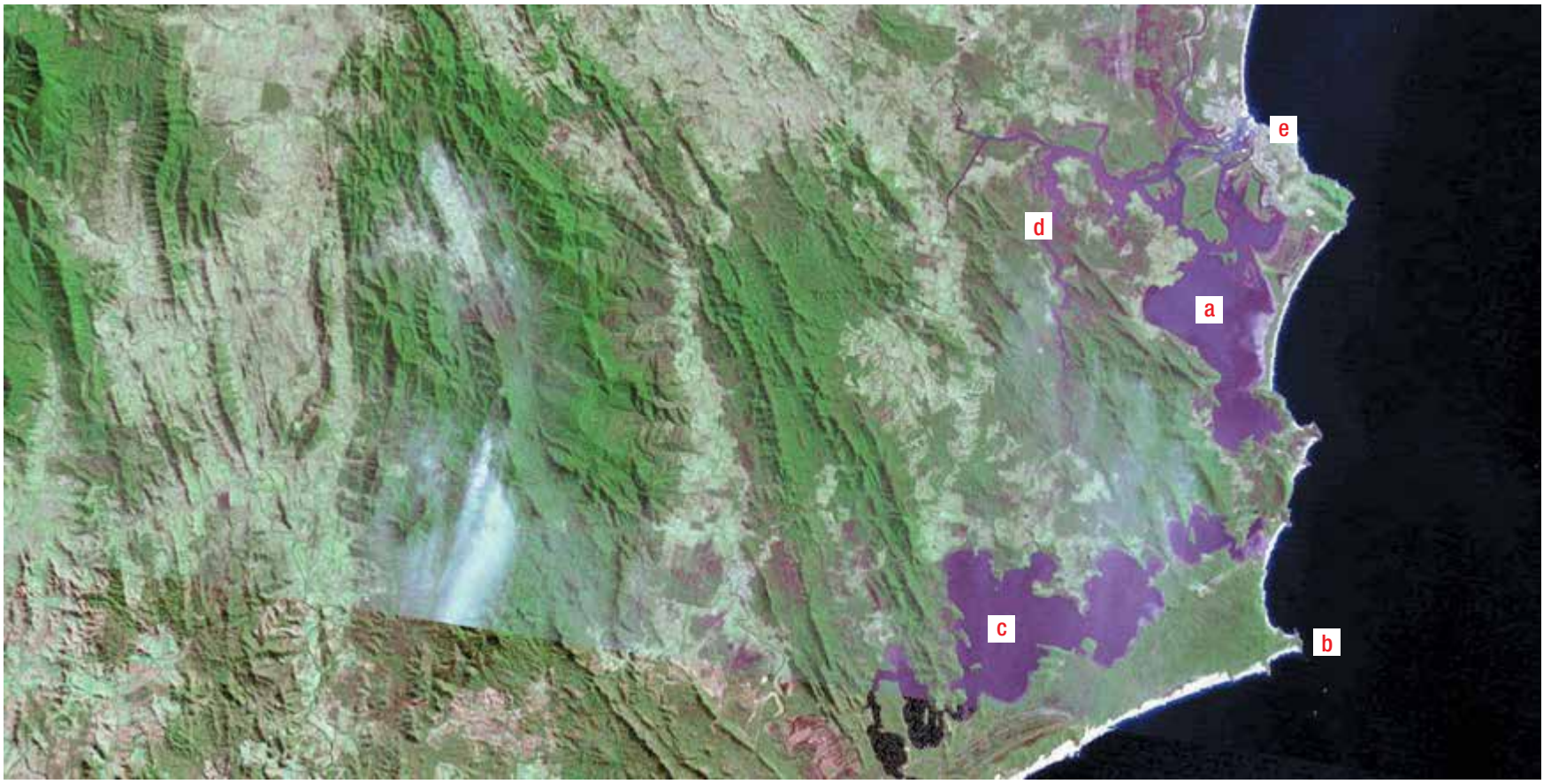
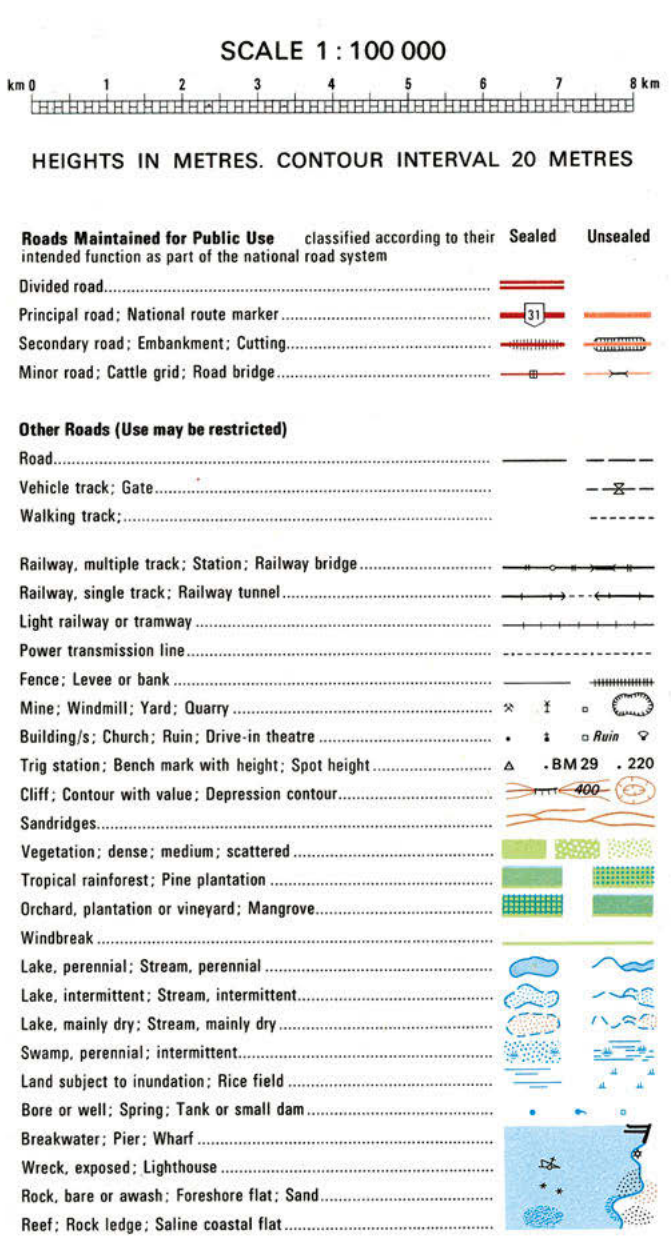


Figure 3.4a Satellite image of Wallis and Myall lakes in NSW.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Study Figure 3.4a. Identify the features labelled a to e.
4. Identify the feature of the biophysical environment located at:
   - **a** GR 564146
   - **b** GR 557193
   - **c** GR 558186
   - **d** GR 534244.
5. Identify the feature of the constructed environment located at:
   - **a** GR 537397
   - **b** GR 588353
   - **c** GR 510368
   - **d** GR 531160.
6. Which two rivers meet at GR 430380?
7. What type of vegetation dominates in AR 5124?
8. What type of land use is found in AR 5214?
9. What type of road links Seal Rocks (AR 5610) to the main road at Bungwhal (AR 4716)?
10. Name the biophysical feature centred on GR 547156.
11. What is the direction of Seal Rocks (AR 5610) from Forster (AR 5538)?
12. In which direction is the Wallingat River flowing in AR 4232?
13. Identify the feature of the biophysical environment located 9.8 km to the north-west of Seal Rocks lighthouse (AR 5610).
14. What is the aspect of the slope in AR 5524?
15. What is the bearing of Cape Hawke Lookout (AR 5835) from Forster Lighthouse (AR 5339)?
16. What is the length of the bridge linking Forster (AR 5538) to Tuncurry?
17. Estimate the distance by road from GR 536393 to Elizabeth Beach (GR 556226).
18. Calculate the time it would take to travel from GR 536393 to Elizabeth Beach (GR 556226) at an average speed of 60 km/h.
19. Estimate the area of Wallis Island's Nature Reserve.
20. Estimate the density of buildings in AR 5317.
21. What is the height of the landform feature at GR 496190?
22. What is the height of the landform feature at GR 445263?
23. What is the difference in elevation of Booti Hill (AR 5524) and Yaric (AR 5519)?
24. Estimate the local relief experienced on a traverse from GR 461300 to GR 480336.
25. Estimate the local relief in AR 5519.
26. Calculate the gradient of the slope between Yaric (GR 556193) and GR 562200.
27. Identify the settlement pattern in AR 5620.



Wallis Lake topographic map extract (Forster: latitude 38˚40′S, longitude 146˚13′E)

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3.5 Port Stephens (NSW) topographic map extract

ACTIVITIES

1. Identify the feature of the biophysical environment located at:
   - **a** GR 236795
   - **b** GR 234773
   - **c** GR 255769
   - **d** GR 212786.
2. Identify the feature of the constructed environment located at:
   - **a** GR 221767
   - **b** GR 223795
   - **c** GR 252764
   - **d** GR 239802.
3. What is the grid reference of Nelson Head Lighthouse?
4. What type of landform is found at AR 2382?
5. Name the vegetation type found in AR 2179.
6. What is the direction of Glovers Hill (AR 2178) from Tomaree Head?
7. What is the bearing of Stephens Peak (AR 2379) from Yacaaba (GR 251819)?
8. What is the aspect of the slope in AR 2581?
9. What is the straight-line distance between Yacaaba summit and Nelson Head Lighthouse (AR 2180)?
10. What is the elevation of Glovers Hill (AR 2178)?
11. What is the difference in elevation between Yacaaba (AR 2581) and the summit of Tomaree Headland?
12. What is the local relief in AR 2581?
13. Construct the cross-section between:
    - **a** Point A and B
    - **b** Point C and D.
14. Calculate the vertical exaggeration of the cross-sections you have drawn.
15. What is the average gradient of the slope from the summit of Yacaaba (GR 251819) to the shoreline at GR 251816?
16. Study Figure 3.5a and then complete the following tasks:
    - **a** Name the features numbered 1–4.
    - **b** In which direction was the camera pointing when the photograph was taken?
17. Study Figure 3.5b and the complete the following tasks:
    - **a** Name the features 1–5.
    - **b** In which direction was the camera pointing when the photograph was taken?
18. Study Figure 3.5c and then complete the following tasks:
    - **a** Name the features numbered 1–5.
    - **b** In which direction was the camera pointing when the photograph was taken?

Figure 3.5a Fingal Bay in NSW.

Figure 3.5b Shoal Bay in NSW.

Figure 3.5c Zenith Beach/Shoal Bay in NSW.

Port Stephens is a drowned valley estuary and large natural harbour covering approximately 134 square kilometres. It is located to the north of Newcastle.

A narrow channel between two prominent landforms of volcanic origin marks the entrance to Port Stephens. The southern headland, Tomaree, or South Head, rises to 120 metres above sea level, while Yacaaba, the northern headland, is 210 metres in elevation. The harbour is mostly shallow and sandy, but is deep enough in parts to accommodate large vessels.

SCALE 1:25000

0 km 0.5 1 2 km

CONTOUR INTERVAL 10 METRES

- Built up area
- Route marker: National Highway, National Route, State Route
- Major road: paved (with Metroad marker), unpaved
- Secondary road: paved, unpaved
- Minor road: paved, unpaved
- Vehicular track: Stock grid.
- Four-wheel drive track: Gate
- Walking track
- Road tunnel. Crossing
- Railway, heavy. Station. Tunnel
- Railway, light. Monorail
- Landmark feature. Stockyards. Mine
- Water tank or reservoir. Ground tank or dam
- Survey landmark (with height)
- Ancillary contour. Spot height
- Contours. Depression contour
- Cliff, with relative height. Rocky pinnacle
- Quarry or gravel pit. Levee or dyke
- Closed forest: 80-100% crown cover. Open forest: 50-80% crown cover
- Woodland: 20-50% crown cover. Pine forest
- Orchard, plantation or vineyard. Mangrove
- Power transmission line (33kv and above)
- Cableway
- Pipeline, water. Pipeline, other
- Perennial lake. Intermittent lake. Mainly dry lake
- Wet swamp. Dry swamp
- Land subject to inundation. Sand
- Intermittent stream, with waterfall
- Mainly dry stream. Perennial stream
- Large dam or weir
- Ferry route
- Lighthouse or beacon. Breakwater
- Jetty or wharf. Rock, bare or awash
- Slipway. Anchorage. Wreck
- Rock shelf. Reef
- Rocky shoreline. Intertidal flat
- Building, small. Building, large. Homestead
- Place of worship. School. State Emergency Service
- Ambulance station. Police station. Emergency headquarters
- Fire station. Telephone exchange. Post office
- Electricity substation, small. Electricity substation, large. Hospital
- Wind generator. Windpump. Rural fire station

BOUNDARIES

- State Forest
- Mine Subsidence District
- National Park, Nature Reserve or State Conservation Area
- Local Government
- Cadastre
- State

ISBN 978-1-139-77461-1

Cambridge University Press

Port Stephens topographic map extract (Port Stephens: : latitude 32°71'S; longitude 152°16')

ISBN 978-1-139-77461-1

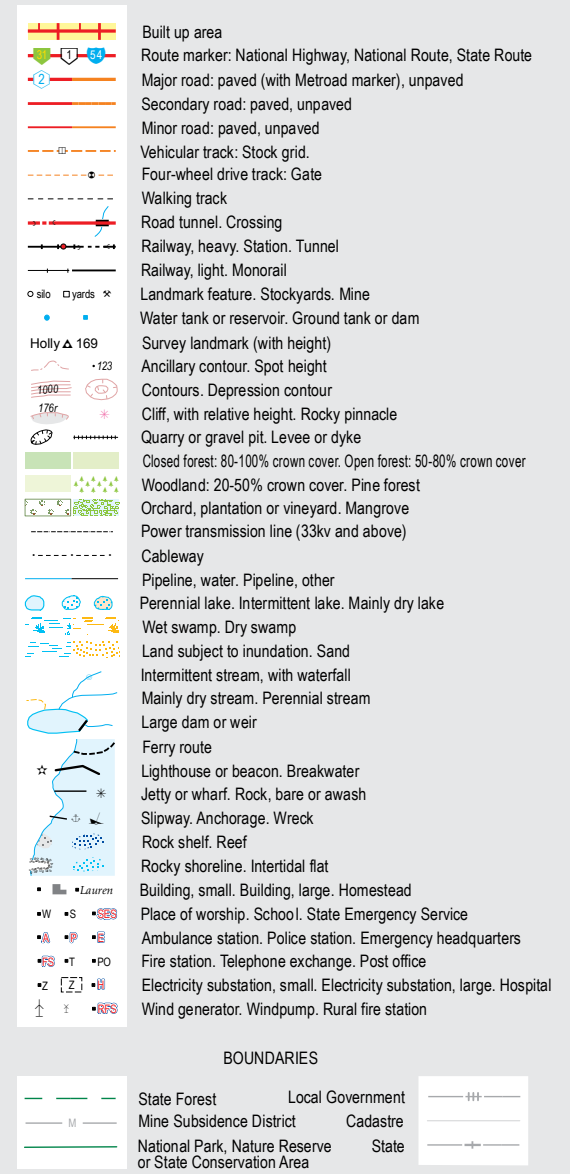
3.6 Eden (NSW) topographic map extract

Figure 3.6a Eden in NSW.

ACTIVITIES

1. What is the scale of the map?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 588955
   - **b** GR 554912
   - **c** GR 575933
   - **d** GR 575906.
4. Identify the feature of the constructed environment located at:
   - **a** GR 588928
   - **b** GR 585932
   - **c** GR 583949
   - **d** GR 605898
   - **e** GR 555928
   - **f** GR 590888.
5. What is the grid reference of Eden's police station?
6. What is the land use in AR 5993?
7. What type of landform feature is Whale Beach part of?
8. What type of delta is found extending into Curalo Lagoon?
9. What type of landform centred on GR 590930?
10. Name the vegetation type found in AR 5595.
11. What creek flows into the sea at Bungo Beach (GR 570929)?
12. What is the direction of flow of Freshwater Creek in AR 5694?
13. What type of recreational activities are available in AR 5796?
14. What is the direction of Northcote Point (AR 5591) from the Eagles Claw (AR 5993)?
15. What is the bearing of the war memorial (AR 5893) from Edrom Lodge (AR 6089)?
16. What is the aspect of the slope in AR 6095?
17. What is the straight-line distance between Torarago Point (GR 572905) and Lookout Point (GR 592927)?
18. What is the length of Aslings Beach?
19. What is the length of the Eden Breakwater?
20. What is the density of buildings in AR 5692?
21. What is the elevation of the Lazy-a at GR 555932?
22. Identify the features numbered 1 to 6 on Figure 3.6a.
23. In what direction was the camera facing when the photograph in Figure 3.6a was taken?

Eden is a town on the south coast of New South Wales, 478 kilometres to the south of Sydney. The coastline features rugged cliffs and wide, sandy surf beaches. European settlement in the area dates from 1843. The town's main industries include fishing, forestry and tourism. The traditional owners of the land are the Thaua, or Thawa, people of the Yuin nation.



SCALE 1:25000

0 km 0.5 1 2 km

CONTOUR INTERVAL 10 METRES

ISBN 978-1-139-77461-1

Eden topographic map extract (Eden: latitude 37°04′S, longitude 149°56′E)

ISBN 978-1-139-77461-1

Cambridge University Press

3.7 Mount Buller (Vic.) topographic map extract

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 490889
   - **b** GR 496867.
4. Identify the feature of the constructed environment located at:
   - **a** GR 502891
   - **b** GR 536873
   - **c** GR 514897
   - **d** GR 519885.
5. What is the direction of Mount Buller village from the summit of Mount Buller (GR 490889)?
6. In what direction is Cow Camp Creek flowing in AR 5187?
7. In what direction is Buller Creek flowing in AR 4889?
8. What is the bearing of Little Mount Buller (AR 4986) from the summit of Mount Buller (GR 490889)?
9. What is the bearing of the top of the Horse Hill Triple Chair from its base in AR 5189?
10. What is the length of the Horse Hill Triple Chair?
11. What is the length of the Bull Run Quad Chair (AR 5088)?
12. What is the difference in elevation between Little Mount Buller (AR 4986) and Mount Buller (GR 490889)?
13. What is the elevation of the wildlife bridge at GR 501909?
14. What is the elevation of the water supply reservoir in AR 5089?
15. What is the average gradient of Gin Creek from its source at GR 505884 and where it joins Black Dog Creek in AR 5186?
16. What is the gradient of the Tyrol T-Bar, which has its base in AR 5189?
17. Construct the cross-section from point A (GR 4990) to point B (490875). Use a vertical scale of 1 cm = 200 m.
18. Calculate the vertical exaggeration of the cross-section you have constructed.
19. Study Figure 3.7a. In which direction was the camera facing when the photograph was taken?
20. Study Figures 3.7b and 3.7c. Locate the features labelled a to f on the map extracts.

Figure 3.7a Mount Buller in Victoria.

SCALE 1:30 0000

0 250 500 750 1,000 Metres

CONTOUR INTERVAL 20 METRES

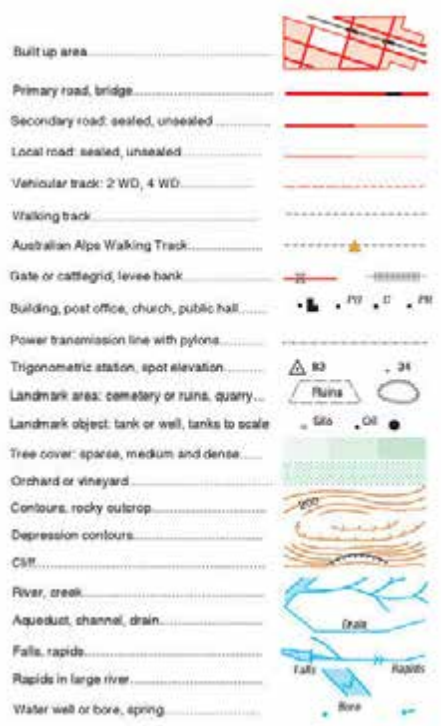


Figure 3.7b A view of Mount Buller from the north-east.

ISBN 978-1-139-77461-1

Mount Buller topographic map extract (Mount Buller: latitude 37°08´S, longitude 146°26´E)

Figure 3.7c A view of Mount Buller from the south.

ISBN 978-1-139-77461-1

3.8 Grampians (Vic.) topographic map extract

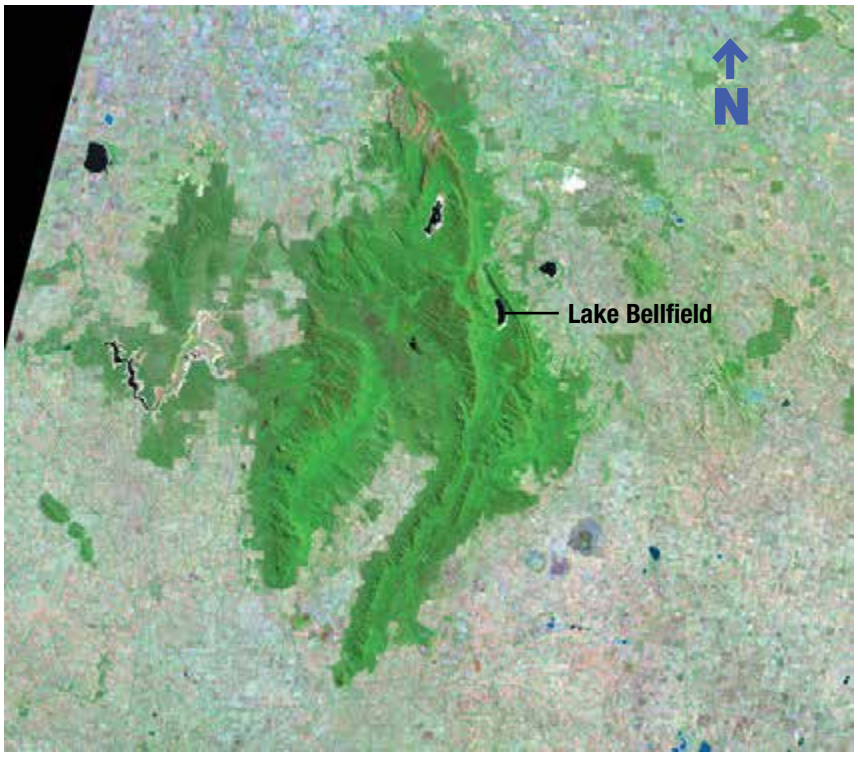
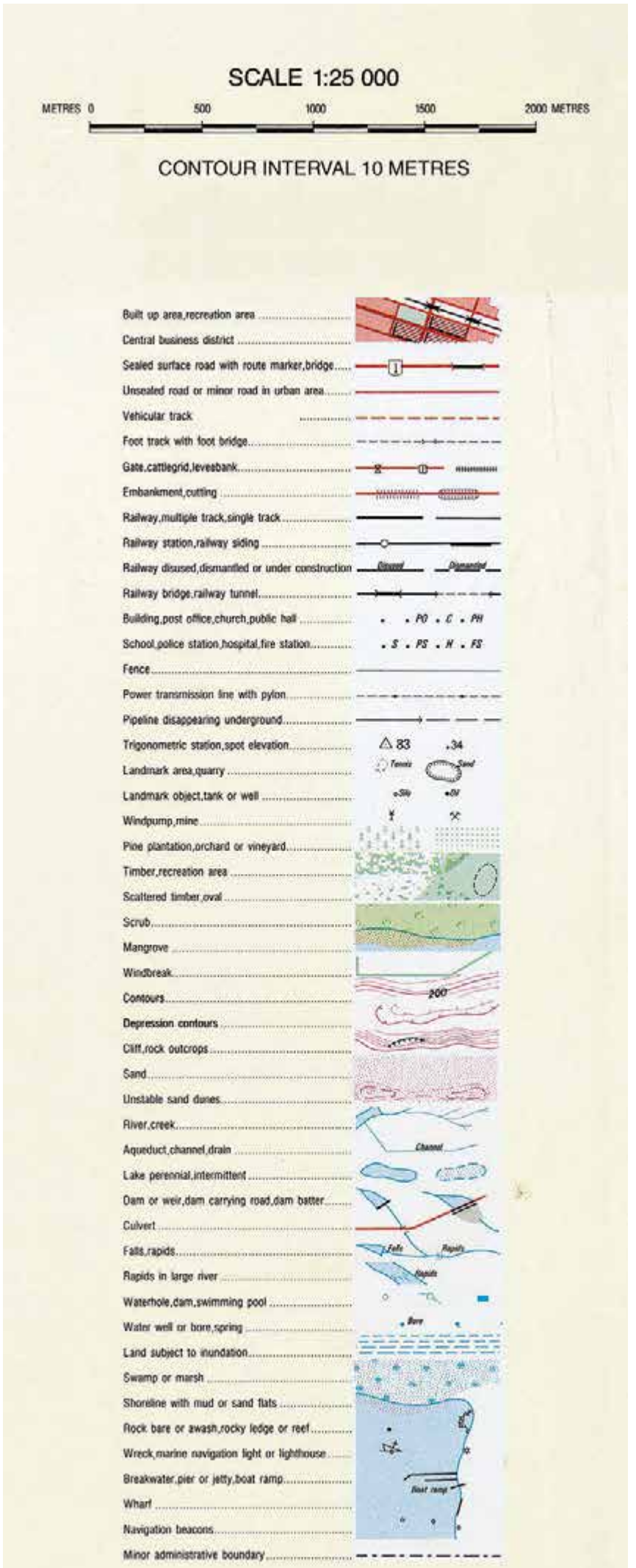


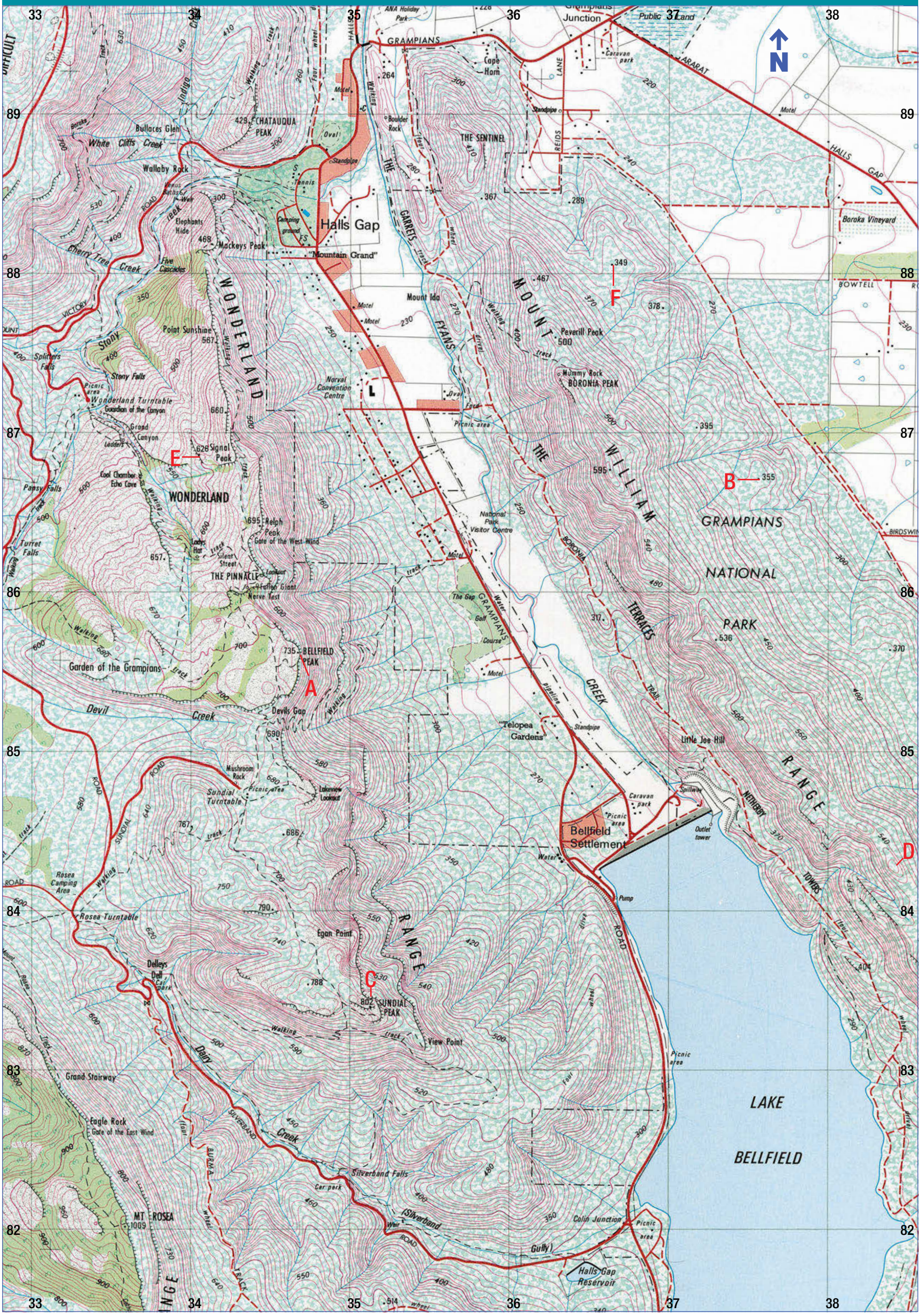
Figure 3.8a The Grampians rise from the plains of the Western and Wimmera districts of Victoria to a height of 1164 m. The area is popular with rock climbers and bushwalkers, who are attracted by the area's spectacular scenery - includes material © CNES 2007, Distribution Astrium Services/Spot Image S.A., France, all rights reserved.



ACTIVITIES

1. What is the scale of the map extract?
2. Study Figure 3.8a. Describe the land use in the area surrounding the Grampians National Park.
3. Identify the feature of the biophysical environment located at:
   - **a** GR 382840
   - **b** GR 336870
   - **c** GR 363876
   - **d** GR 350823
   - **e** GR 337867.
4. Identify the feature of the constructed environment located at:
   - **a** GR 373845
   - **b** GR 358855
   - **c** GR 364845
   - **d** GR 357863
   - **e** GR 383883.
5. What type of vegetation is found in AR 3584?
6. What type of commercial land use is found in AR 3589?
7. Name the feature of the constructed environment located 3 km north-west of Little Joe Hill (AR 3785).
8. In which direction does the creek flow in AR 3788?
9. What is the aspect of the slope in AR 3686?
10. What is the bearing of Sundial Peak (AR 3583) from Bellfield Peak (AR 3485)?
11. What is the length of the Lake Bellfield dam wall?
12. What is the height of Relph Peak (AR 3486)?
13. Estimate the elevation of the surface of Lake Bellfield.
14. Estimate the height of the landform feature at GR 345854.
15. What is the difference in elevation of Peverill Peak (AR 3687) and Bellfield Peak (AR 3485)?
16. Estimate the density of buildings in AR 3685.
17. Calculate the average gradient of the slope between Sundial Peak (AR 3583) and the shore of Lake Bellfield (GR 369825).
18. Construct the cross-section from point A (Bellfield Peak AR 3485) to point B (spot height AR 3786). Use a vertical scale of 1 cm = 250 m.
19. Calculate the vertical exaggeration of the cross-section that you constructed in Activity 18.
20. Construct the cross-section from point C (Sundial Peak GR 351834) to point D (GR 384843). Use a vertical scale of 1 cm = 200 m.
21. Calculate the vertical exaggeration of the cross-section that you constructed in Activity 20.
22. Construct the cross-section from point E (Signal Peak AR 3486) to point F (spot height GR 366881). Use a vertical scale of 1 cm = 40 m.
23. Calculate the vertical exaggeration of the cross-section that you constructed in Activity 22.
24. **a** List four land uses present on the map extract.
    b Locate two features of the built environment and two features of the physical environment on which one of these land uses depends.

Grampians topographic map extract (Halls Gap: latitude 37°08′S, longitude 142°31′E)



ISBN 978-1-139-77461-1

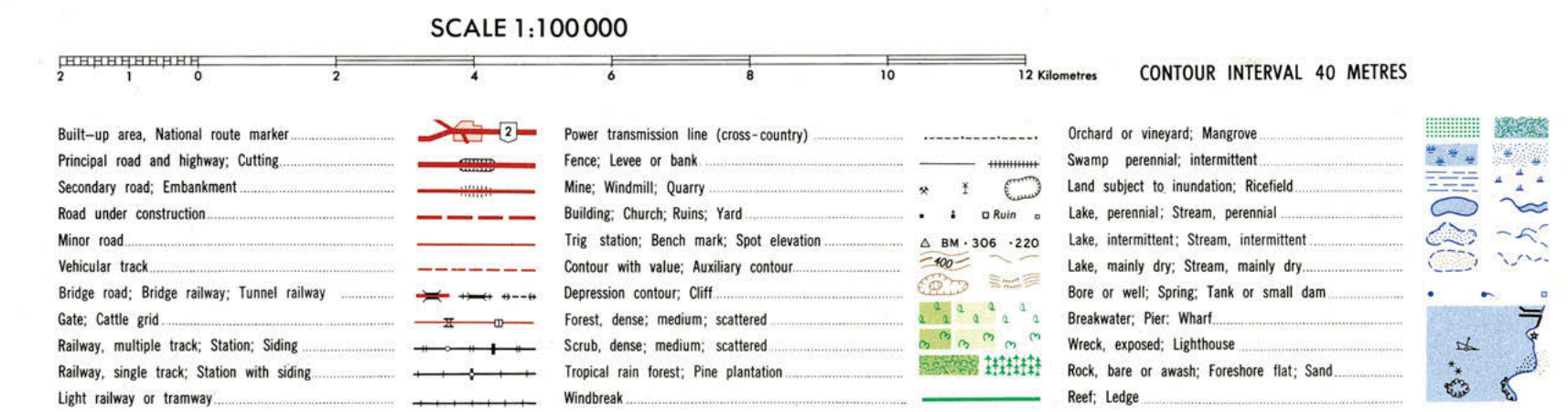
3.9 Lake Pedder (Tas.) topographic map extract

Figure 3.9a Lake Pedder before being flooded by the Lake Pedder Dam.

Figure 3.9b Lake Pedder after inundation.

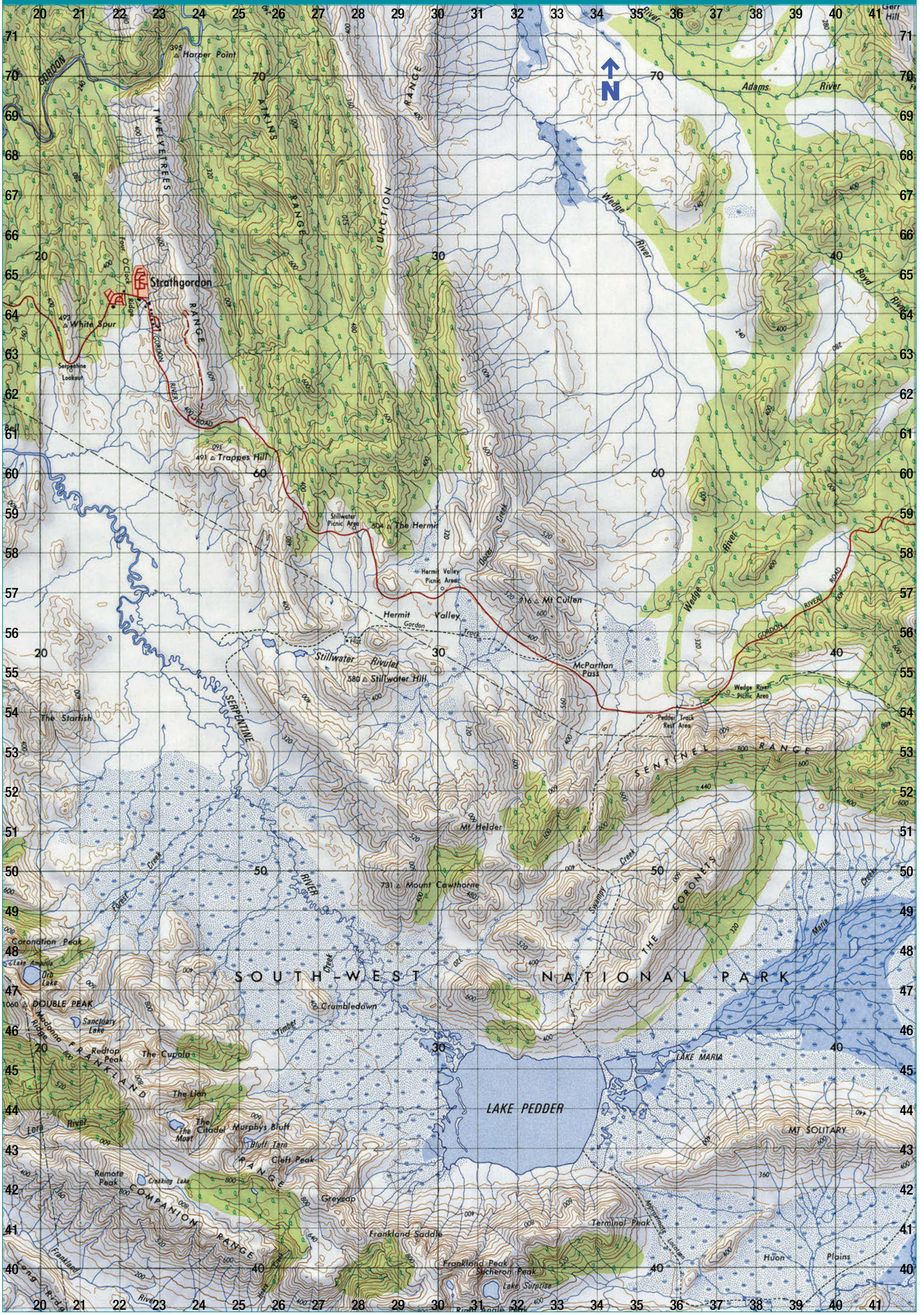
ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 325568
   - **b** GR 313394
   - **c** GR 290496
   - **d** GR 333552
   - **e** GR 252432.
4. Identify the feature of the constructed environment located at:
   - **a** GR 277558
   - **b** GR 207627
   - **c** GR 279586
   - **d** GR 373545.
5. Study Figure 3.9a. Construct a photo sketch and label the prominent features of the physical environment. In which direction was the camera facing when the photograph was taken?
6. Name the river into which the waters of Lake Pedder once flowed.
7. What type of vegetation is found in AR 2662?
8. What type of vegetation dominates the floodplain of the Serpentine River?
9. What type of vegetation is found in AR 4046?
10. What is the biophysical feature located in AR 2343?
11. In what direction does Maria Creek flow in AR 3948?
12. What is the direction of Mount Solitary (AR 3843) from Mount Helder (AR 3051)?
13. What is the aspect of the slope in AR 3046?
14. What is the bearing of Mount Helder (GR 305510) from the summit of Mount Solitary (GR 388435)?
15. Estimate the distance by road from Strathgordon (GR 225644) to the Wedge River Picnic Area (GR 373545).
16. Calculate the time it would take to ride a bike from Strathgordon (GR 225644) to the Wedge River Picnic Area (GR 373545) at an average speed of 10 km/h.
17. What is the area of Lake Pedder?
18. What is the height of the landform feature at GR 244604?
19. Estimate the height of Mount Solitary (AR 3843).
20. Estimate the height of the peak at GR 371504.
21. Estimate the height of the peak at GR 310470.
22. What is the difference in elevation of Mount Cawthorne (GR 290496) and Stillwater Hill (GR 282548)?
23. What is the local relief in AR 3256?
24. Calculate the gradient of the slope between the summit of Mount Solitary (GR 388435) and GR 388417.
25. Construct a cross-section from GR 228465 to Mount Cawthorne (GR 290496). Use a vertical scale of 1 cm = 200 m.
26. Calculate the vertical exaggeration of the cross-section that you constructed in Activity 25.
27. Construct a cross-section from GR 388400 to GR 388460. Use a vertical scale of 1 cm = 150 m.
28. Calculate the vertical exaggeration of the cross-section that you constructed in Activity 27.
29. What evidence is there that glaciation played a role in shaping the landscape in the south-west quadrant of the map extract?
30. The flooding of Lake Pedder was the source of a bitter debate between conservationists and those supporting an expansion of Tasmania's capacity to produce hydro-electricity. In recent years, conservationists have argued that the reservoir should be drained and the lake restored. Working in groups, compile a list of the arguments for and against such a proposal. Conduct a class debate. Topic: 'The Lake Pedder reservoir should be drained and the original lake restored'. Write an exposition outlining your view on the issue.



ISBN 978-1-139-77461-1

Lake Pedder topographic map extract before inundation (Strathgordon: latitude 42°46′S, longitude 146°03′E)



ISBN 978-1-139-77461-1

3.10 Lake St Clair (Tas.) topographic map extract

ACTIVITIES

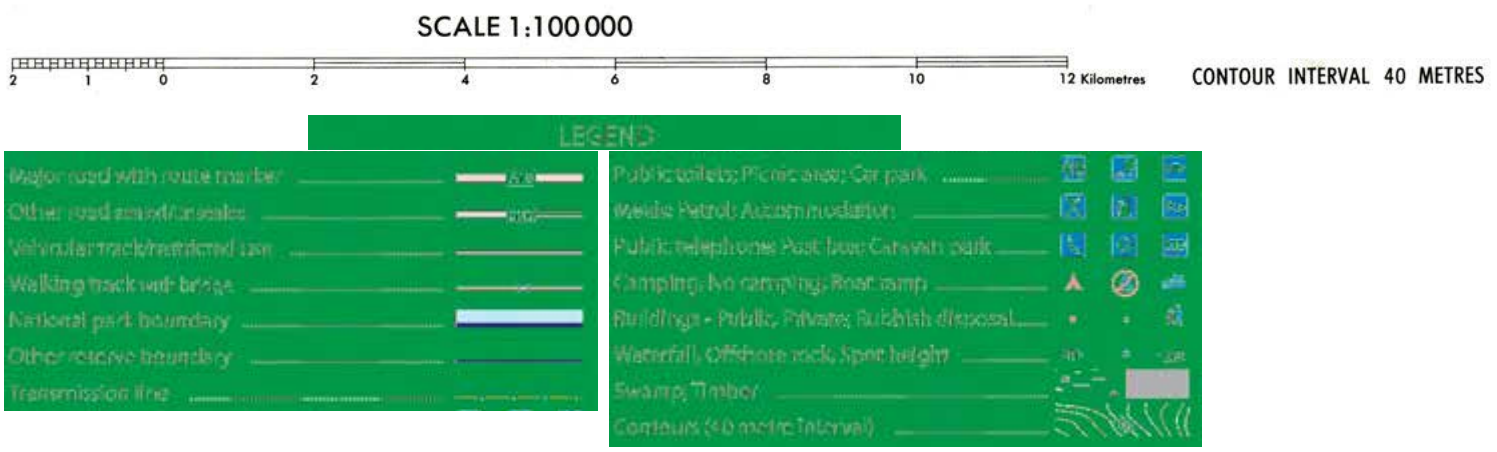
1. What is the scale of the map?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 189516
   - **b** GR 195541
   - **c** GR 272599
   - **d** GR 345390.
4. Identify the feature of the constructed environment located at:
   - **a** GR 254581
   - **b** GR 346384
   - **c** GR 254496
   - **d** GR 318370.
5. What type of landform features in AR 2246?
6. What type of vegetation is found at GR 230620?
7. What tributary joins Narcissus River at GR 251515?
8. What river flows from Lake Petrarach (GR 243439) to Lake St Clair in AR 3137?
9. What is the direction of flow of Hamilton Creek in AR 2148?
10. In what direction is the Alma River flowing in AR 1941?
11. What type of recreational activity is available in AR 2457?
12. What is the direction of Castle Crag (GR 251598) from Walled Mountain (AR 1856)?
13. What is the bearing of:
    - **a** Mt Ida (GR 3047) from Mount Gould (AR 2152).
    - **b** Mount Ossa (GR 198641) from Cathedral Mountain (GR 202623).
    - **c** Mount Spurling (GR 310525) from Lamonts Lookout (GR 250451)?
14. What is the aspect of the slope in:
    - **a** AR 2063
    - **b** AR 3041
    - **c** AR 2544
    - **d** AR 2745?
15. What is the straight-line distance between the summit of Mount Ossa (AR 1964) and Mount Byron (AR 2246)?
16. What is the length of the Lake St Clair ferry run from the jetty at GR 317372 to the jetty at Narcissus Bay (AR 2548)?
17. Estimate the area of Lake Meston in the north-east quadrant.
18. What is the elevation of:
    - **a** Lake Marion
    - **b** Lake St Clair
    - **c** Lake Helen (AR 2645)?
19. What is the elevation of the lake found on Gould Plateau?
20. What is the difference in elevation between Mount Olympus (GR 270448) and Mt Ida (GR 308478)?
21. What is the difference in elevation between Lake St Clair and Mount Byron?
22. Construct the cross-section between Mount Olympus (GR 270448) and Mt Ida (GR 308478).
23. Study the Table 3.10a and then answer the following questions:
    - **a** What is the average minimum temperature experienced?
    - **b** What are the wettest months at each station?
    - **c** What is the seasonal distribution of rainfall?
24. Estimate the local relief experienced in a traverse from the summit of Mount Olympus to the shores of Lake St Clair (GR 283455).
25. Construct the cross-section from the summit of Mount Olympus (GR 269447) to the summit of Mount Ida (GR 305475). Use a vertical scale of 1 cm = 250 m.
26. Calculate the vertical exaggeration of the cross-section that you constructed in activity 26.
27. Construct the cross-section from the peak at GR 243383 to the summit of Mount Rufus (GR 255358). Use a vertical scale of 1 cm = 250 m.
28. Calculate the vertical exaggeration of the cross-section that you constructed in activity 28.
29. Write a paragraph outlining why the area shown on the map extract is suited to the production of hydro-electricity.
30. Refer to Table 3.10a. Construct a Lake St Clair climate graph and complete the following tasks:
    - **a** Which month has the highest mean maximum temperature?
    - **b** Which month has the lowest mean minimum temperature?
    - **c** What is the annual range of mean daily maximum temperatures?
    - **d** Which month receives the highest mean rainfall?
    - **e** Which month receives the lowest mean rainfall?
    - **f** Describe the seasonal distribution of rainfall.

Lake St Clair is a lake in the central high-lands of Tasmania. It forms part of the Cradle Mountain–Lake St Clair National Park. It has an area of approximately 45 square km and a maximum depth of 200 m. This makes it Australia's deepest lake.

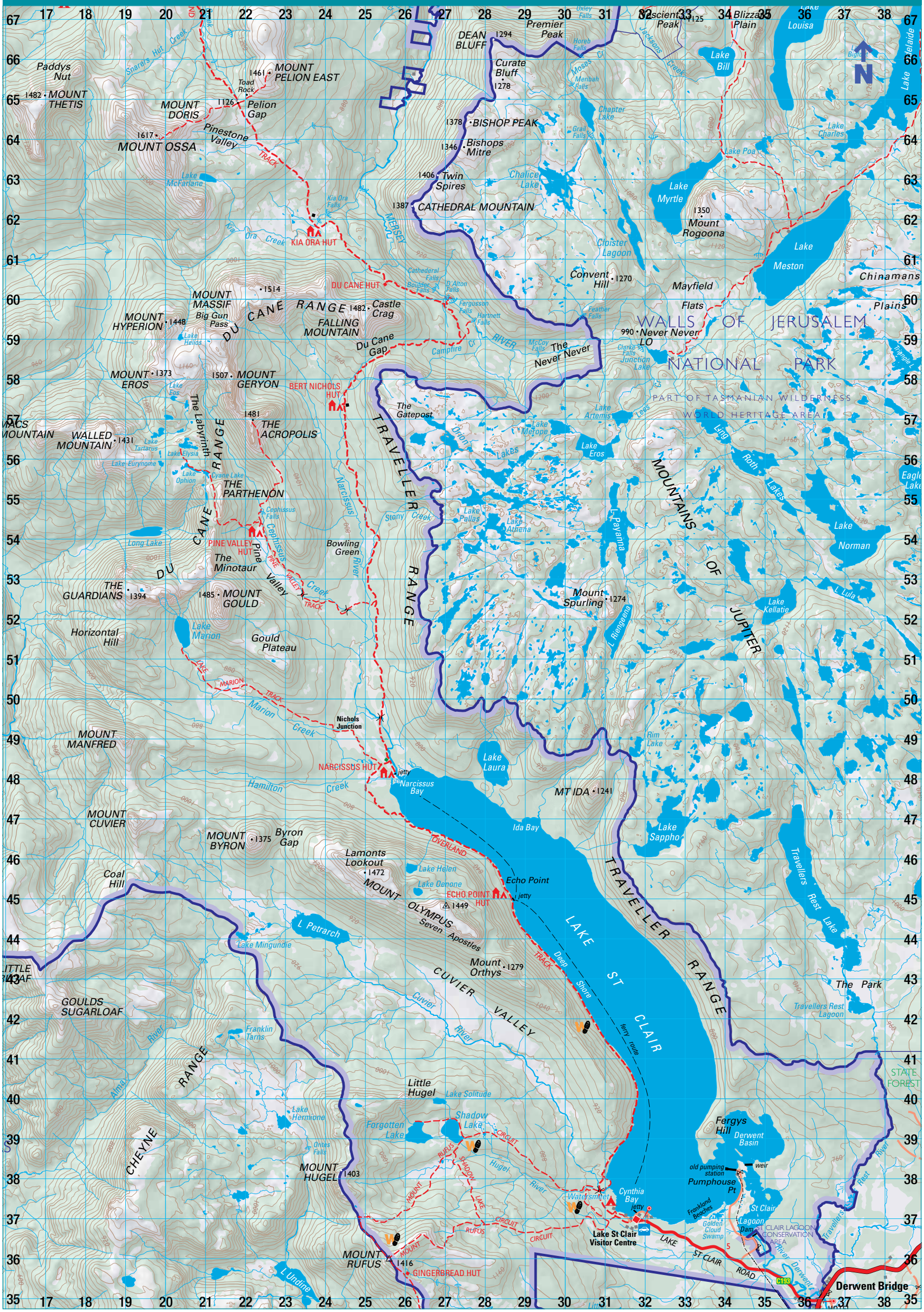
Figure 3.10a Lake St Clair in Tasmania.

Table 3.10a Climate data for Lake St Clair, elevation 735 m, latitude 42˚10′S, longitude 146˚22′E

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean min. temp. (C˚)	7.2	7.5	6.1	4.5	2.8	1.2	0.4	0.8	1.6	3.2	4.5	6.1	3.8
Mean max. temp. (C˚)	18.3	18.8	16.2	12.8	9.7	7.5	6.6	7.7	9.7	12.1	14.1	16.0	12.3
Mean rainfall (mm)	81	75	85	127	138	137	164	160	159	148	124	115	1511



Lake St Clair topographic map extract (Lake St Clair: latitude 42°10′S, longitude 146°22′E)



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3.11 Cradle Mountain (Tas.) topographic map extract

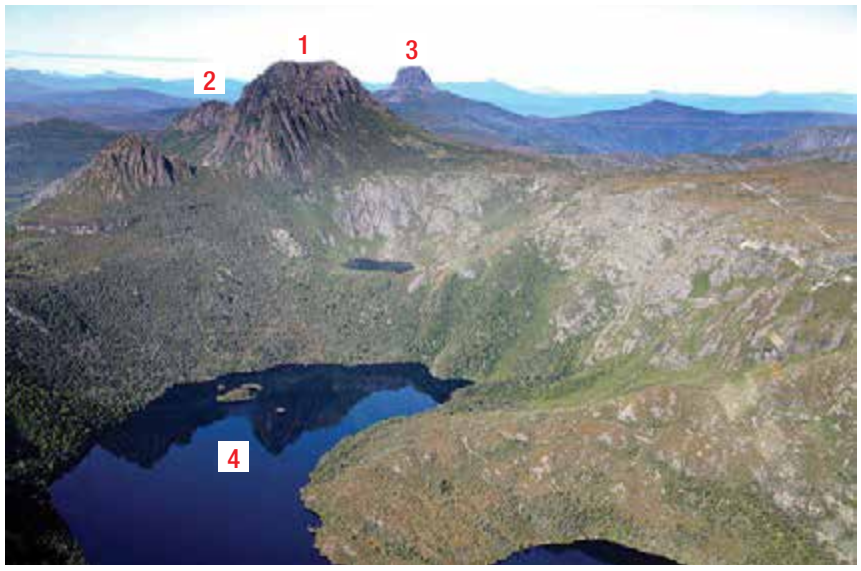


Figure 3.11a View of Cradle Mountain across Dove Lake.

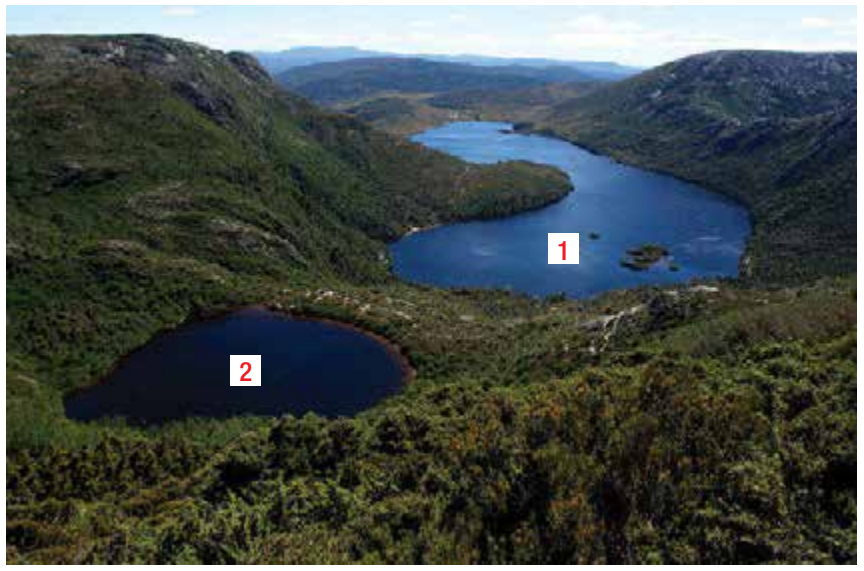


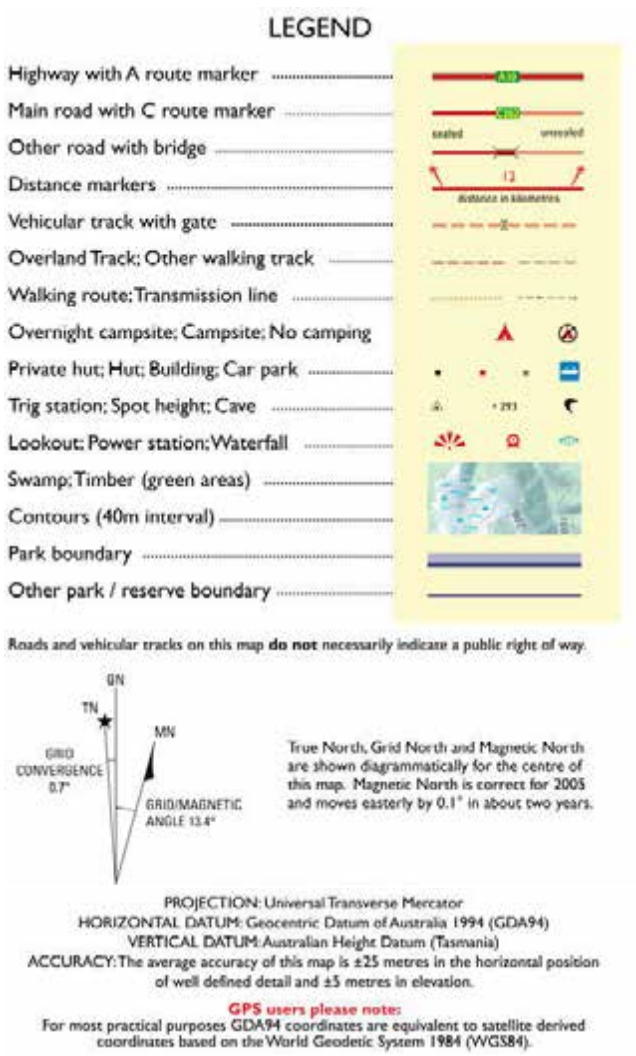
Figure 3.11b View from the slopes of Cradle Mountain.

Cradle Mountain is found in Tasmania's Cradle Mountain–Lake St Clair National Park. Rising to 1545 m above sea level, it is one of the principal tourist attractions in the state. Cradle Mountain is composed of dolerite columns of volcanic origin.

ACTIVITIES

1. What is the scale of the map?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   a. GR103849
   b. GR116886
   c. GR135879
   d. GR110873.
4. Identify the feature of the constructed environment located at:
   a. GR116902
   b. GR125885
   c. GR108875
   d. GR111895.
5. What is the grid reference of the Scout Hut in the north-west quadrant?
6. What type of landform is found at AR1284?
7. What is the type of vegetation found in:
   a. AR1088
   b. AR1189?
8. What type of recreational activity dominates in the area covered by the Cradle Mountain topographic map extract?
9. What is the direction of flow of Ronny Creek in AR1089?
10. What is the direction of Crater Lake from Dove Lake?
11. What is the direction of Suttons Tran from Lake Wilks?
12. What is the aspect of the slope in AR1388?
13. What is the straight-line distance between the summit of Cradle Mountain and Mount Campbell?
14. What is the bearing of Little Horn (AR1285) from Cradle Mountain (AR1184)?
15. Estimate the area of Dove Lake.
16. What is the difference in elevation between Cradle Mountain (AR1184) and Little Horn (AR1285)?
17. What is the elevation of:
    a. Lake Lilla
    b. Dove Lake?
18. What is the gradient of the slope from the summit of Little Horn and Glacier Rock (AR1288)?
19. What geomorphological processes are responsible for the landscape and landform features found on the Cradle Mountain topographic map extract?
20. Identify the features numbered 1–4 in Figure 3.11a.
21. In what direction was the camera pointing when the photograph was taken?
22. Identify the features numbered 1–2 in Figure 3.11b.
23. In what direction was the camera pointing when the photograph was taken?
24. What is the grid reference of the boatshed shown in Figure 3.11c?
25. Construct a photosketch of Figure 3.11c. Label the features of the biophysical environment.

Figure 3.11c View of Cradle Mountain across Dove Lake.



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Cradle Mountain topographic map extract (Cradle Moutain: latitude 41˚65´S, longitude 145˚94´E)

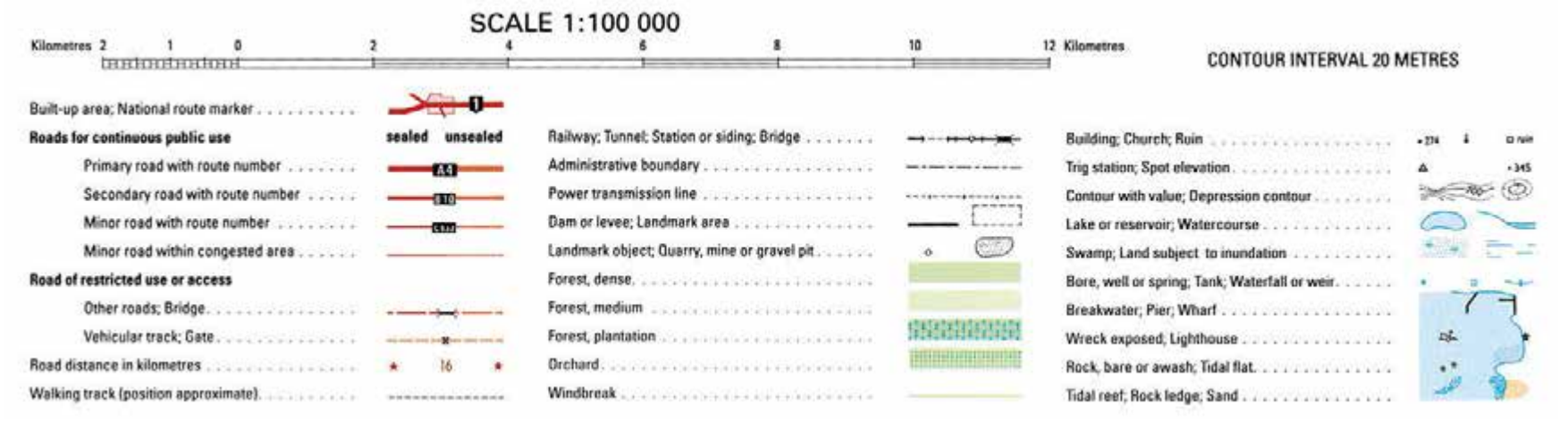
ISBN 978-1-139-77461-1

3.12 Tamar (Tas.) topographic map extract

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 820550
   - **b** GR 884448
   - **c** GR 848566
   - **d** GR 806319.
4. Identify the feature of the constructed environment located at:
   - **a** GR 960502
   - **b** GR 928369
   - **c** GR 940426
   - **d** GR 917463
   - **e** GR 917453.
5. What is the area reference of Batman Bridge?
6. What creek flows into Port Dalrymple at GR 847417?
7. What type of vegetation is found in AR 8531?
8. What type of land use is centred on GR 890470 and shown in Figure 3.12a?
9. What type of land use is found in AR 9857?
10. Name the physical feature found in AR 9736.
11. What is the direction of the Curries River Dam from George Town?
12. In which direction is Curries River flowing in AR 9652?
13. Identify the feature of the physical environment located 4.5 km to the south-east of Hebe Reef (AR 7755).
14. What is the aspect of the slope in AR 8635?
15. What is the bearing of Egg Island (GR 971343) from Peaked Hill (GR 833341)?
16. What is the straight-line distance between Kelso Bay (GR 824490) and George Town (GR 855493)?
17. Estimate the distance by road from Kelso Bay (GR 824490) to George Town (GR 855493) via West Arm Road and the West Tamar, Batman and East Tamar Highways.
18. Calculate the time it would take to travel from Kelso Bay (GR 824490) to George Town (GR 855493) via West Arm Road and the West Tamar, Batman and East Tamar highways at an average speed of 90 km/h.
19. Estimate the area of the lake formed by the Curries River Dam (GR 960502).
20. Estimate the density of buildings in AR 9042.
21. Estimate the height of the landform feature at GR 879517.
22. Estimate the height of the landform feature at GR 951463.
23. Estimate the height of Sea Hill (GR 794497).
24. What is the difference in elevation of Mount George (AR 8949) and George Town SL (AR 8951)?
25. Estimate the local relief experienced on a traverse from the summit of Murphys Hill (GR 976362) to the banks of the Tamar River (GR 970348).
26. Calculate the average gradient of the traverse described in Activity 25.
27. Estimate the local relief in AR 9844.
28. Calculate the average gradient of the slope between GR 951463 and GR 929440.
29. Construct a precis map showing the relationship between topography and transport.
30. Construct a photo sketch of Figure 3.12a. Label the prominent features of the physical and built environments.

Figure 3.12a Bell Bay Comalco Aluminium Smelter. This is in the area centred on GR 890470 on the Tamar topographic map extract opposite.



Tamar topographic map extract (George Town: latitude 41°06′S, longitude 146°49′E)

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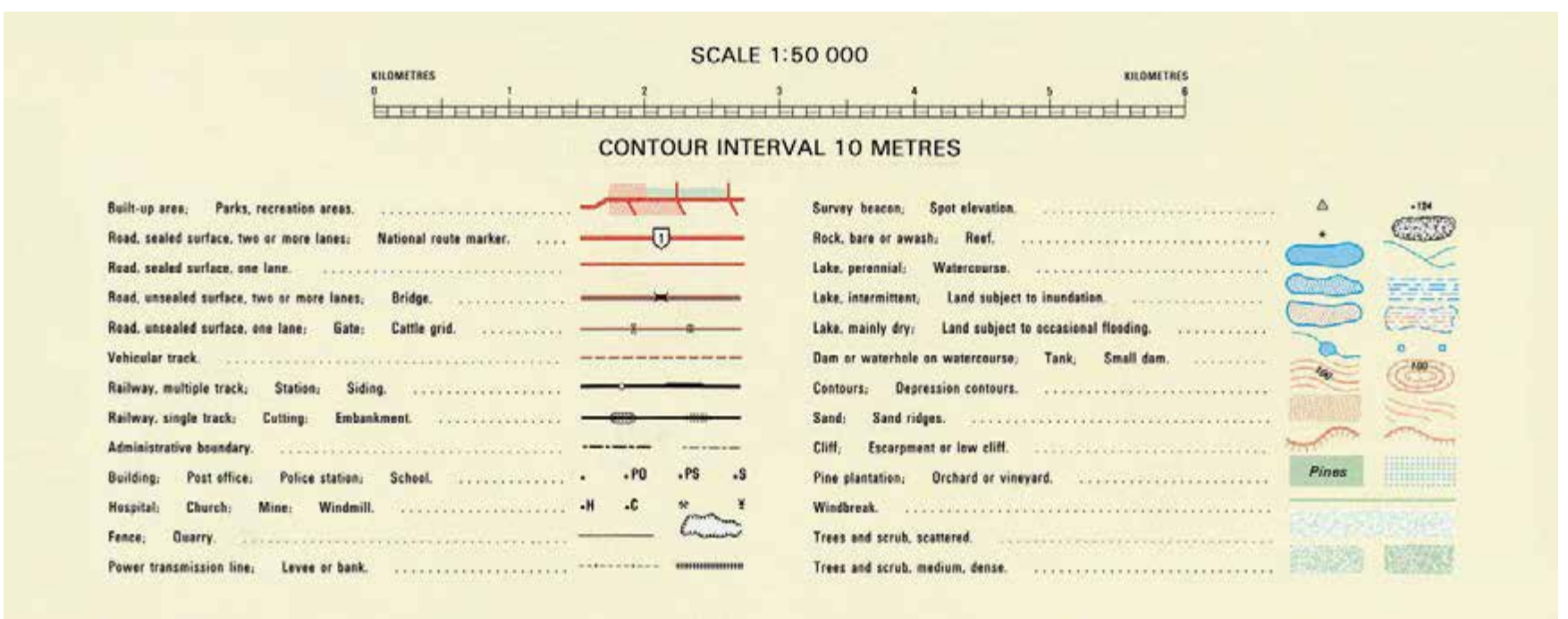
3.13 Barossa Valley (SA) topographic map extract

Figure 3.13a Barossa Valley vineyards.

Figure 3.13b Grapes ready for harvest.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 147702
   - **b** GR 127663
   - **c** GR 110664
   - **d** GR 093688.
4. Identify the feature of the constructed environment located at:
   - **a** GR 100715
   - **b** GR 121728
   - **c** GR 108658
   - **d** GR 071688
   - **e** GR 085714.
5. What waterway flows into the Gawler River at GR 116768?
6. What type of vegetation is found in AR 0870?
7. What type of vegetation is found in AR 1476?
8. What type of land use is found in AR 0968?
9. Name the physical feature found in AR 0867.
10. What is the standard of road linking GR 134664 and GR 150658?
11. What is the direction of Tanunda from Lyndoch?
12. In which direction is the North Para or Gawler River flowing in AR 0972?
13. Identify the feature of the built environment located 3.5 km to the south of the intersection at GR 116768.
14. What is the aspect of the slope in AR 1271?
15. What is the bearing of Pewsey Vale Peak (GR 127663) from the Orlando Winery (GR 100714)?
16. What is the straight-line distance between Lyndoch railway station (GR 064686) and Tanunda railway station (GR 128774)?
17. Estimate the distance by rail from Lyndoch railway station (GR 064686) to Tanunda railway station (GR 128774).
18. Calculate the time it would take to travel from Lyndoch railway station (GR 064686) to Tanunda railway station (GR 128774) at an average speed of 60 km/h.
19. Estimate the area of the golf course centred on GR 095737.
20. What is the density of buildings in AR 0872?
21. What is the density of buildings in AR 1467?
22. What is the height of the landform feature at GR 090660?
23. Estimate the height of McLaren Hill (GR 090689).
24. What is the difference in elevation of Pewsey Vale Peak (AR 1266) and the shed at GR 152657?
25. Estimate the local relief experienced on a traverse from GR 077667 to GR 084651.
26. Estimate the local relief in AR 1372.
27. Calculate the gradient of the slope between the spot height at GR 135722 and GR 130729.
28. What is the gauge of the railway line linking Lyndoch and Tanunda?
29. Name the settlement pattern evident in AR 1373.
30. Name the settlement pattern found in the north-west quadrant of the map extract.
31. Undertake library research. Account for the large number of German place names in the Barossa Valley.



Barossa Valley topographic map extract (Tanunda: latitude 34°34′S, longitude 138°56′E)

ISBN 978-1-139-77461-1

3.14 Port Hedland (WA) topographic map extract

ACTIVITIES

1 Study the Pilbara Region map (Figure 3.14a) and complete the following tasks:
- **a** What is the direction of Newman from Port Hedland?
- **b** Estimate the straight-line distance between Port Hedland and Newman.
- **c** What is the distance by rail between Port Hedland and Newman?
- **d** How long would it take an ore train travelling at an average speed of 30 km/h to travel from Port Hedland to Newman?
- **e** What evidence is there that the Pilbara Region has low rainfall?
- **f** What mineral is mined at Newman?

2 Study the Newman topographic map extract (Figure 3.14b) and complete the following activities:
- **a** Identify the feature of the constructed environment located at:
  - **i** GR 801157
  - **ii** GR 799144
  - **iii** GR 760144
  - **iv** GR 740162.
- **b** What creek passes under the railway bridge at GR 792163?
- **c** What type of land use is found in AR 7713?
- **d** List the recreational facilities available to the people of Newman.
- **e** In which direction does Whaleback Creek flow in AR 7715?
- **f** What is the height of the landform feature at GR 787113?
- **g** What is the bearing of the cemetery (AR 8012) from the church (GR 788144)?
- **h** Undertake research. Find out who operates the Newman mine. Where is its ore sold? How profitable is this activity? How many people does the mine employ? How long is the mine expected to operate?

3 Study the Port Hedland topographic map extract opposite and then complete the following activities:
- **a** Identify the feature of the biophysical environment located at:
  - **i** GR 712545
  - **ii** GR 592538.
- **b** Identify the feature of the constructed environment located at:
  - **i** GR 659519
  - **ii** GR 655530
  - **iii** GR 645523
  - **iv** GR 702453.
- **c** Name four creeks flowing into the estuary containing Port Hedland's port facilities.
- **d** What type of land use is found in AR 7148?
- **e** What direction is Finucane Island wharf (AR 6353) from Port Hedland International Airport?
- **f** Estimate the area of the brine pond in the north-east quadrant of the map extract.
- **g** What is the density of buildings in AR 7642?

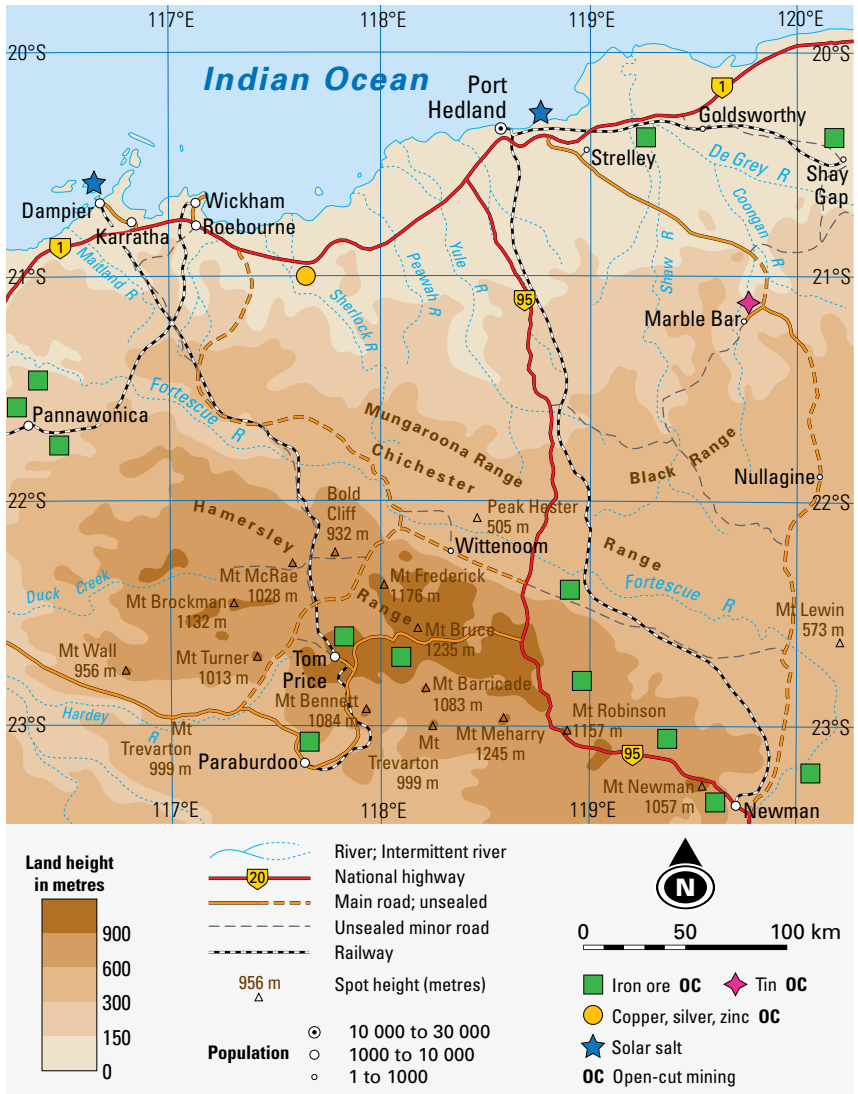


Figure 3.14a The Pilbara Region in WA.

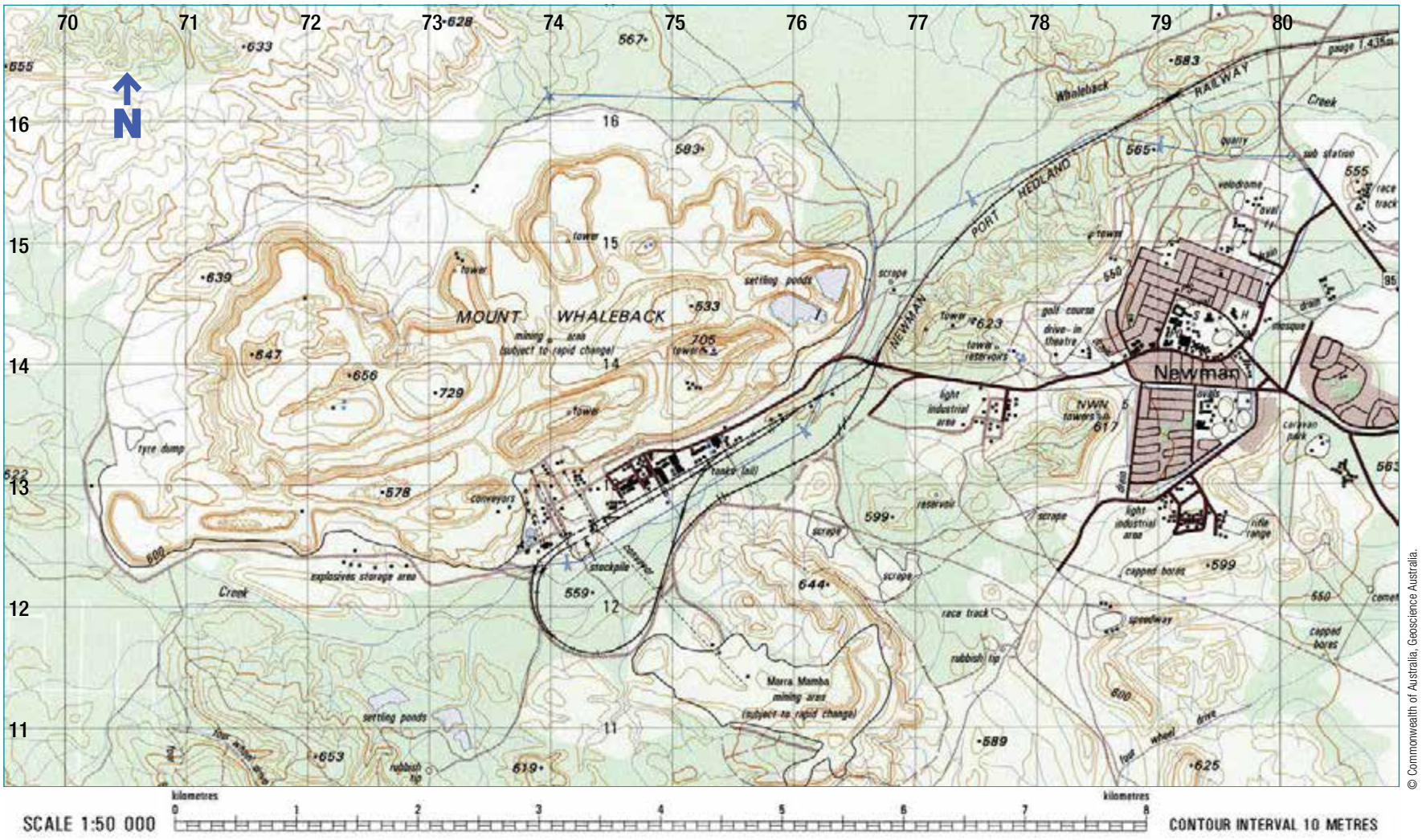


Figure 3.14b Newman topographical map extract.

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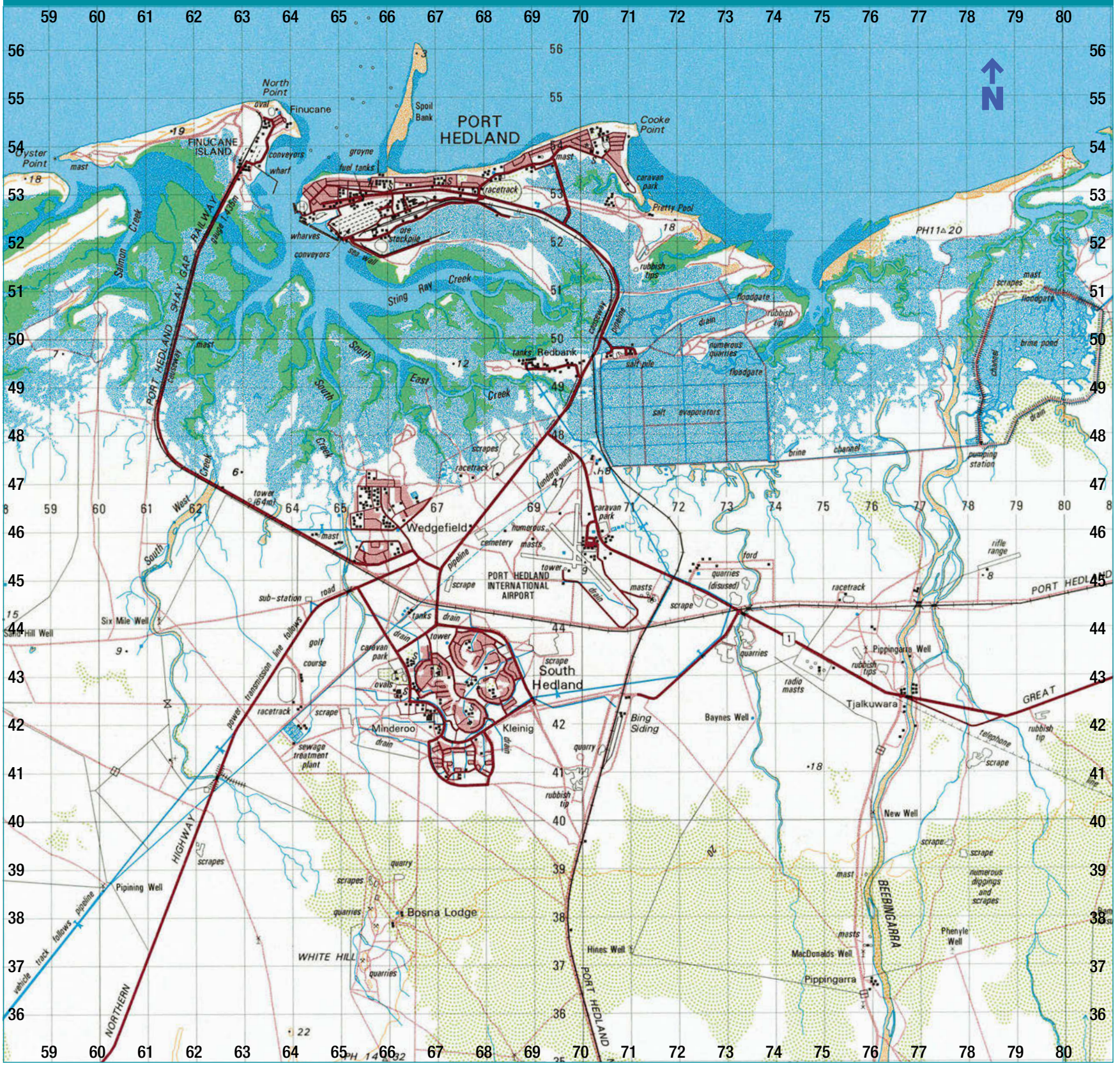
Port Hedland topographic map extract (Port Hedland: latitude 20°18′S, longitude 118°35′E)



ISBN 978-1-139-77461-1

3.15 Daintree (Qld) topographic map extract

ACTIVITIES

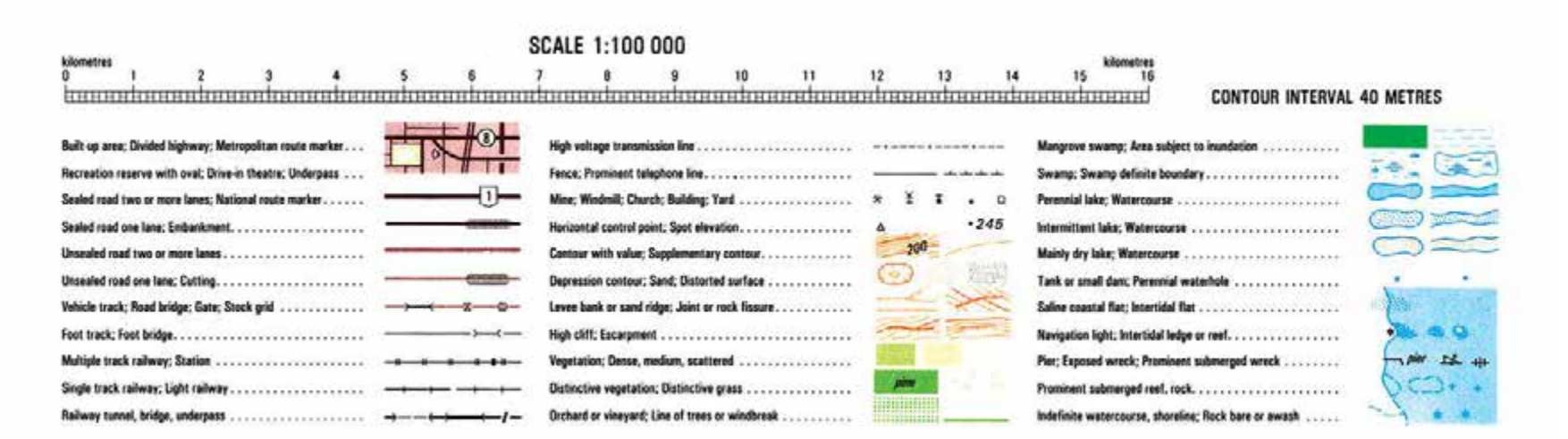
1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 382033
   - **b** GR 383997
   - **c** GR 357978
   - **d** GR 255835.
4. Identify the feature of the constructed environment located at:
   - **a** GR 287016
   - **b** GR 289036
   - **c** GR 251829
   - **d** GR 309875.
5. What river flows into the sea at GR 298823?
6. What type of vegetation is found in:
   - **a** AR 2495
   - **b** AR 3197?
7. What type of land use is found in AR 2589?
8. What is the biophysical feature found in AR 3285?
9. What is the direction of Snapper Island (GR 395975) from Dayman Point (GR 310873)?
10. In which direction is the Mossman River flowing in AR 2178?
11. Estimate the width of the Daintree River in AR 3399.
12. Identify the feature of the built environment located 8.2 km to the north-west of Port Douglas (GR 360770).
13. What is the bearing of Morey Reef (GR 350778) from Dayman Point (GR 310873)?
14. What is the length of the landing ground located to the north of the Daintree River?
15. Estimate the distance by road from Dayman Point (GR 310873) to the intersection at GR 267988.
16. Calculate the time it would take to travel from Dayman Point (GR 310873) to the intersection at GR 267988 at an average speed of 60 km/h.
17. Estimate the density of buildings in AR 2484.
18. What is the settlement pattern in AR 3092?
19. What is the difference in elevation of Mount Somerset (GR 255835) and Mount Beaufort (GR 280795)?
20. What is the local relief experienced on a traverse from the summit of Mount Somerset (GR 255835) to Mount Beaufort (GR 280795)?
21. Construct the vegetation transect from GR 200970 to GR 337970.
22. Construct a precis map showing the pattern of vegetation on the map extract.
23. Describe the nature of the coastline in the area between Port Douglas and the Port of Mossman.
24. Study Figure 3.15a and complete the following tasks:
    - **a** What type of photograph is featured?
    - **b** In what direction was the camera facing when the photograph was taken?
    - **c** Construct an annotated photo sketch of Port Douglas.
25. What evidence is there that the Daintree River has changed its course?
26. Working in groups, brainstorm the attractions of the physical environment that make the Daintree area popular with ecotourists.
27. Use Table 3.15a to construct a climate graph for Port Douglas. Then complete the following tasks:
    - **a** Which is the hottest month?
    - **b** Which is the coolest month?
    - **c** What is the average annual range of mean daily maximum temperatures?
    - **d** Which is the wettest month?
    - **e** Which is the driest month?
    - **f** Describe the seasonal distribution of rainfall.
    - **g** Construct a column graph showing the annual distribution of raindays.

Table 3.15a Climate data for Port Douglas: elevation 4 m, latitude 16˚48´S, longitude 145˚47´E

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean min. temp. (C˚)	23.7	23.5	22.8	21.5	19.5	17.7	16.8	17.1	18.6	20.8	22.3	23.3	20.6
Mean max. temp. (C˚)	30.3	30.1	29.5	28.3	26.7	25.1	24.6	25.3	26.7	28.3	29.5	30.3	27.9
Mean rainfall (mm)	396	421	428	205	72	48	26	24	32	47	105	204	2008
Mean number of raindays	15.7	15.8	16.4	13.5	9.9	7.1	5.4	5.2	5.2	6.1	8.7	11.5	120.4

Figure 3.15a Port Douglas in Queensland.

Figure 3.15b Ecotourists in the Daintree in Queensland.



Daintree topographic map extract (Port Douglas: latitude 16˚48′S, longitude 145˚47′E)

ISBN 978-1-139-77461-1

3.16 Noosa (Qld) topographic map extract

Figure 3.16a Aerial photograph of Noosa Heads, 1971.

Figure 3.16b Aerial photograph of Noosa Heads, 1996.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 118808
   - **b** GR 072798
   - **c** GR 104816
   - **d** GR 115804.
4. Identify the feature of the constructed environment located at:
   - **a** GR 079819
   - **b** GR 041804
   - **c** GR 088783
   - **d** GR 053836.
5. Use the map extract to identify the features labelled a to e in Figure 3.16b.
6. What river flows into Lake Cooroibah in AR 0386?
7. What type of vegetation is found in AR 0187?
8. What type of land use is found in GR 056787?
9. Name the recreational land use found in AR 0180.
10. What is the direction of Lake Weyba from Noosa Head (GR 118821)?
11. In which direction is the Noosa River flowing in AR 0387?
12. Identify the feature of the biophysical environment located 6.5 km to the north-west of Keuser Island (AR 0779).
13. What is the bearing of Noosa Hill (GR 104816) from the drive-in theatre (GR 049789)?
14. What is the straight-line distance between Noosa Hill and Seawah Hill (GR 066958)?
15. What is the area of Lake Weyba?
16. Estimate the density of buildings in AR 0479.
17. Estimate the height of the landform feature at GR 065955.
18. Estimate the local relief in AR 0695.
19. Construct the vegetation transect from GR 000880 to GR 062880.
20. What indications are there that much of the land around Noosa Heads is low lying?
21. Study the map extract and the aerial photographs of Noosa Heads in 1971 and 1996 (Figures 3.16a and 3.16b). Write a report describing the effects of human activity on the estuary of the Noosa River.
22. Working in groups, compile a list of the benefits of the type of human intervention described in Activity 21. List the possible environmental costs associated with this type of intervention. Share the findings of your group's discussions with the rest of the class. Take a vote to see whether such environmental impacts are justified.
23. Describe the nature of the coastal environment between Peregian Beach (AR 0971) and Teewah (AR 0693).

Hypothetical: you be the judge

An Indonesian-owned transnational corporation has submitted a development application for a large resort complex in the area between the Noosa River and Lake Cooraibah. When completed the complex will house a 400-room, five-star hotel and convention centre, a casino, a Greg Norman–designed 18-hole golf course, 1000 apartments and 300 detached dwellings lining the Noosa River. The resort will be linked to Noosa by a new four-lane bridge.

The land is currently unoccupied. It is covered by coastal eucalypt forest and mangrove wetlands. Some of the area is subject to inundation following periods of above-average rainfall. The local Aboriginal community says that the area contains a number of sacred sites.

The development application has divided the Noosa community. The pro-development council is keen for the resort to go ahead. A number of councillors stand to benefit financially from additional economic activity that the resort's construction will generate. Local conservationists are outraged by the proposal. Others fear that the lifestyle that attracted them to the area will be spoilt by the influx of 2000 additional residents and up to 2000 additional tourists.

ACTIVITIES

1. Working in groups, use the map extract and aerial photographs to evaluate the site's suitability for the proposed development.
2. Working in the same groups, brainstorm the arguments for and against the proposed development. Share the points raised in your group's discussion with the rest of the class.
3. As a class, debate the statement: 'The Noosa Shire Council should approve the development application'. At the end of the debate, conduct a secret ballot to determine whether the class will recommend that the development should proceed.
4. Determine which point of view you agree with. Write an exposition outlining the arguments you would use to justify your position.
5. In groups of four to five students, brainstorm the strategies or methods you could use to influence public opinion and the local council's decision-making processes. Share your group's list with the rest of the class.
6. As a class, role-play one of the methods or strategies identified in Activity 5.

Noosa topographic map extract (Noosa Heads: latitude 26˚23′S, longitude 153˚06′E)

Figure 3.16c Aerial photograph of Noosa Heads.

SCALE 1:100 000

kilometres 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 kilometres

CONTOUR INTERVAL 20 METRES

Built-up area; Divided highway; Metropolitan route marker
Recreation reserve with oval; Drive-in theatre; Underpass
Sealed road two or more lanes; National route marker
Sealed road one lane; Embankment
Unsealed road two or more lanes
Unsealed road one lane; Cutting
Vehicle track; Road bridge; Gate; Stock grid
Foot track; Foot bridge
Multiple track railway; Station
Single track railway; Light railway
Railway tunnel, bridge, underpass

High voltage transmission line
Fence; Prominent telephone line
Mine; Windmill; Church; Building; Yard
Horizontal control point; Spot elevation
Contour with value; Supplementary contour
Depression contour; Sand; Distorted surface
Levee, bank or sand ridge; Joint or rock fissure
High cliff; Escarpment
Vegetation; Dense, medium, scattered
Vegetation distinctive; Distinctive grass
Orchard or vineyard; Line of trees or windbreak

Mangrove swamp; Area subject to inundation
Swamp; Swamp definite boundary
Perennial lake; Watercourse
Intermittent lake; Watercourse
Mainly dry lake; Watercourse
Tank or small dam; Perennial waterhole
Saline coastal flat; Intertidal flat
Navigation light; Intertidal ledge or reef
Pier; Exposed wreck; Prominent submerged wreck
Prominent submerged reef, rock
Indefinite watercourse, shoreline; Rock bare or awash

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3.17 Cairns (Qld) topographic map extract

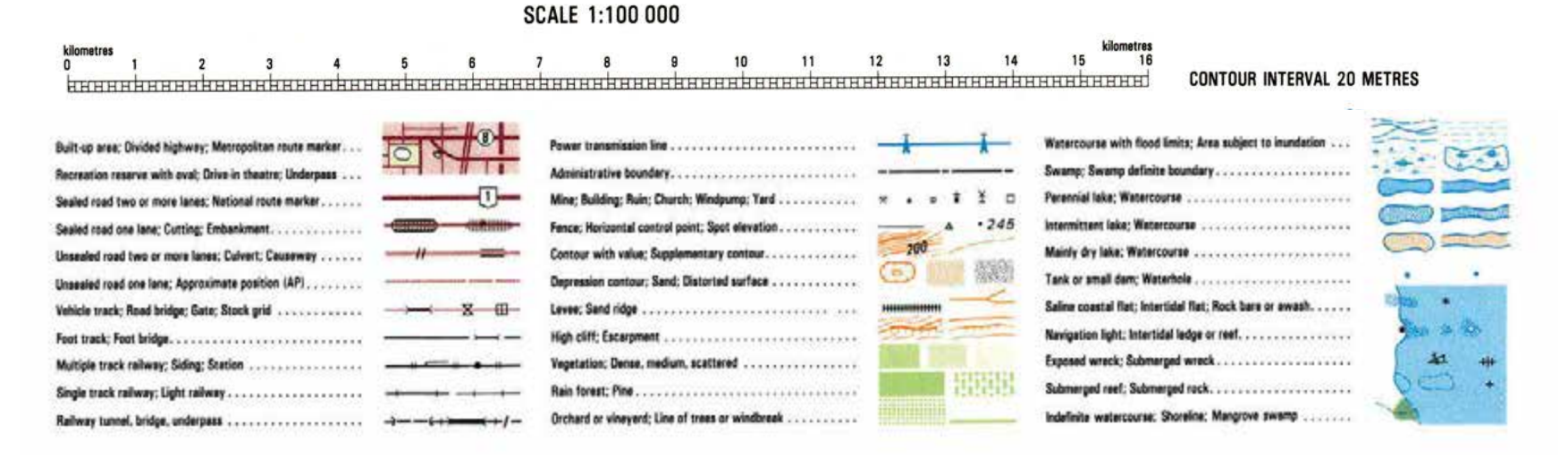
ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - a GR 553383
   - b GR 599503
   - c GR 608448
   - d GR 568270.
4. Identify the feature of the constructed environment located at:
   - a GR 558362
   - b GR 690211
   - c GR 671226
   - d GR 583466.
5. Study the satellite image of Cairns and surrounding area (Figure 3.17a) and complete the following tasks:
   - a Identify the features numbered 1–8.
   - b Describe the site of Cairns.
   - c What restricts the expansion of Cairns to the south-east and west?
   - d Describe the relationship between vegetation and topography.
   - e How do we know that there are crops in various stages of the growth cycle in the agricultural areas surrounding Cairns?
6. What river flows into the sea at AR 6834?
7. What type of vegetation is found in AR 7222?
8. What type of land use is found in AR 6139?
9. Name the biophysical feature found in AR 6142.
10. What is the direction of Yorkeys Knob (AR 6341) from Palm Cove (AR 5847)?
11. In which direction is the Barron River flowing in AR 6134?
12. What is the aspect of the slope in AR 6127?
13. What is the bearing of Taylor Point (GR 608448) from Yorkeys Point (GR 637418)?
14. What is the straight-line distance between Haycock Island (GR 608496) and the summit of Earl Hill (GR 613426)?
15. What is the length of the main runway at Cairns Airport (GR 666328)?
16. Estimate the distance by road from Cairns Airport (GR 666328) to Palm Cove (GR 583478).
17. Calculate the time it would take to travel from Cairns Airport (GR 666328) to Palm Cove (GR 583478) at an average speed of 60 km/h.
18. Estimate the area of Admiralty Island.
19. What is the height of the landform feature at GR 748281?
20. What is the difference in elevation of Earl Hill (GR 613426) and Red Peak (GR 581365)?
21. Estimate the local relief in AR 6142.
22. Calculate the gradient of the slope between the spot height at GR 748281 and the building at GR 745267.
23. What is the type of settlement pattern found in AR 6828?
24. What is the gauge of the railway passing through the Barron Gorge?
25. Construct a precis map showing the relationship between landform, settlement and transport infrastructure in the area shown in the map extract.

Figure 3.17a Satellite image of Cairns and surrounding area.

Figure 3.17b Cairns central business district.

Figure 3.17c Outskirts of township of Cairns.



Cairns topographic map extract (Cairns: latitude 16°55′S, longitude 145°46′E)

ISBN 978-1-139-77461-1

3.18 Uluṟu (NT) topographic map extract

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. What is the Aboriginal name for the Olgas?
4. Identify the feature of the biophysical environment located at:
   a. GR 750002
   b. GR 039957.
5. Identify the feature of the constructed environment located at:
   a. GR 032935
   b. GR 005077
   c. GR 755014
   d. GR 989029.
6. What type of vegetation cover is found in the area covered by the map extract?
7. What type of land use is centred on GR 000070?
8. What is the direction of Voyages Sails in the Desert hotel from Uluṟu (Ayers Rock)?
9. Identify the feature of the built environment located 10 km to the north of the Entrance station (AR 9802).
10. What is the aspect of the slope in AR 0595?
11. What is the bearing of the summit of Uluṟu (GR 045952) from the Sunset Viewing Area at GR 008972?
12. What is the length of the runway at Ayers Rock Airport?
13. What is the straight-line distance between the summit of Uluṟu (GR 045952) and the Voyages Ayers Rock Resort (GR 004073)?
14. Estimate the distance by road from Ayers Rock Airport (GR 988124) to the intersection at GR 039941.
15. Calculate the time it would take to travel from Ayers Rock Airport (GR 988124) to the Voyages Sails in the Desert hotel (GR 004070) at an average speed of 60 km/h.
16. Estimate the area of Uluṟu.
17. Estimate the density of buildings in AR 0794.
18. What is the height of Uluṟu?
19. What is the height of Mount Olga (GR 750002)?
20. What is the difference in elevation of Uluṟu and Mount Olga?
21. What is the local relief in AR 0495?
22. Calculate the gradient of the slope between GR 750002 and GR 736999.
23. Study the inset map of Uluṟu and complete the following tasks:
   a. Construct the cross-section from point A to point B.
   b. Construct the cross-section from point C to point D.
24. Calculate the vertical exaggeration of the cross-sections you drew in Activity 23.
25. Name the drainage pattern evident in the area occupied by Kata Tjuṯa.
26. Study Figures 3.18a–c. Construct a photo sketch of at least one of these photographs.
27. Study Figure 3.18d and the topographic map extract. What land use change has occurred in the vicinity of Uluṟu since 1985?

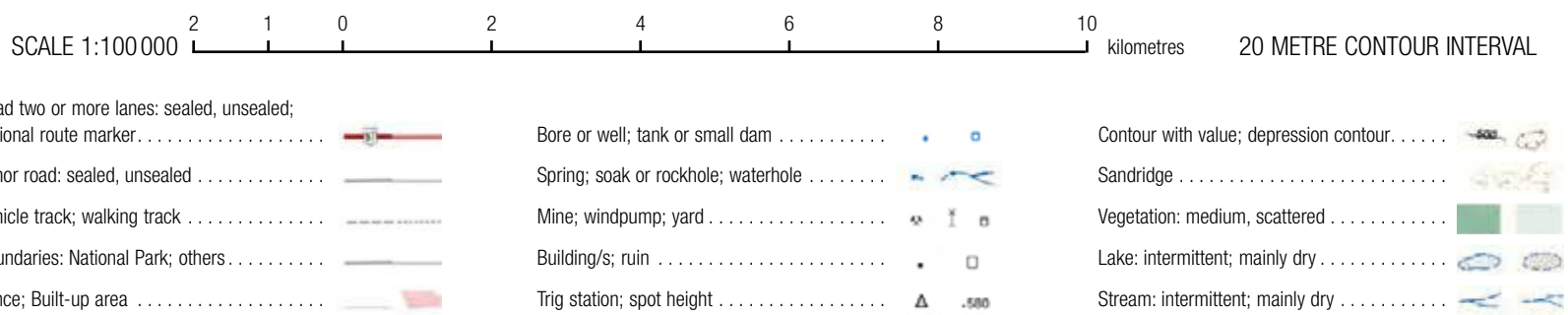
Since the Uluṟu topographic map extract was produced the Yulara Tourist Village has been renamed Sails in the Desert resort and the Yulara Aerodrome has been renamed Ayers Rock Airport.

Figure 3.18a Kata Tjuṯa (the Olgas).

Figure 3.18b Uluṟu.

Figure 3.18c Voyages Sails in the Desert hotel, Ayers Rock Resort.

Figure 3.18d Aerial shot of Uluṟu.



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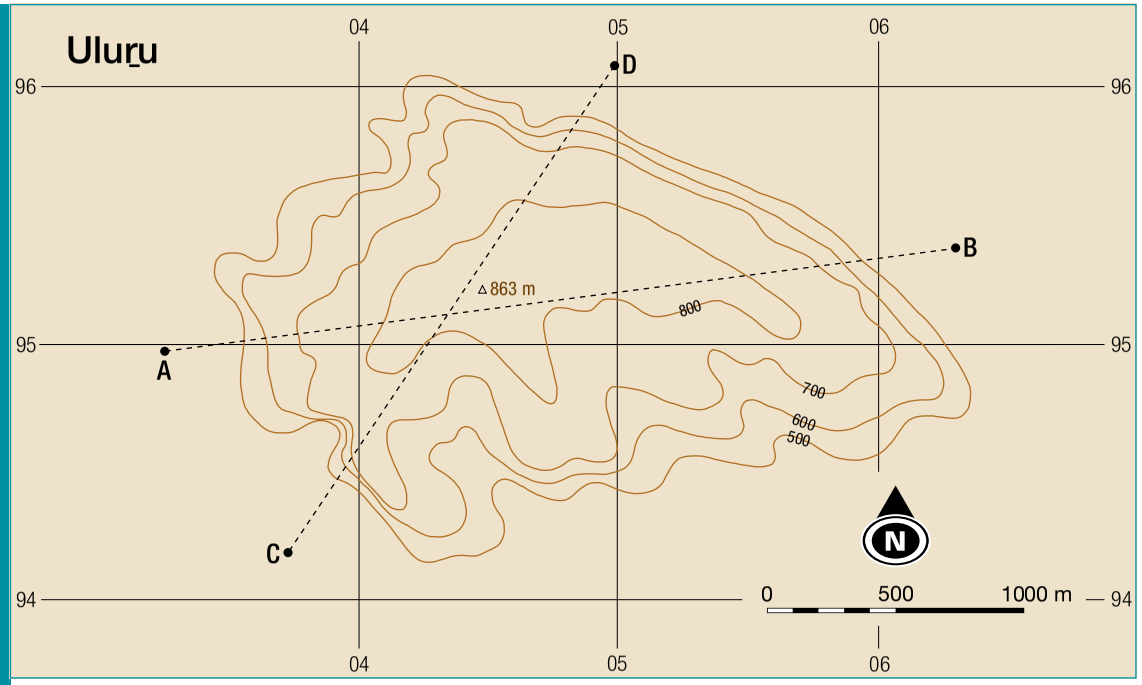
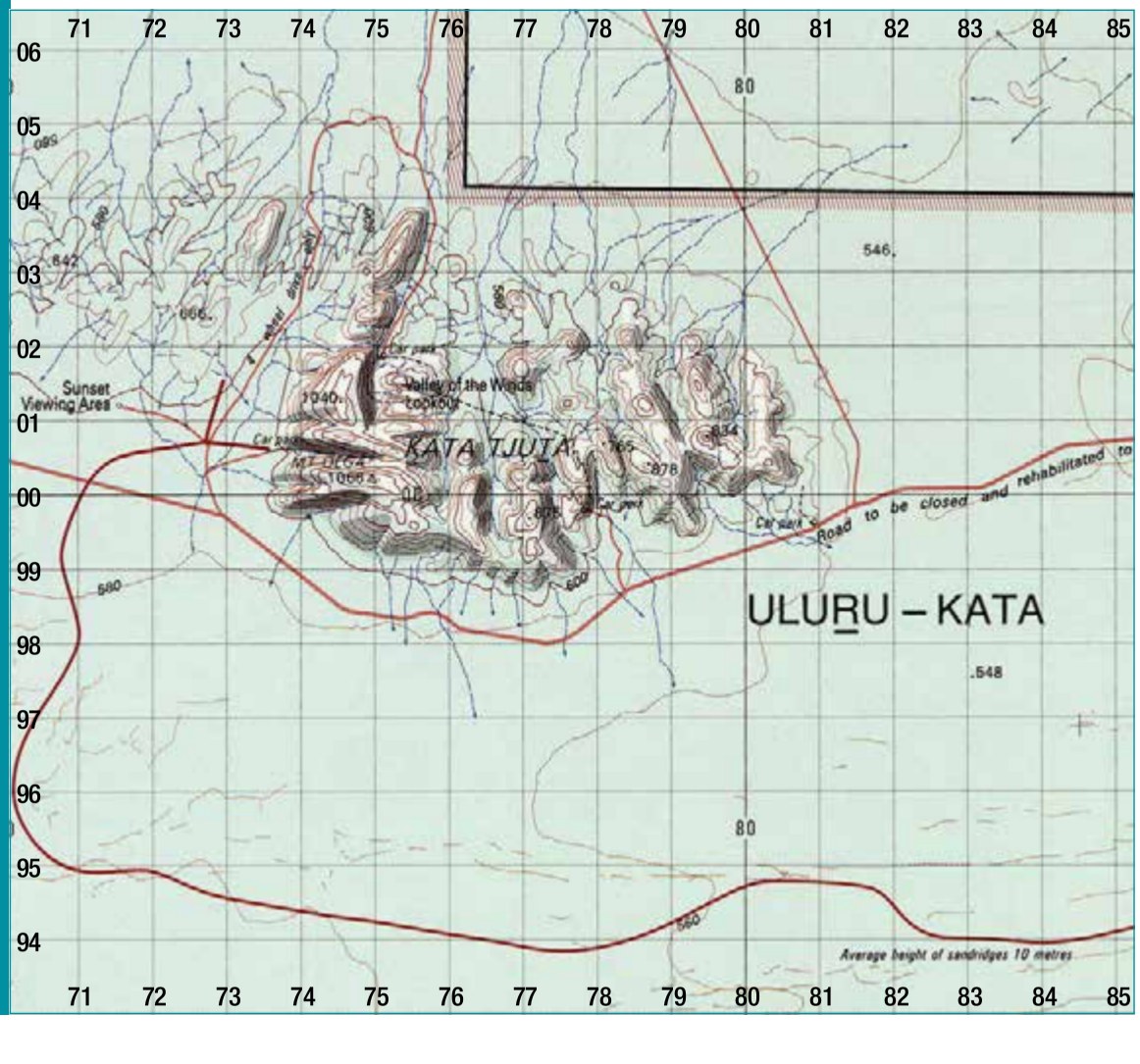
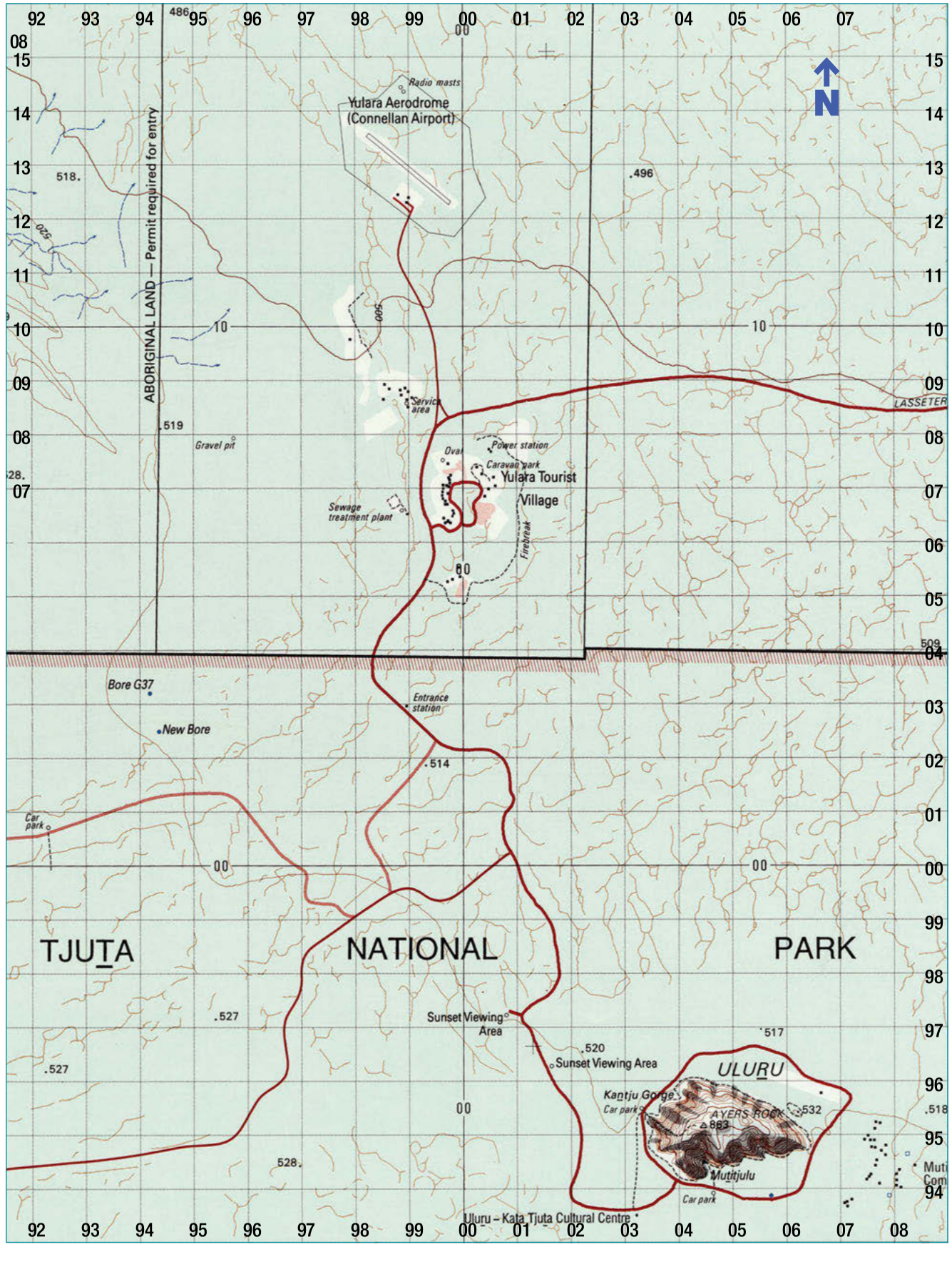
Uluru topographic map extract (Uluṟu: latitude 25°21'S, longitude 131°05'E)







3.18 ULURU (NT) TOPOGRAPHIC 7
Cambridge University Press

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3.19 Gallipoli (Turkey) topographic map extract

THE GALLIPOLI CAMPAIGN

When World War I broke out in August 1914, the Ottoman Empire (Turkey) remained neutral. At first it was unwilling to side with either the Central Powers (Germany and Austro-Hungary) or the Allies (Britain, France and Russia). Within months, however, Turkey sided with Germany. Britain and France officially declared war on the Ottoman Empire in November 1914.

With the war in Europe at a stalemate, the British sought to open a new front in the east from which to attack Germany. To achieve this strategic objective they decided to send a naval force through the heavily defended Dardanelles (the waterway connecting the Aegean Sea to the Sea of Marmara) to capture Constantinople (now Istanbul, the Turkish capital).

A fleet of 16 British and French battleships and cruisers moved into the Dardanelles early on 18 March 1915. The French battleship *Bouvet* hit a mine and sank within minutes, resulting in the loss of nearly 600 lives. Two British battleships were also destroyed and three other vessels were crippled. By the end of the day the fleet had abandoned its attempt to break through the Turkish defences. Turkey had defeated the world's greatest naval power.

The British and French commanders were convinced that they could not force their way through the Dardanelles without first silencing Turkey's land-based guns.

Planning for the invasion of the Gallipoli Peninsula started immediately. An army of British, Australian, New Zealand, Indian and French soldiers was assembled in Egypt and on the Greek Islands close to the peninsula. British troops were to make the main landing at Cape Helles, at the tip of the peninsula. Shortly before the British landing, troops from the Australian and New Zealand Army Corps (ANZAC) were to land to the north at Gaba Tepe.

At dawn on 25 April 1915 the first ANZAC troops landed at North Beach (the location of the existing Anzac Memorial and Dawn Service site) and at Anzac Cove, just south of the nearby headland, Ari Burnu. The aim was to capture the strategically important Sari Bair Range and then advance inland to Mal Tepe to cut off the movement of Turkish reinforcements to Cape Helles.

Turkish resistance was light at first, but as the day progressed Turkish defences were strengthened. The Allies' objectives for the day were never achieved. Turkish forces pushed the exhausted ANZAC troops back to their beachhead (a footing gained on hostile shores by an army). Field commanders called for the immediate withdrawal of the troops, but were instead ordered by their superiors to dig in and wait for further orders.

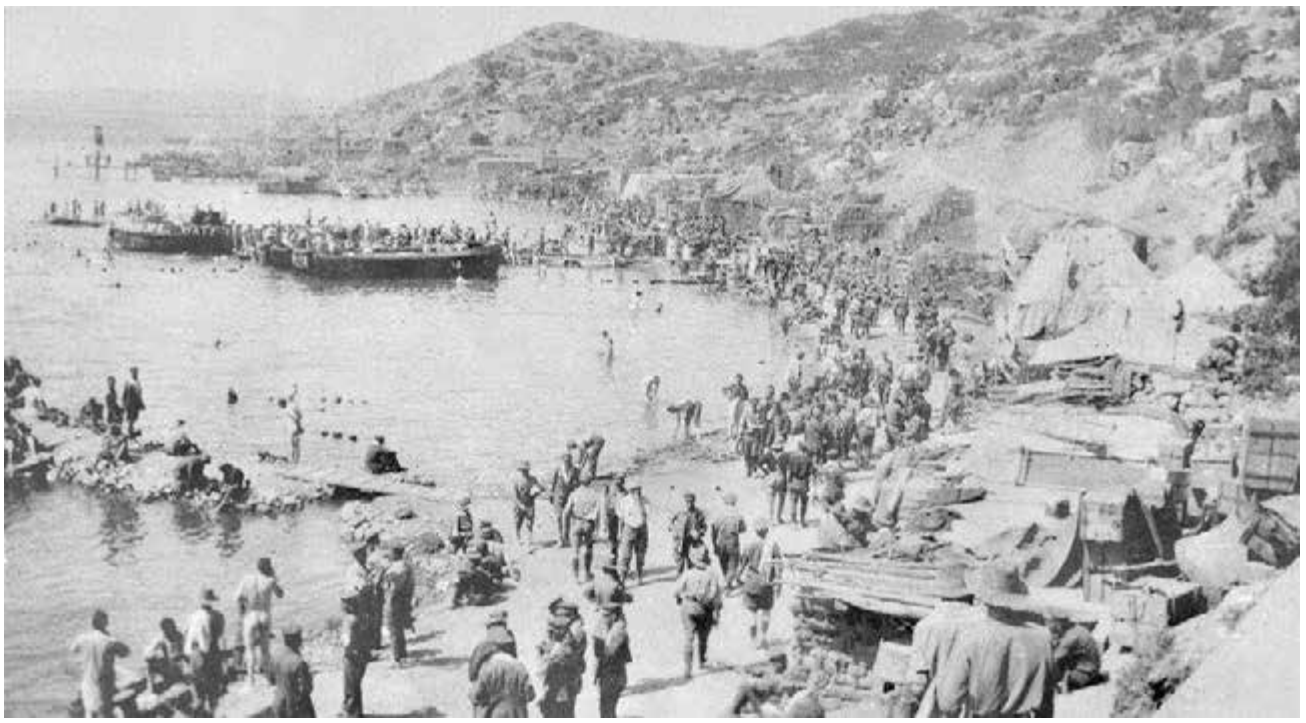

Figure 3.19a Anzac Cove viewed from Hell Spit, 1915. Ari Burnu can be seen in the background. Watson's Pier is towards the top of the photograph.

For the following four months Allied forces remained dug in at their beachhead. All their attempts to break out were cut off by the Turkish forces, whose defensive positions occupied the higher ground.

In August 1915, one final attempt was made to break the stalemate. Thousands of additional British troops landed at Suvla Bay, to the north of the ANZAC positions. At the same time, ANZAC troops mounted an attack from the ANZAC beachhead and an assault on Turkish positions at Lone Pine (see Figure 3.19n, page 81). It became known as the 'August Offensive'. While the offensive increased the area occupied by Allied forces, it failed to break the stalemate.

Supplies of weapons, ammunition, fresh food and drinking water were all in short supply. Casualties on both sides were very heavy. Many deaths were caused by disease. At times the proportion of the Allied forces who were sick reached almost 50 per cent. A common illness was dysentery (an infection of the intestines resulting in severe diarrhoea), and the smell of rotting bodies hung over the battlefield.

By November 1915 the British and French governments concluded that the Gallipoli campaign should end. The evacuation commenced in December. It was completed in early January 1916, by which time more than 83 000 men had been evacuated from the beachhead.

From a strategic and operational point of view, the Gallipoli landings were a failure. The Gallipoli campaign cost Australia 26 111 casualties, including 8709 deaths. The campaign would, however, be a defining event in Australian history. It helped to shape our national identity and was the birth of the Anzac tradition.

Figure 3.19b Anzac Cove, 1915. This is a hand-coloured photograph.

Figure 3.19c Anzac Cove viewed from Hell Spit, 2000. Ari Burnu can be seen in the background.

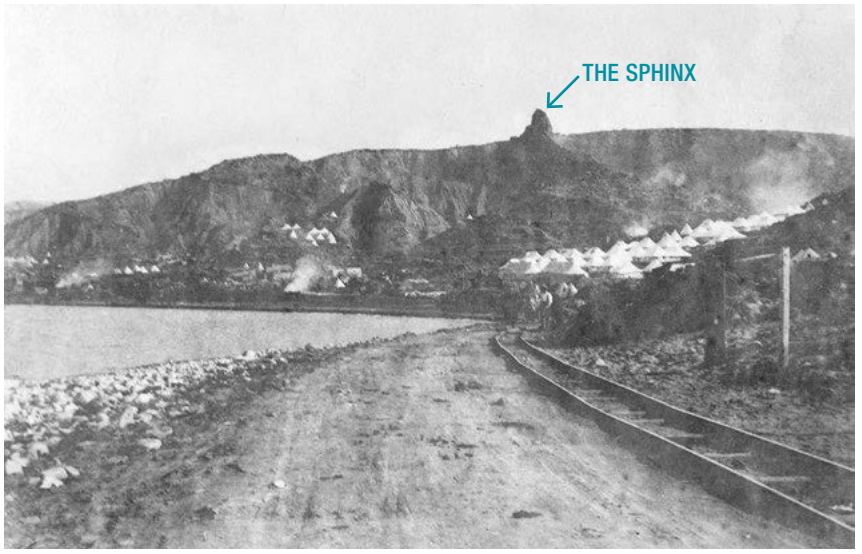

Figure 3.19d North Beach, the principal ANZAC landing place, viewed from Ari Burnu. The Sphinx can be seen in the background. The rail line was used to move supplies to and from Anzac Cove.

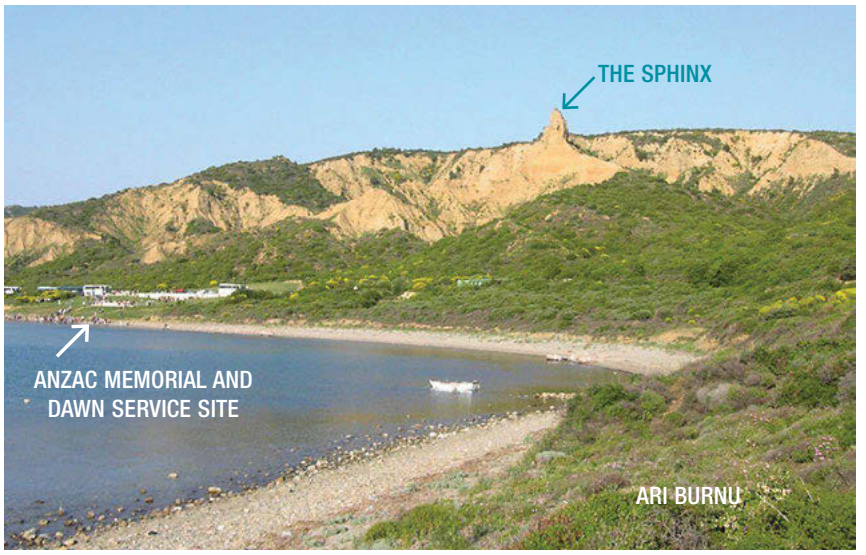

Figure 3.19e North Beach viewed from Ari Burnu, 2000.

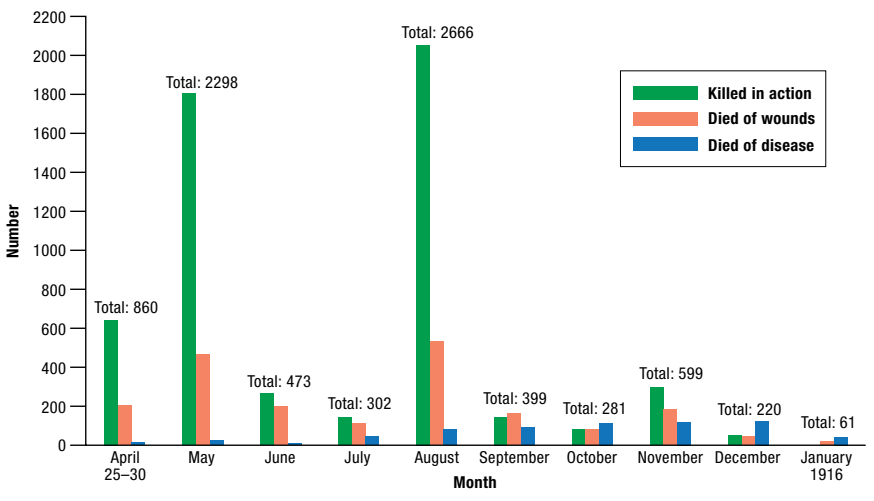

Figure 3.19f Australians killed at Gallipoli, 25 April 1915 to 8 January 1916.

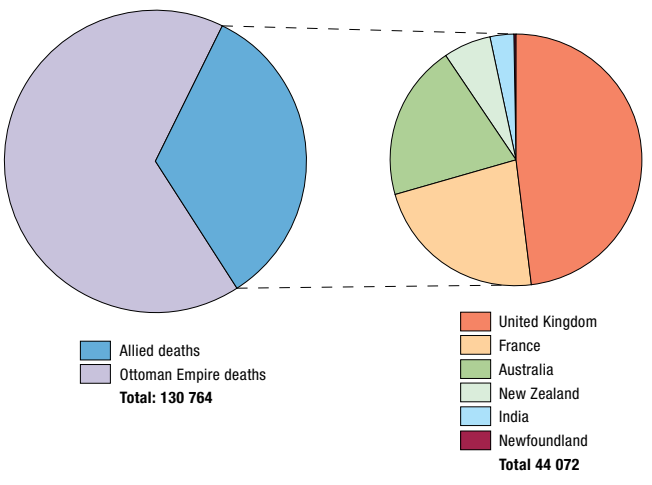

Figure 3.19g Gallipoli casualties.

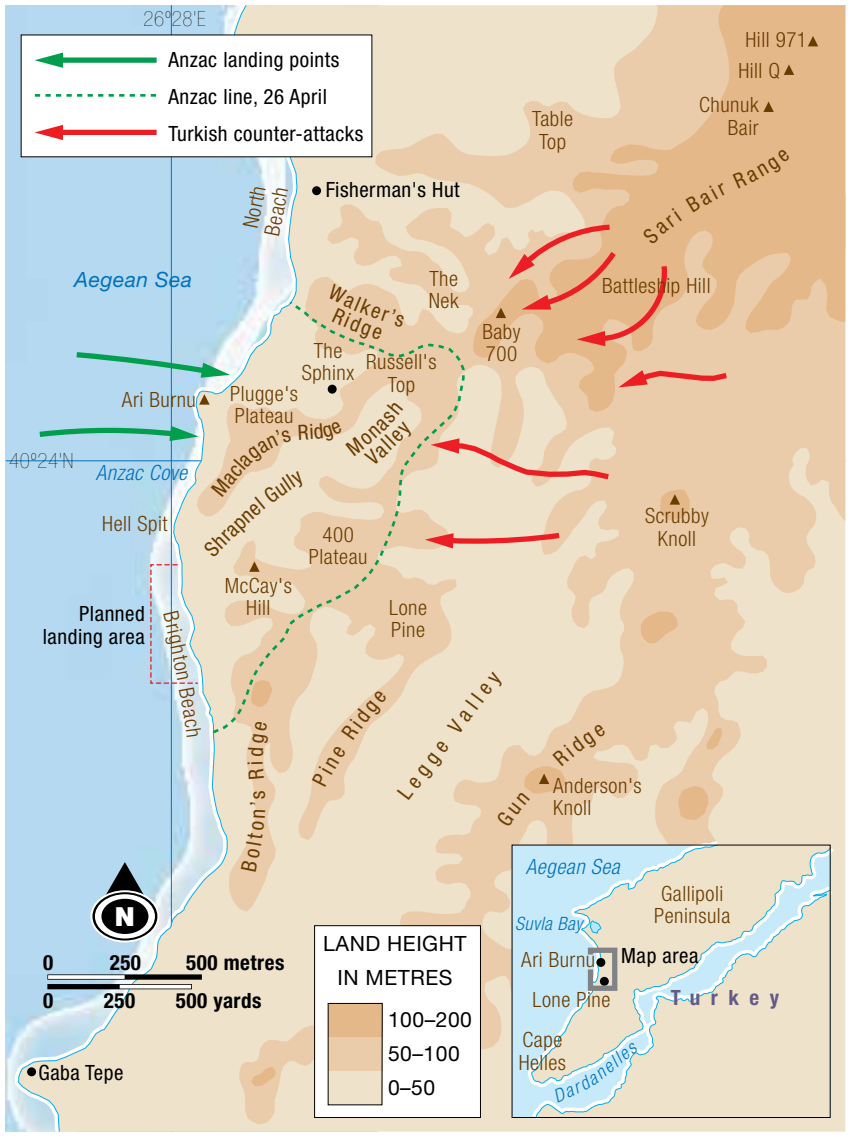

Figure 3.19h Territory occupied by ANZAC troops on 25–26 April 1915.

Figure 3.19i North Beach viewed from Plugge's Plateau.

Figure 3.19j Looking north from Plugge's Plateau over North Beach and up to Suvla Bay in the distance, 2005.

Gallipoli topographic map extract (Gallipoli: latitude 40°24′N, longitude 26°27′E)

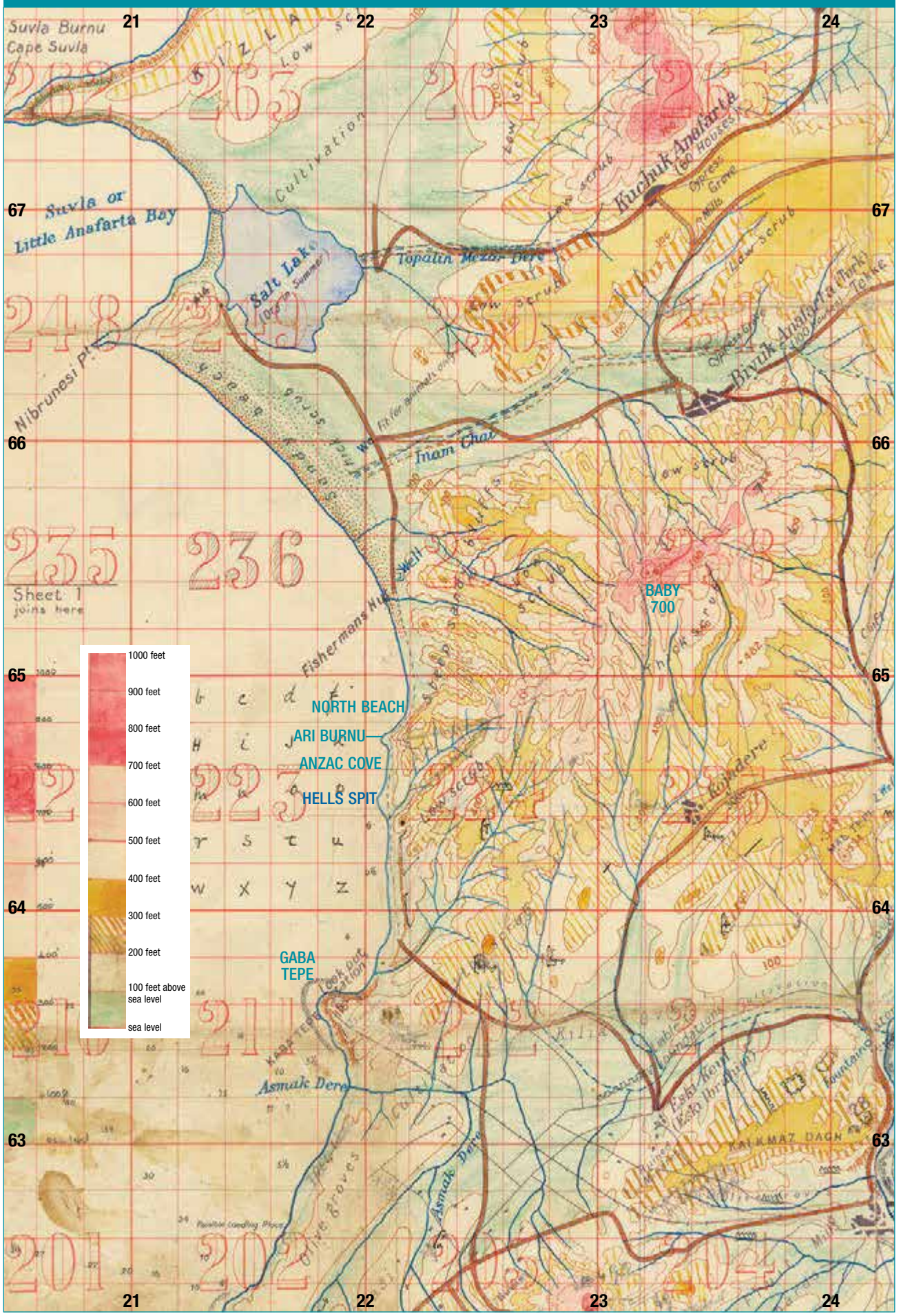

Figure 3.19k An extract from the Maclaurin Map.

The Maclaurin Map

The map shown in Figure 3.19k was used by Colonel Henry Maclaurin, commander of the 1st Brigade, at the Anzac Cove landing. Maclaurin was born in Sydney in 1878, and worked as a barrister before enlisting in the AIF (Australian Imperial Force). He was killed at Gallipoli on 27 April 1915 by a Turkish sniper. Before the landing, Maclaurin marked on the map the position of the Turkish defences and coloured in the contours.

Figure 3.19l The Maclaurin Map. The area shown in Figure 3.19k is indicated.

Topography

Overlooking Anzac Cove is a steep, sloping natural amphitheatre (a level area of land surrounded by a semi-circular rising slope) and escarpment. Immediately beyond Ari Burnu point, at the northern end of Anzac Cove, lays North Beach. Further north lays Ocean Beach, which sweeps away to the north in a great semi-circle towards the lowlands of Suvla Bay.

Along this coastline, steep and sparsely vegetated spurs run down to the sea from a range of high hills. Immediately behind North Beach is the distinctive landform feature known as 'The Sphinx' (Yuksek Tepe). This is a weathered pinnacle from which the ground falls steeply away into deep, narrow gullies.

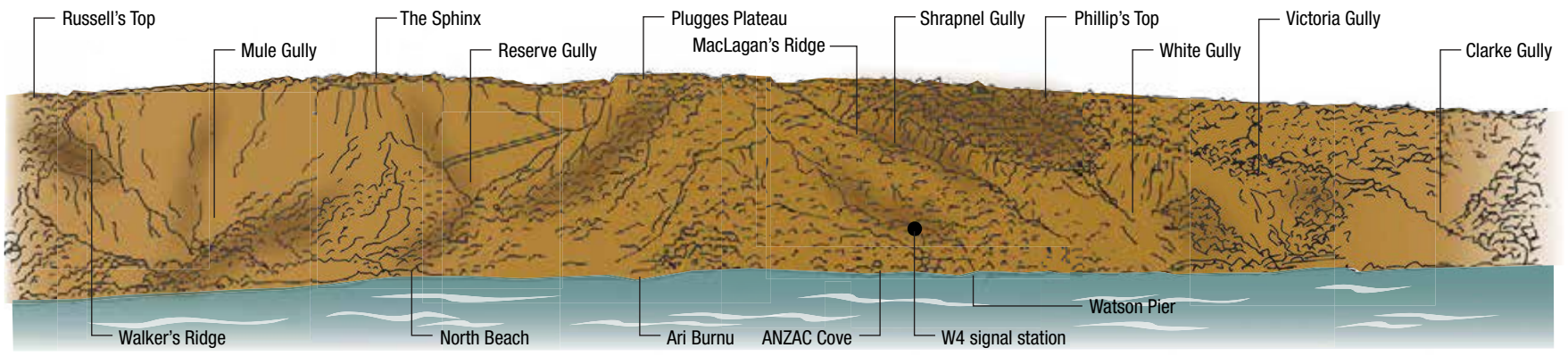

Figure 3.19m Profile of the Gallipoli coastline.

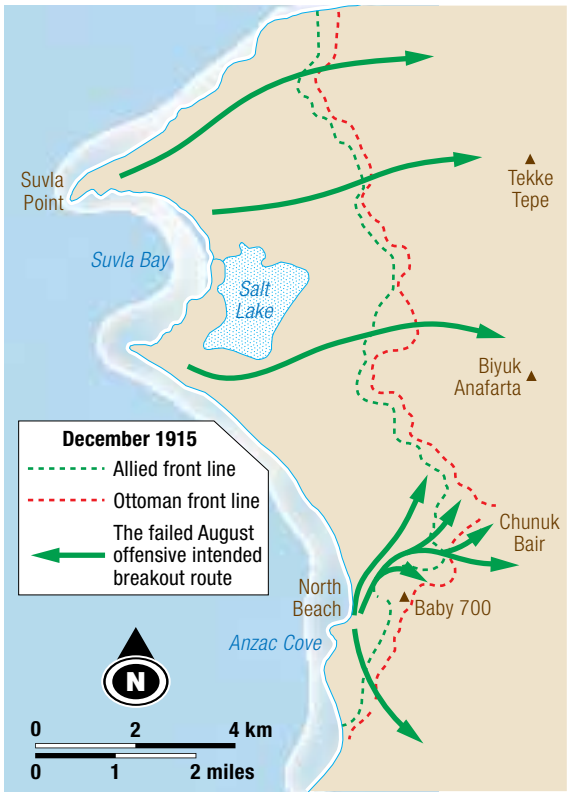

Figure 3.19n The front line at Gallipoli, August–December 1915.

Turkish map of the ANZAC encampment, 1916

The map shown in Figure 3.19o was drawn for the Turkish Mapping Directorate after the evacuation of the Allies from Gallipoli in December 1915 and January 1916. Allied fortifications are shown in blue, Turkish fortifications in red. Place names were printed in Ottoman Turkish, with English translations added later.

Above Ari Burnu you can see the piers built on North Beach. At the end of the first pier (called Williams Pier by the Anzacs) can be seen the ship called *The Milo*. This ship was grounded to act as a breakwater. Leading from the piers are tramways, which were used to move supplies from the piers to Anzac Cove.

The map shows four grounded boats at Anzac Cove. One of these, a steel lifeboat from *HMT Ascot*, was removed from Anzac Cove in 1921 and is now on display in the Australian War Memorial in Canberra. The remaining boats were used for scrap or eventually rusted away.

The map also features a number of Christian cemeteries, an Indian Muslim cemetery and Turkish cemeteries.

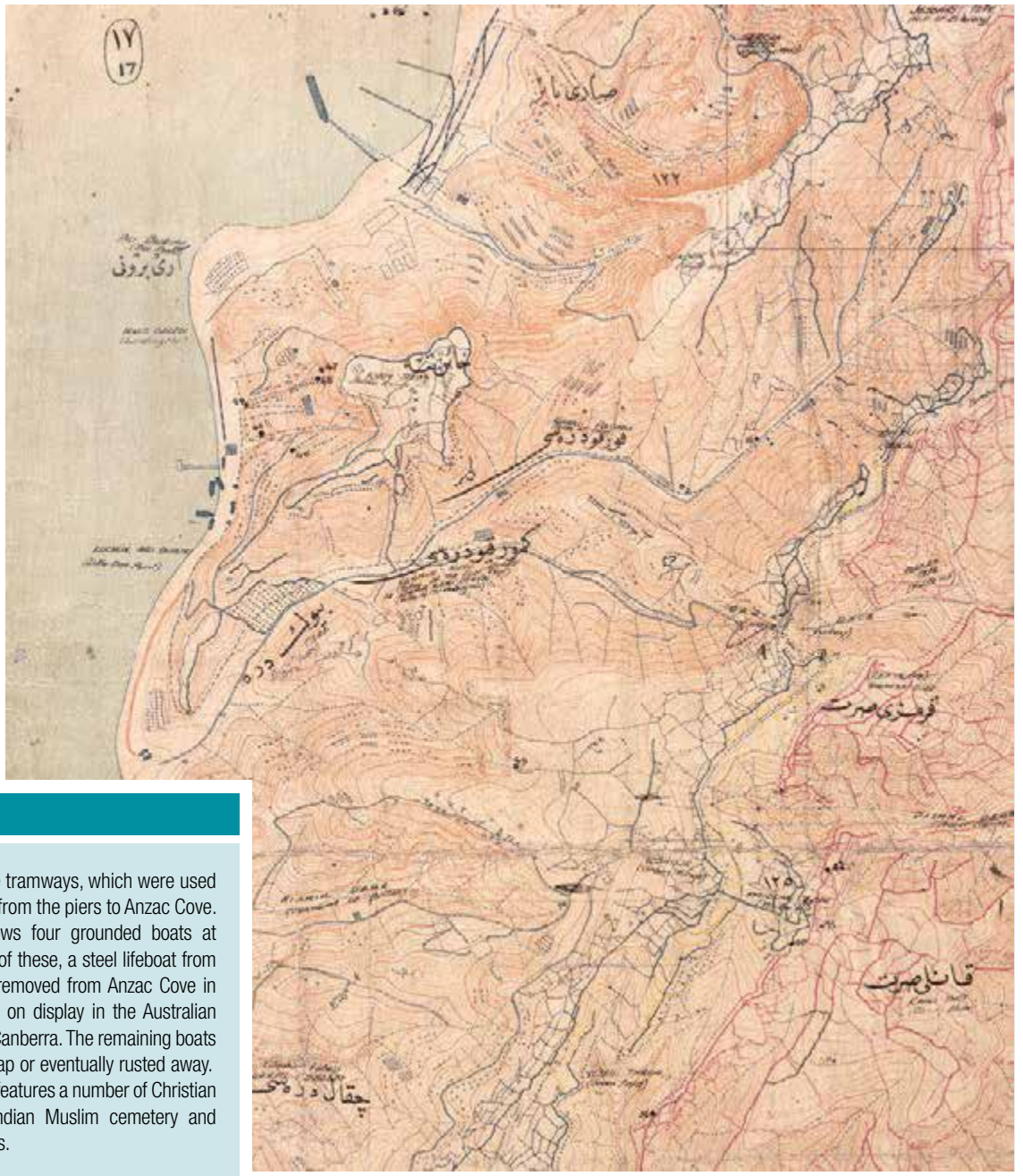

Figure 3.19o Turkish map of the ANZAC encampment at Gallipoli, 1916.

ACTIVITIES

1. Read the text 'The Gallipoli Campaign' (page 78) and study Figures 3.19h and 3.19k (pages 79 and 80) and then complete the following tasks:
   - **a** Locate the following landform features on Figure 3.19k. State the grid reference of each feature.
     - **i** Gaba [Kaba] Tepe
     - **ii** North Beach
     - **iii** Ari Burnu
     - **iv** Anzac Cove
     - **v** Suvla Bay
     - **vi** Baby 700
     - **vii** Nibrunesi Point
     - **viii** Salt Lake.
   - **b** Locate the following features of the constructed environment on Figure 3.19k.
     - **i** Fisherman's Hut
     - **ii** Biyuk Anafarta.
2. Study the photographs of Anzac Cove (Figures 3.19a to 3.19c, page 78) and then complete the following tasks:
   - **a** Describe the topography of Anzac Cove.
   - **b** In groups, discuss the advantages and disadvantages of Anzac Cove as a landing place.
   - **c** Write a paragraph explaining why Anzac Cove proved to be such a difficult site from which to mount major military operations.
   - **d** Describe the activities taking place in Figures 3.19a and 3.19b.
3. Study Figure 3.19k (page 80) and then answer the following questions:
   - **a** What is the direction of Baby 700 from Anzac Cove?
   - **b** What is the direction of Nibrunesi Point from Anzac Cove?
   - **c** What is the general aspect of the slope in AR 2267?
   - **d** What is the elevation of Kojadere (AR 2364)?
   - **e** What is the difference in elevation between Anzac Cove and the summit of Baby 700?
4. Study Figures 3.19d and 3.19e (page 79) and then complete the following tasks:
   - **a** State the direction in which the camera was facing when these photographs were taken.
   - **b** Working in groups, discuss the advantages and disadvantages of North Beach as a landing place.
   - **c** As a group, decide which of the locations (Anzac Cove or North Beach) was the better location for a large-scale landing of troops and military equipment.
   - **d** Construct a photo sketch of Figure 3.19e. Label Ari Burnu, the Sphinx and the Anzac Memorial and Dawn Service site.
   - **e** Based on your observations, explain why North Beach, rather than Anzac Cove, was selected for the annual Anzac Dawn Service.
5. Study Figures 3.19f and 3.19g (page 79) and then answer the following questions:
   - **a** In which month of the campaign was the largest number of Australians killed?
   - **b** Why did the number of troops killed in action peak in the month identified above?
   - **c** Which was the second-most costly month in terms of the numbers killed in action and those who died from their wounds?
   - **d** In what month did the number of deaths from disease peak?
   - **e** What proportion of troops killed were from the Ottoman Empire (Turkey)?
   - **f** Which Allied country had the greatest number of troops killed during the Gallipoli Campaign?
   - **g** What proportion of total Allied deaths was Australian?
   - **h** How many New Zealand troops were killed at Gallipoli?
6. Study Figure 3.19h (page 79) and then complete the following tasks:
   - **a** Estimate the area of land occupied by Anzac forces on 25–26 April 1915.
   - **b** Name the planned site of the Gallipoli landing. Describe its location relative to Anzac Cove.
7. Study Figures 3.19i and 3.19j (page 79) and then complete the following tasks:
   - **a** Write a paragraph describing the nature of the activities that are taking place in Figure 3.19i.
   - **b** Identify the features of the physical environment that are visible in both Figures 3.19i and 3.19j.
8. Study Figure 3.19k (page 80) and then complete the following tasks:
   - **a** Construct a precis map featuring the topography of the area covered by the map.
   - **b** Describe the nature of the topography in the area around Anzac Cove and North Beach.
   - **c** Working in groups, discuss how this topography hindered attempts by Anzac troops to achieve the campaign's military objectives.
   - **d** Suggest why the topography south of Gaba Tepe meant that the campaign's planners selected that area as the most suitable for a landing site.
9. Study Figure 3.19m (page 80). Locate the following locations, each of which holds an important place in the history of the Gallipoli Campaign. Try locating them on Figure 3.19k (page 80).
   - **a** Plugge's Plateau
   - **b** The Sphinx
   - **c** Walker's Ridge
   - **d** Ari Burnu
   - **e** Shrapnel Gully
   - **f** Maclagan's Ridge.

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THEMES IN GLOBAL GEOGRAPHY

4.1 Biomes

A biome is a large geographical area with distinctive plant and animal species that are adapted to that particular environment. The climate and geography of a region determines what type of biomes are found there. The Earth's major biomes are shown in Figure 4.1a.

Each biome consists of many ecosystems whose communities have adapted to the small differences in climate and the environment within the biome.

All living things are closely related to their environment. Any change in one part of an environment causes a ripple effect of change through other parts of the environment. There are three kinds of change:

- **Habitat destruction** People are directly destroying habitat, include cutting down forests, filling in wetlands and dredging rivers.
- **Habitat fragmentation** Much of the world's remaining terrestrial habitat has been fragmented by road construction and other forms of 'development'. Aquatic species' habitats have been fragmented by dams and water diversions. Many of these habitat fragments may not be large or connected enough to support species that need a large territory. The loss and fragmentation of habitat make it difficult for migratory species to find places to rest and feed along their migration routes.
- **Habitat degradation** Pollution, introduced species and disruption of ecosystem processes (for example, changes in the intensity and frequency of fire) are some of the ways habitats are degraded. When this occurs the ability to support native plants and animals declines.

Table 4.1a Area of biomes

Biome	*Percentage of the Earth's land surface*
Tropical rainforest	8
Tropical savanna	24
Desert	21
Chaparral	2
Grasslands	7
Temperate (deciduous) forest	7
Coniferous (boreal) forest	14
Arctic and alpine tundra	5
Other (polar and cities)	12

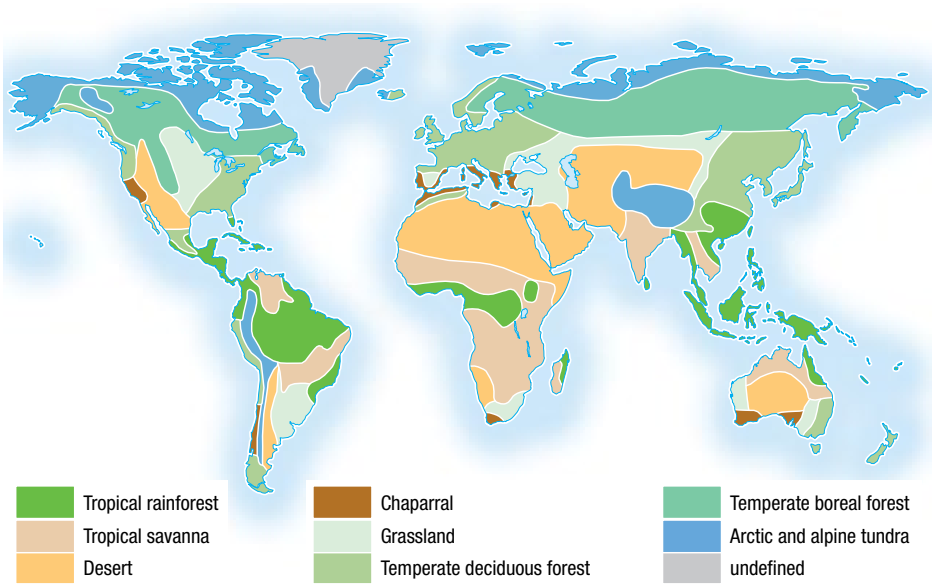

Figure 4.1a Biomes of the world.

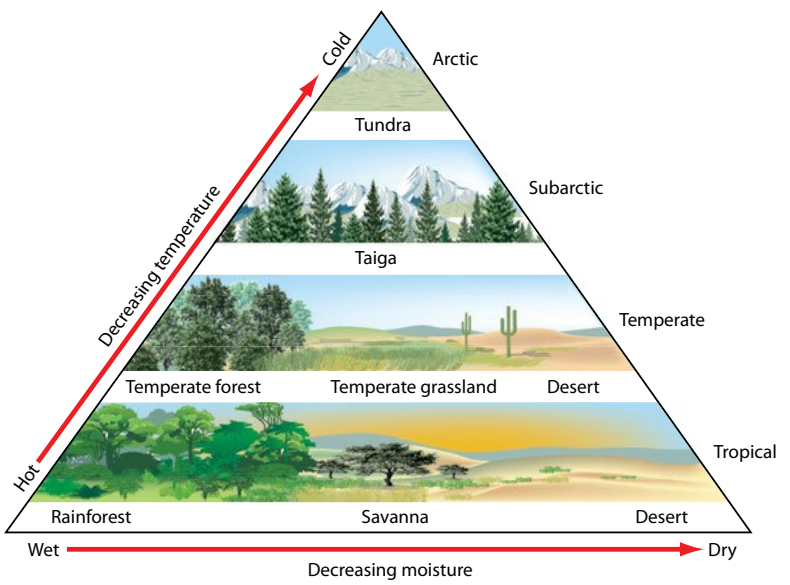

Figure 4.1b Land-based biomes are determined by climate (temperature and moisture).

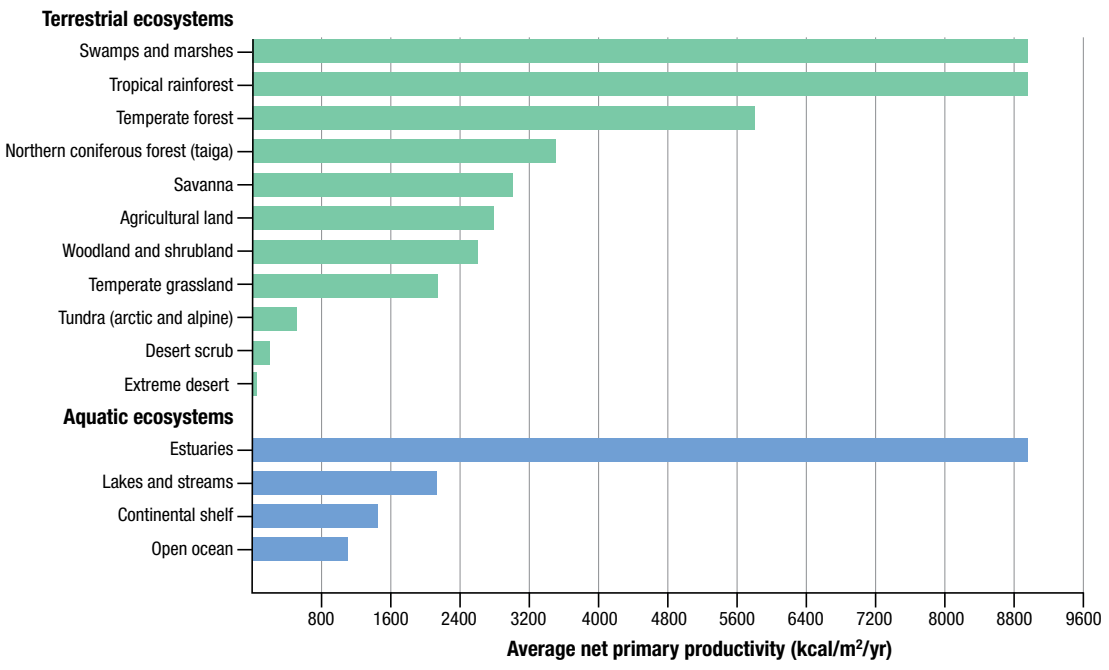

Figure 4.1c Average net primary productivity of ecosystems.

PROTECTING BIOMES AND ECOSYSTEMS

Conservation is the practice of protecting endangered habitats and their associated plant and animal species. The establishment of *protected areas* through legal measures can serve to protect critical ecosystems. *Habitat restoration* is also possible in some cases, but is often very expensive.

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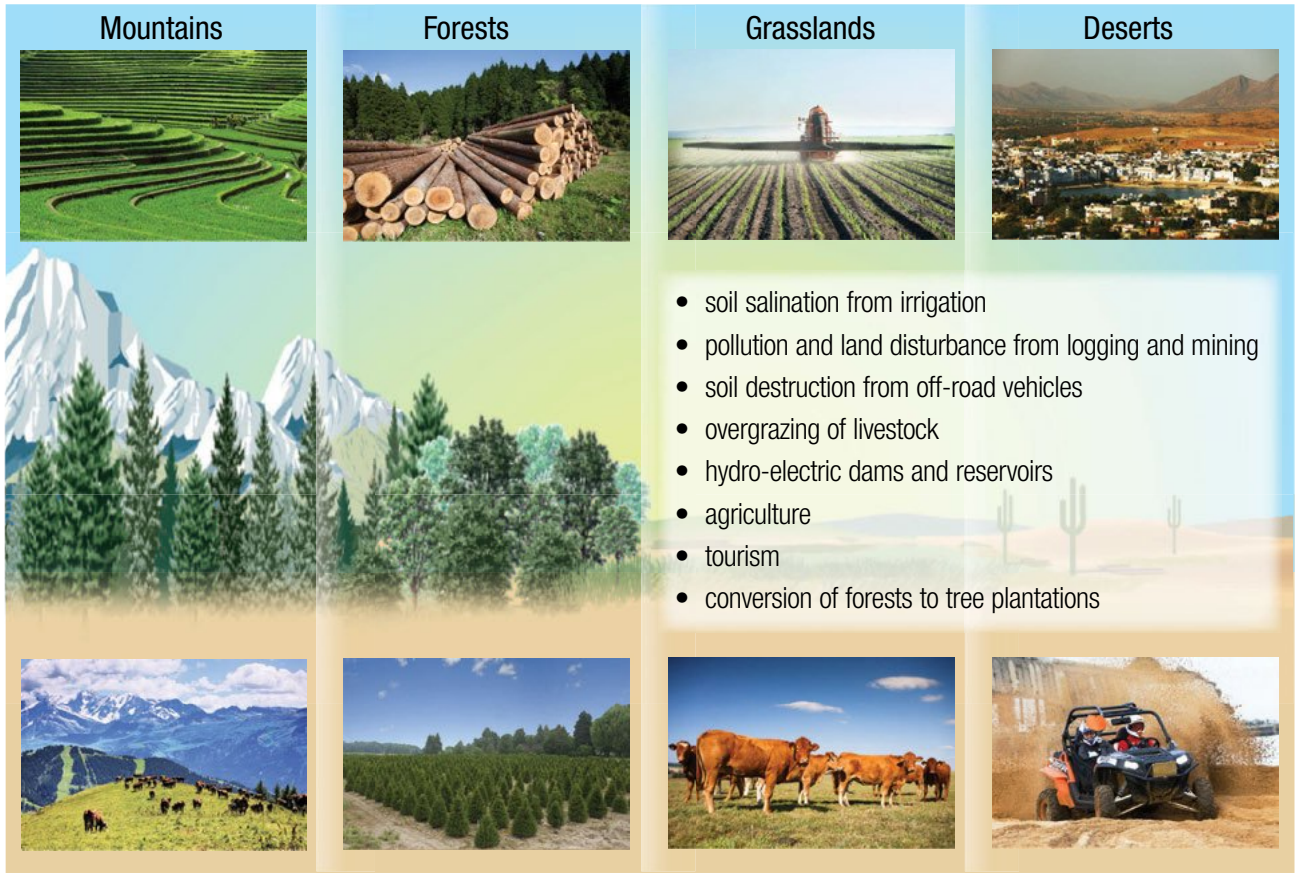

Figure 4.1d Major human effects on land-based (terrestrial) ecosystems.

Figure 4.1e Major effects of humans on marine ecosystems and coral reefs (acquatic ecosystems).

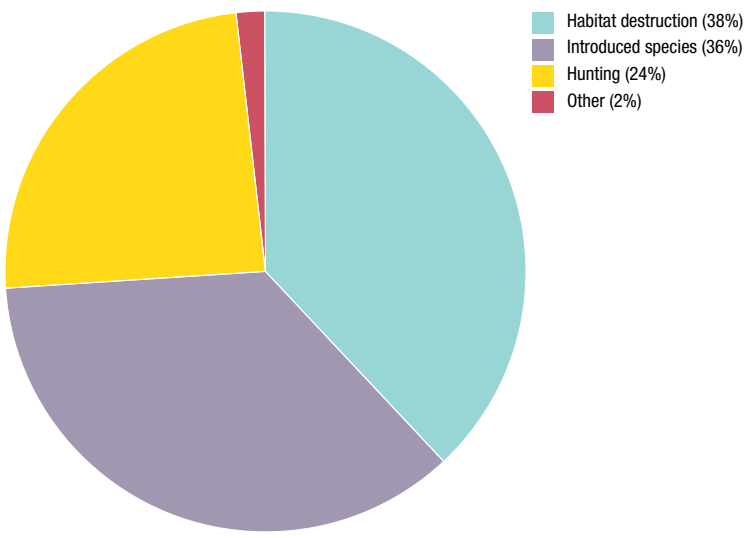

Figure 4.1f Causes of species loss.

ACTIVITIES

1. Study Figures 4.1a, 4.1b and an atlas map showing the Earth's climate zones. Write a paragraph or two outlining the relationship between attitude, climate and the distribution of the Earth's major biomes.
2. Study Table 4.1a. Construct a pie graph showing the percentage of the Earth's surface occupied by each of the major terrestrial biomes.
3. Study Figure 4.1b. Which biomes exist under the following conditions:
   - a high temperatures and dry conditions
   - b high temperatures and wet conditions
   - c high temperatures and moderate rainfall
   - d low temperatures and moderate precipitation
   - e moderate temperatures and high rainfall
   - f low temperatures and variable rainfall?
4. Study Figure 4.1c. Which are the world's most productive ecosystems? Which is its least productive?
5. Where are the Earth's most productive aquatic ecosystems found?
6. Study Figures 4.1e and 4.1f. Use the information featured in the illustrations to construct your own mind map documenting human effects on terrestrial and aquatic environments.
7. Study Figure 4.1f. What is the principal cause of species loss? What percentage of species loss is a result of species introduction?

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4.2 Geomorphological hazards

Human activities, especially over the past two centuries, have had a huge effect on the environment and landscape through industrialisation and changes in land use, leading to climate change, deforestation, desertification, land degradation, and air and water pollution. These effects are strongly linked to the occurrence of geomorphological hazards, such as floods, landslides, snow avalanches, soil erosion and others. The work undertaken by geomorphologists includes not only the understanding but also the mapping and modelling of Earth's surface processes, and many of these processes directly affect human activities and societies.

Geomorphological hazards include earthquakes and volcanic activity, and mass movements of soil and rock material. These hazards can kill tens of thousands of people, devastate whole communities, disrupt communications and cause great economic hardship.

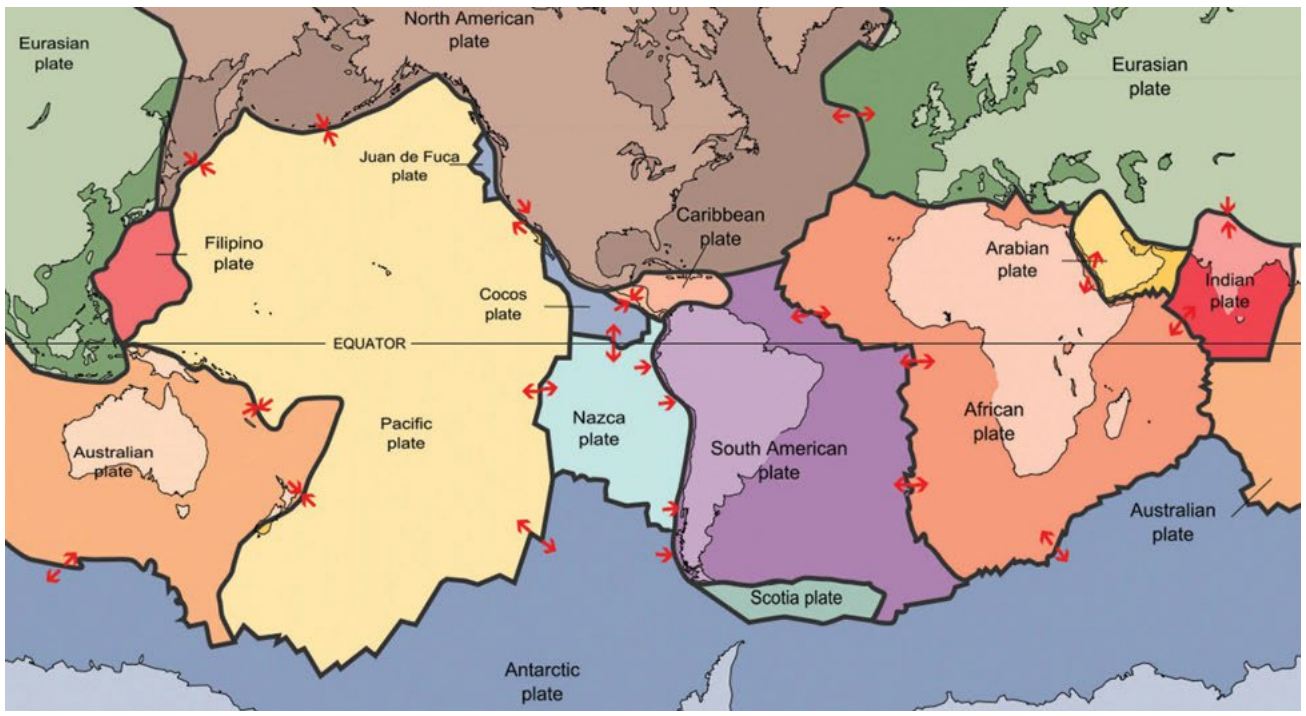

Figure 4.2a The Earth's crust is broken into eight vast segments or plates and several smaller plates.

Plate tectonics

The Earth's *crust* is broken into eight vast segments or *plates* (and several smaller plates) that travel slowly across the face of the planet, a movement powered by currents deep within the Earth's liquid *mantle*. The name given to this process is *plate tectonics*.

Type of Margin	Divergent	Convergent	Transform
Motion	Spreading	Subduction	Lateral sliding
Effect	Constructive (oceanic lithosphere created)	Destructive (oceanic lithosphere destroyed)	Conservative (lithosphere neither created or destroyed)
Topography	Ridge/Rift	Trench	No major effect
Volcanic activity?	Yes	Yes	No

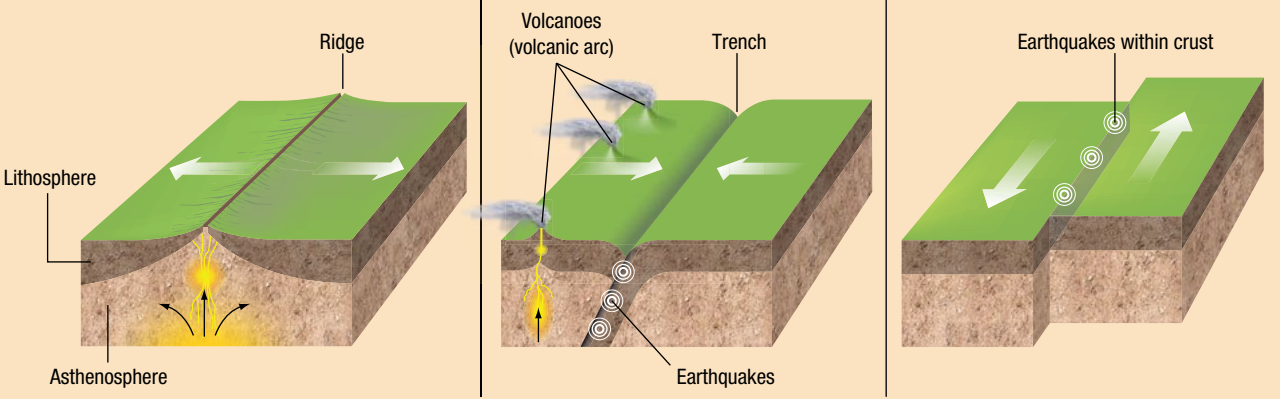

Figure 4.2b The three main tectonic plate boundary types.

Earthquakes

Earthquakes occur when the pressure deep within the Earth's crust builds and is then released suddenly. While they are most commonly associated with the movement of the Earth's crustal plates, smaller, often less destructive earthquakes can occur well away from the plate margins. These are usually associated with faults (lines of weaknesses) in the rock strata.

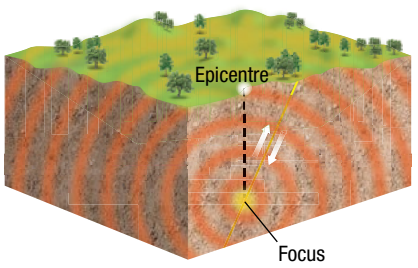

Figure 4.2d Earthquake epicentre and focus.

Volcanic eruptions

Volcanic eruptions occur when molten material (*magma*) forces its way to the Earth's surface through cracks or faults in the Earth's crust.

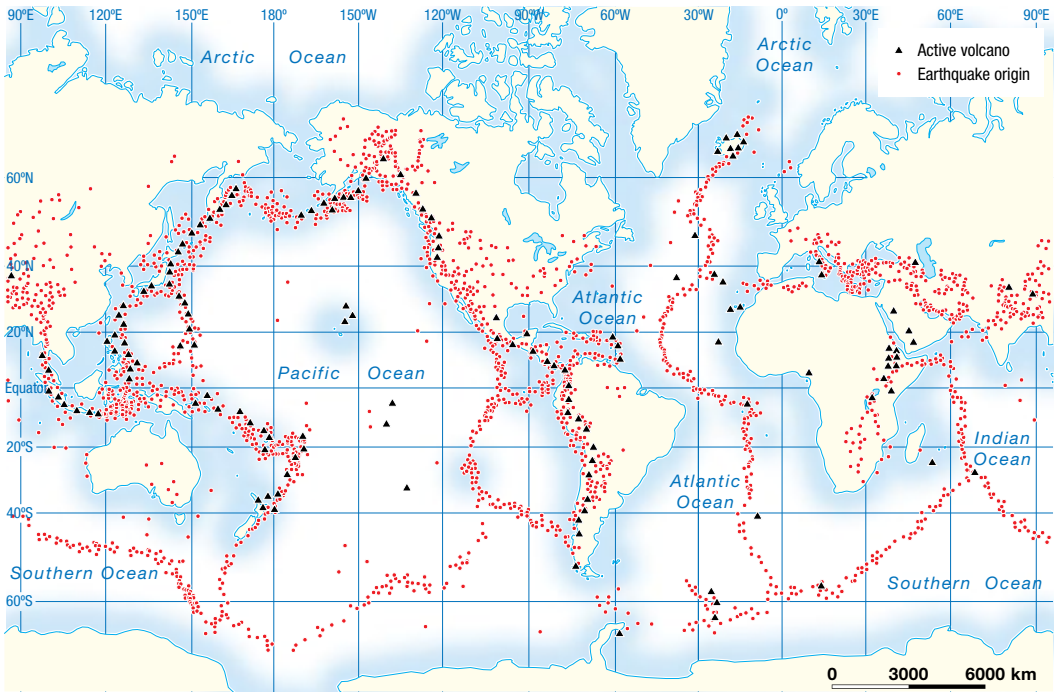

Figure 4.2c Recent earthquakes and volcanic eruptions.

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Table 4.2a The Richter scale

Magnitude	Description	Impacts	Average frequency
Less than 2.0	Micro	Micro-earthquakes, not felt or felt rarely by sensitive people. Recorded by seismographs.	1 300 000
2.0–2.9	Minor	Often felt by people, but very rarely causes damage. Shaking of indoor objects can be noticeable.	130 000
3.0–3.9			
4.0–4.9	Light	Noticeable shaking of indoor objects and rattling noises. Felt by most people in the affected area. Slightly felt outside. Generally causes no to minimal damage. Moderate to significant damage very unlikely. Some objects may fall off shelves or be knocked over.	13 000
5.0–5.9	Moderate	Can cause damage of varying severity to poorly constructed buildings. At most, no to slight damage to all other buildings. Felt by everyone. Casualties range from none to a few.	1319
6.0–6.9	Strong	Damage to many buildings in populated areas. Earthquake-resistant structures survive with slight to moderate damage. Poorly designed structures receive moderate to severe damage. Felt in wider areas; up to hundreds of kilometres from the epicentre. Damage can be caused far from the epicentre. Strong to violent shaking in epicentre area. Death toll ranges from none to 25 000.	134
7.0–7.9	Major	Causes damage to most buildings; some may partially or completely collapse or receive severe damage. Well-designed structures are likely to receive damage. Felt in enormous areas. Death toll ranges from none to 250 000.	15
8.0–8.9	Great	Major damage to buildings; structures likely to be destroyed. Will cause moderate to heavy damage to sturdy or earthquake-resistant buildings. Damaging in large areas, some totally destroyed. Felt in extremely large regions. Death toll ranges from 100 to 1 million.	1
9.0–9.9		Severe damage to all or most buildings with massive destruction. Damage and shaking extends to distant locations. Permanent changes in ground topography. Death toll ranges from 1000 to several million.	

Tsunamis

A tsunami is a series of ocean waves caused by a large earthquake or under-sea volcanic eruption. Tsunami waves are unlike those you see at the beach. They are a surge of water tens of metres high. While the impact of tsunamis is limited to coastal areas, their destructive power can be enormous and their effects extensive. The world's coastal plains are the most densely settled areas of the Earth's surface.

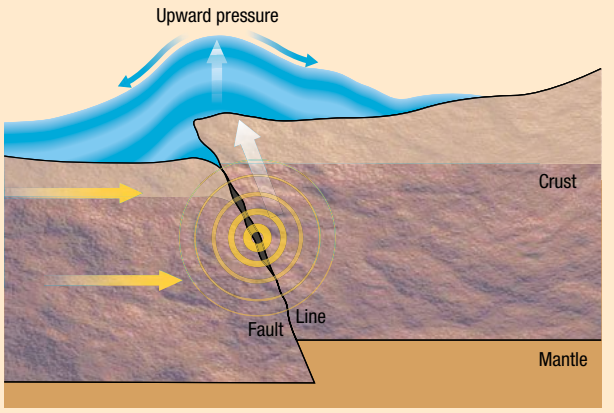

Figure 4.2e Tsunami wave formation.

Table 4.2b Earthquake magnitude versus ground motion and energy

Magnitude change	Ground motion change (displacement)	Energy change
1.0	10.0 times	about 32 times
0.5	3.2 times	about 5.5 times
0.3	2.0 times	about 3 times
0.1	1.3 times	about 1.4 times

Table 4.2c Recent earthquakes and their effects

Year	Place	Size*	Impacts
1976	Tangshan, China	7.8	250 000 people dead; 650 000 homeless
1985	Mexico City, Mexico	8.1	10 000 dead; 1000 large buildings collapse
1989	San Francisco, United States	7.1	62 dead; further 81 die when freeway collapses
1993	Latur, India	6.4	24 000 dead; 150 000 homeless
1994	Los Angeles, United States	6.7	57 dead; 20 000 homeless; over 100 fires
1995	Kobe, Japan	7.2	5500 dead; 310 000 homeless
1998	North-east Afghanistan	6.1	February: 4000 dead
		6.9	June: 3000 dead; 28 villages destroyed
1998	Papua New Guinea	7.0	Earthquake at sea triggers a tsunami; 3000 dead
1999	Turkey	7.8	17 127 dead; 43 953 injured; 20 000 buildings destroyed
2003	Iran	6.3	45 000 dead; 30 000 injured
2004	Great Sumatra–Andaman earthquake and tsunami	9.2	225 000 killed across 11 countries
2008	Sichuan, China	7.9	69 000 killed; 374 600 injured; 4.8 million left homeless
2010	Chile	8.8	525 killed
2011	Christchurch, New Zealand	6.3	185 deaths
2011	Japan (Tohoku) earthquake and tsunami	9.0	15 854 deaths; 3155 people missing; 129 225 buildings totally destroyed, with a further 947 000 buildings partially damaged
2013	Lushan, China	7.0	196 deaths; 11 800 injured; 100 000 people homeless

* Richter scale

Figure 4.2f Lushan earthquake, China, 2013.

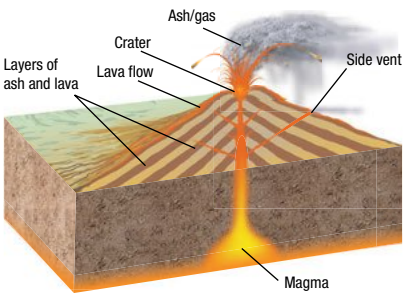

Figure 4.2g Features of a volcano.

Figure 4.2h Active volcanic landscape, Bromo Tengger Semeru National Park, Indonesia.

Table 4.2d Volcanic eruptions causing great loss of life

Year	Place	Impacts
1815	Tambora	92 000 people died, mostly in Indonesia because of starvation caused by the loss of crops and livestock
1883	Krakatau, the Sundra Strait	The resulting tsunami between Java and Sumatra killed 36 000
1902	Pelee, Martinique	Poisonous volcanic gases killed 36 000
1985	Nevado del Ruiz, Colombo	A wave of mud smothered 23 000
1991	Mt Pinatubo, the Philippines	900 people were killed

ACTIVITIES

1. Study Figures 4.2a and 4.2c. Describe the relationship between the distribution of earthquakes and volcanic eruptions.
2. Study Figure 4.2b. Distinguish between divergent, convergent and transform tectonic plate margins.
3. Study Figure 4.2d. Explain the difference between an earthquake's focus and its epicentre.
4. Study Table 4.2a. Select a recent earthquake event and note its magnitude. State the likely effects of an earthquake of that magnitude.
5. Study Table 4.2b. How much greater is the amount of energy released in an earthquake of magnitude 8 compared to one of 7? How much greater is the ground displacement?
6. Study Figure 4.2e. Write a paragraph explaining the origins of a tsunami.
7. Study Table 4.2c. Construct a column graph showing the death toll of the 10 most deadly earthquakes since 1976.
8. Study Figures 4.2g and 4.2h. Construct a photosketch of the Bromo Tengger Semeru National Park's volcanic landscape. Annotate your sketch with the names of the prominent landform features shown.
9. Study Table 4.2d. Construct a column graph showing the death toll of the volcanic eruptions listed.

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4.3 Population and urbanisation

During the 20th century the world's population grew at a rate never before experienced. In late 1999, the world's population reached 6.0 billion. By the middle of 2012 it was more than 7.0 billion. This is a dramatic rise from 1900, when there were only 1.6 billion people on Earth, and from 1950 when there were 2.5 billion. It took from the dawn of history to the year 1820 for the world's population to reach one billion. It took just 12 more years to add the latest billion to the tally.

This growth is expected to continue well into the 21st century, although more slowly. The world's population is expected to grow to 9 billion by 2050, an increase of 50 per cent in 50 years.

Most of this future growth will take place in the countries of the developing world, those least able to cope.

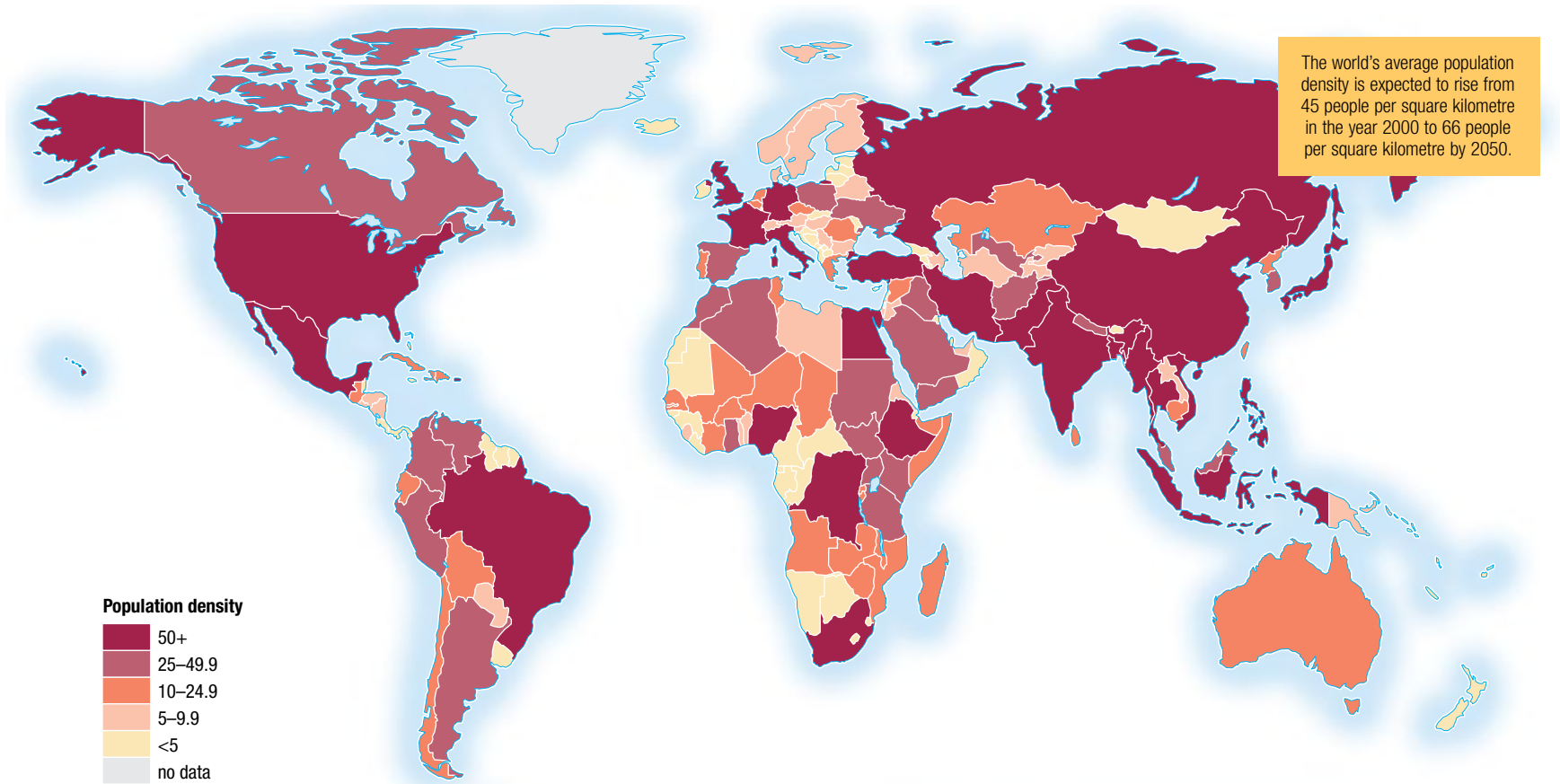

Figure 4.3a Population density, 2012.

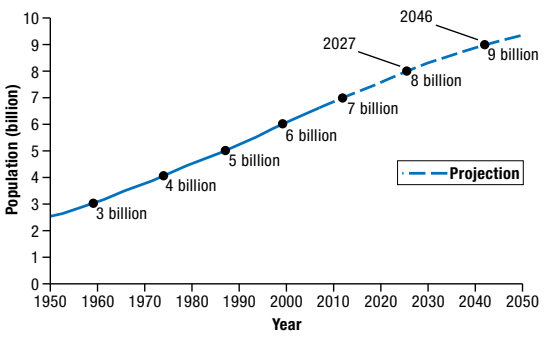

Figure 4.3b World population growth, 1950–2050.

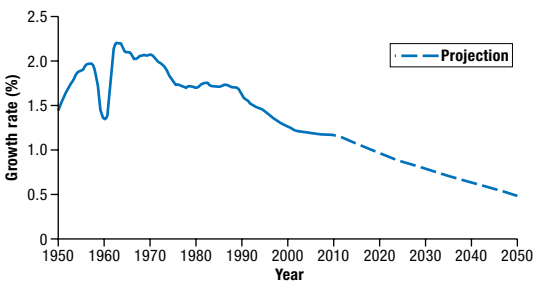

Figure 4.3c World population growth rates, 1950–2050.

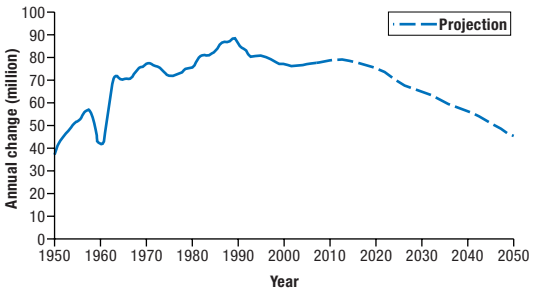

Figure 4.3d Annual world population change, 1950–2050.

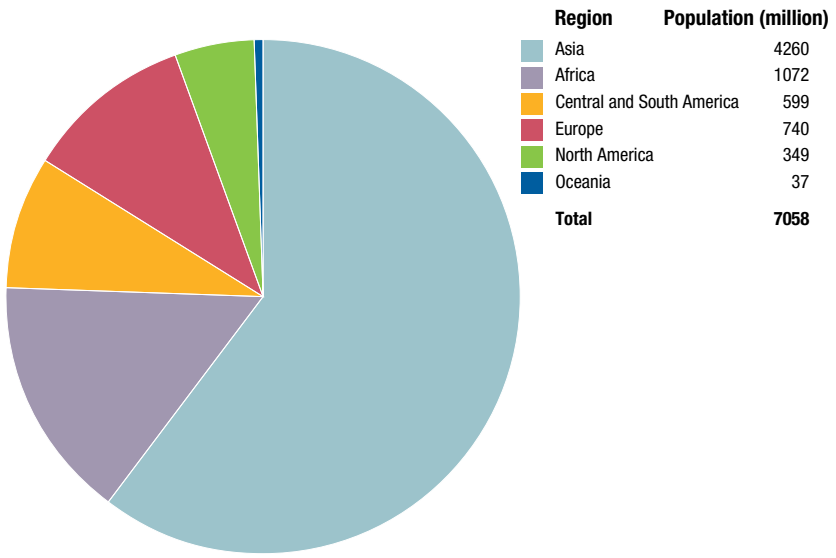

Figure 4.3e Distribution of the world's population, 2012.

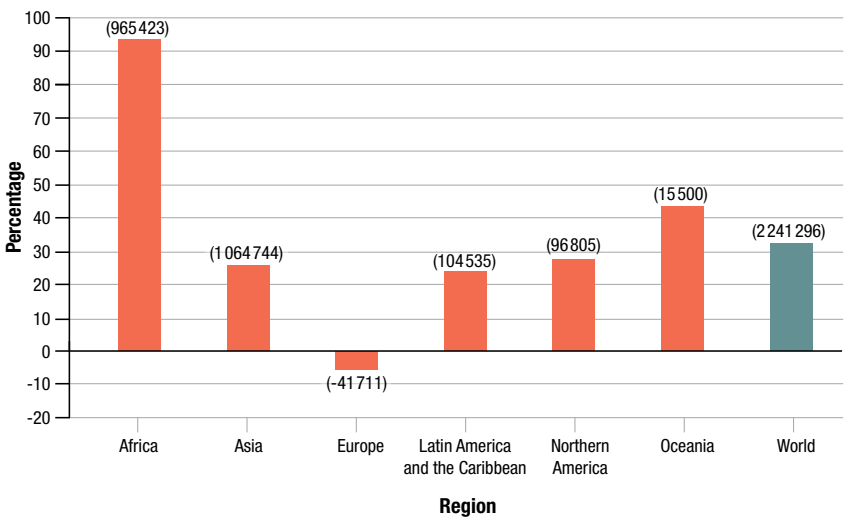

Figure 4.3f Projected population change by region, 2010–50 (millions).

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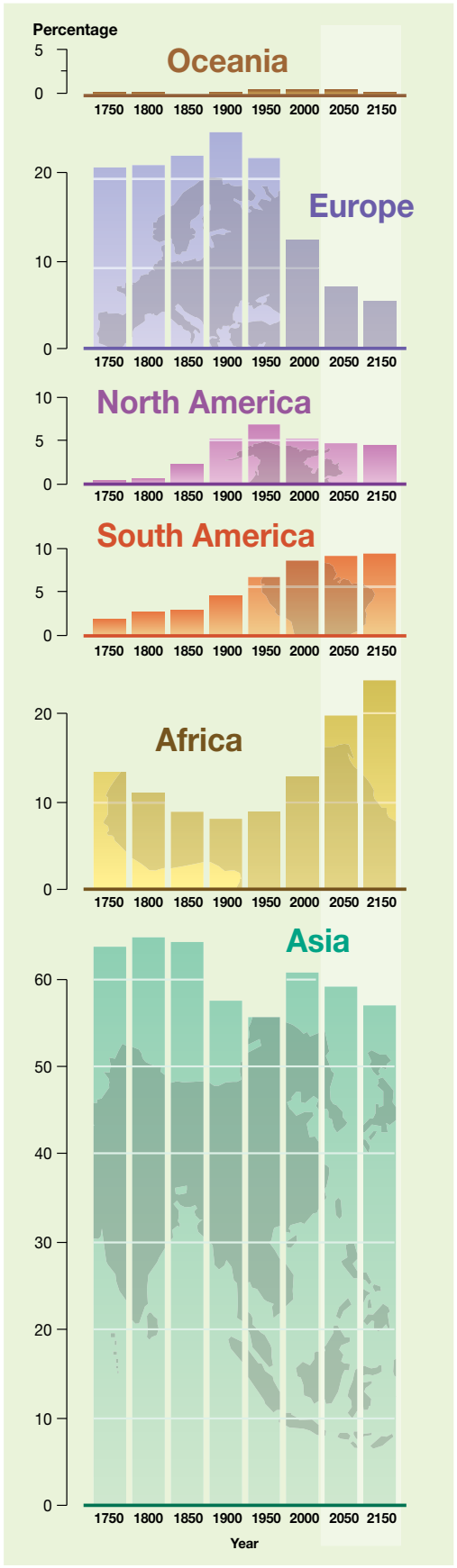
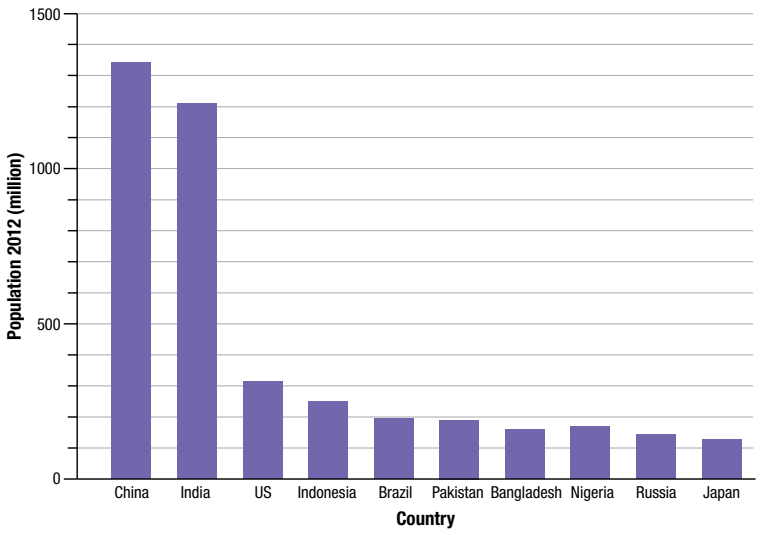


Figure 4.3g Global population distribution (percentage of world's population by region), 1750–2150.



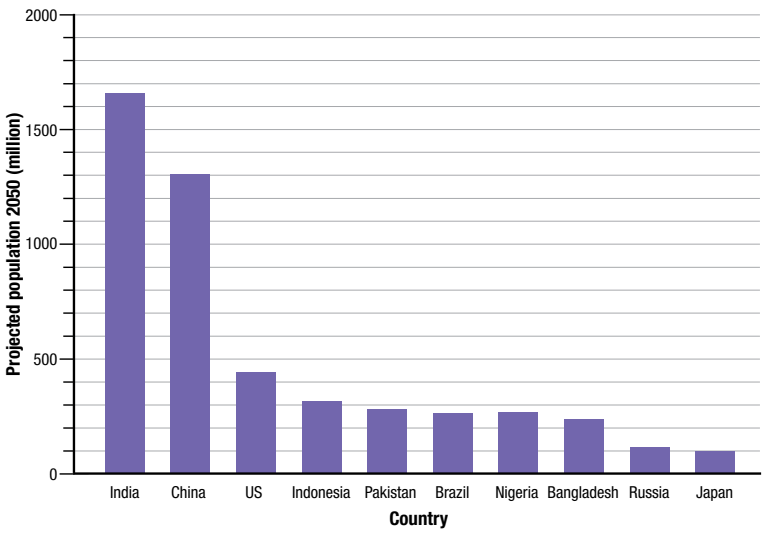
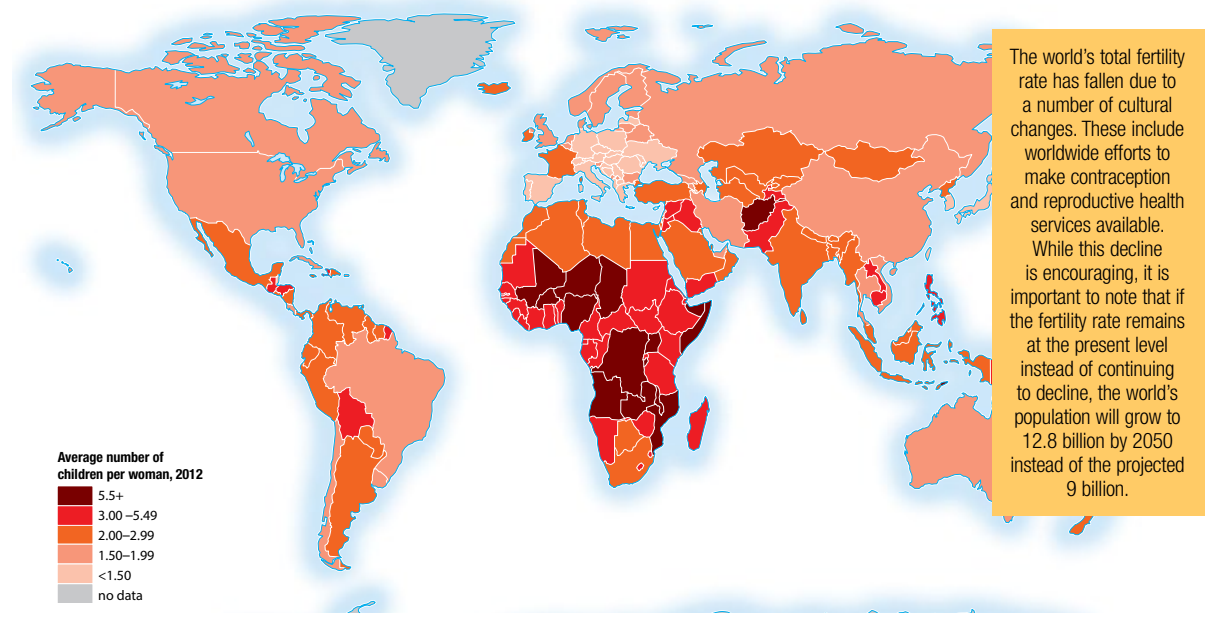


Figure 4.3h World's 10 most populous countries, 2012 and 2050 (projected).

Figure 4.3i Nanjing Road, Shanghai, China

MEGACITIES

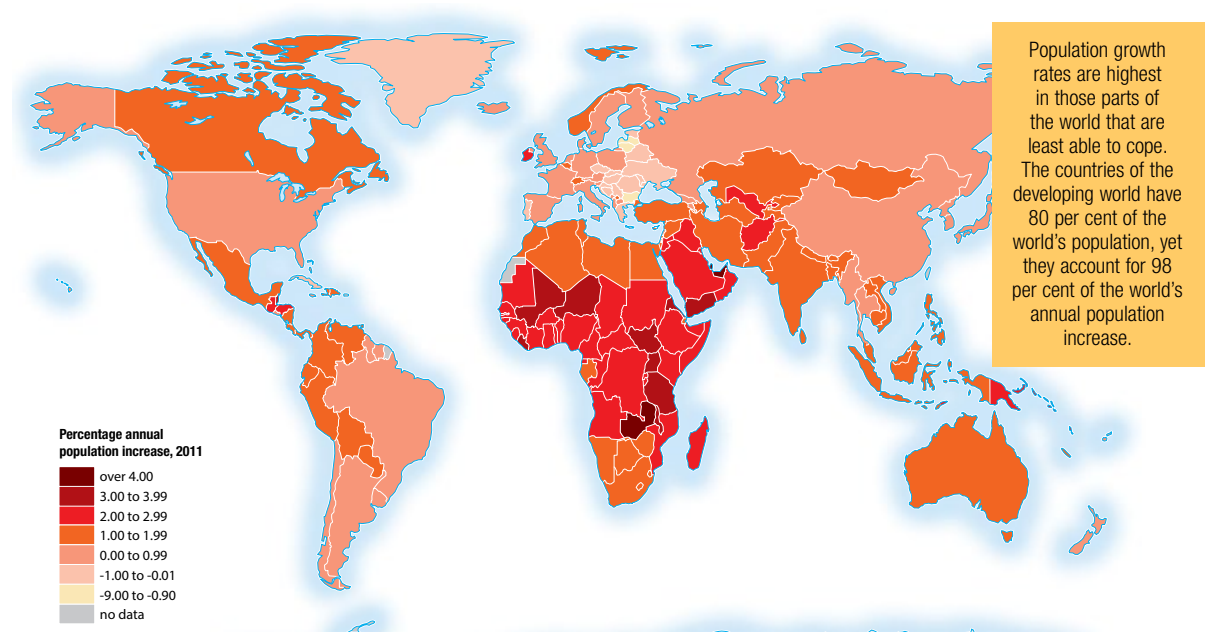
A *megacity* is defined as an urban area with a population in excess of 10 million people. A megacity can be a single metropolitan area or two or more metropolitan areas that converge. The term 'megapolis' is sometimes used synonymously with megacity, but it denotes a semi-continuous chain of large metropolitan cities. In 2013 there were more than 20 megacities in existence – with conurbations such as Mumbai, Tokyo, Seoul, New York City, Karachi and Jakarta having populations in excess of 20 million people.



The world's total fertility rate has fallen due to a number of cultural changes. These include worldwide efforts to make contraception and reproductive health services available. While this decline is encouraging, it is important to note that if the fertility rate remains at the present level instead of continuing to decline, the world's population will grow to 12.8 billion by 2050 instead of the projected 9 billion.

Figure 4.3j Total fertility rate, 2012.

Figure 4.3k Group of Kenyan children.



Population growth rates are highest in those parts of the world that are least able to cope. The countries of the developing world have 80 per cent of the world's population, yet they account for 98 per cent of the world's annual population increase.

Figure 4.3l Annual rate of population increase, 2011.

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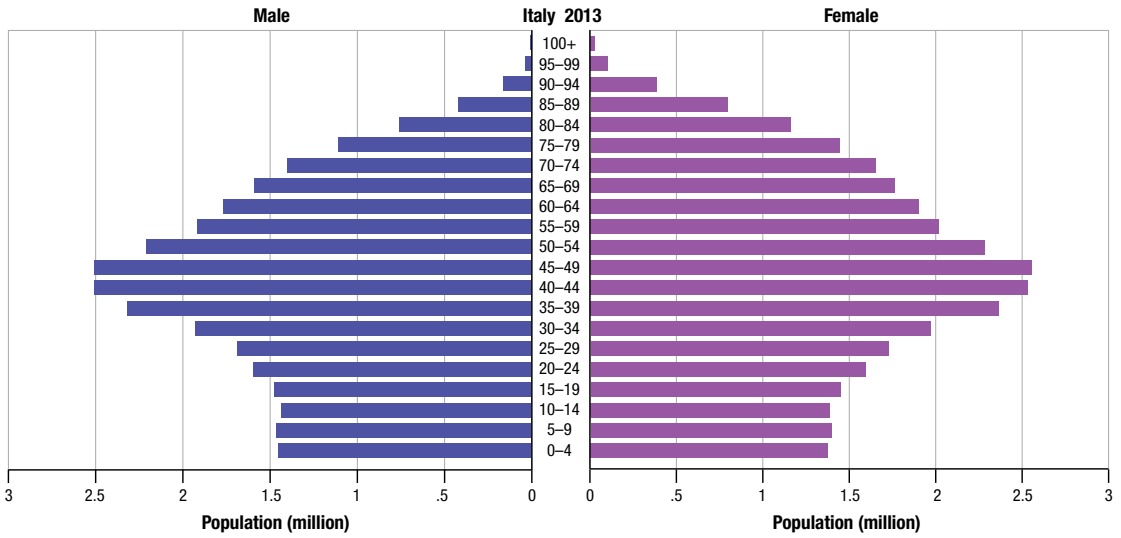

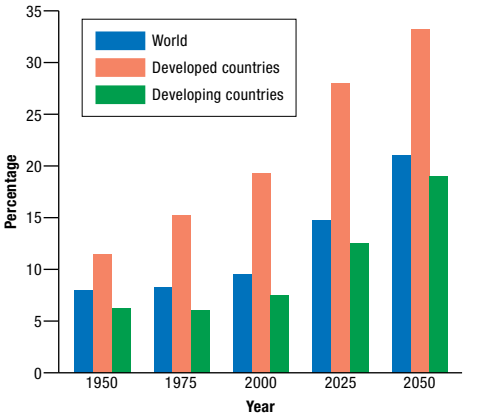

Figure 4.3m Proportion of the population aged 60 or over, 1950–2050.

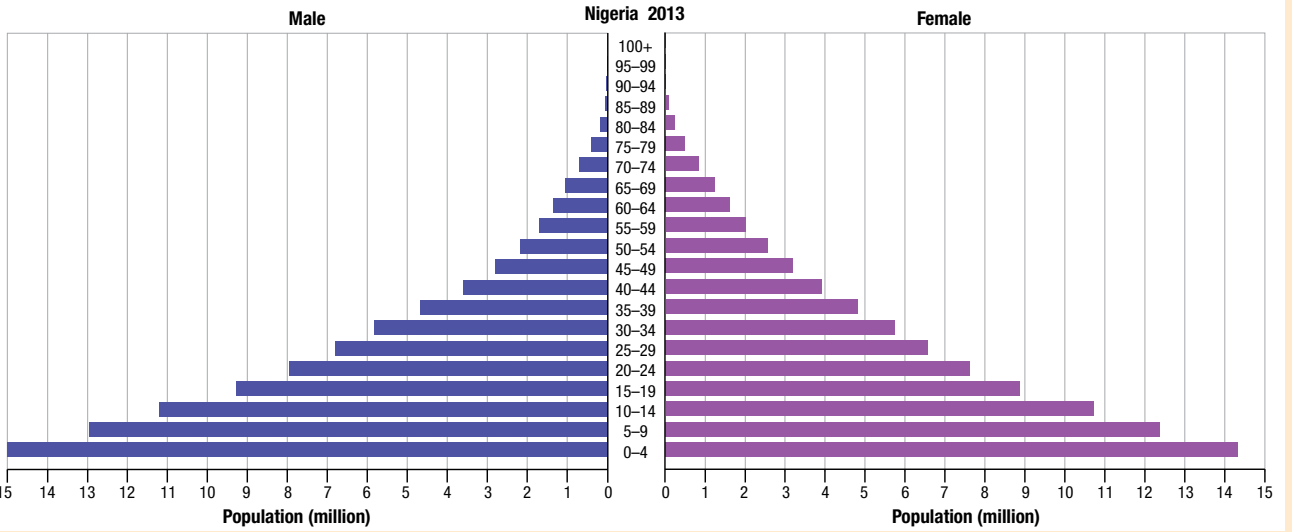

Figure 4.3n Population pyramids, Italy and Nigeria, 2013.

The number of older persons has tripled over the past 50 years; it will more than triple again over the next 50 years. Decreasing fertility along with increasing life expectancy has reshaped the structure of the population in most parts of the world.

Urbanisation

Urbanisation refers to the increasing share of a country's population living in towns and cities. It involves a shift of population from rural to urban areas. The 'push' and 'pull' factors responsible for this movement are shown in Figure 4.3o.

The majority of the world's urban population – in common with most of the world's total population – lives in developing countries. In 2000, developing countries had 2 billion urban dwellers, compared with only 900 million in developed regions.

Over the forthcoming 30 years, virtually all population growth will be in the urban areas of developing countries. Unfortunately, many cities in the developing world find it difficult to cope with the rate of population growth. Too many of the urban poor are forced to live in vast squatter settlements, and the disposal of waste and the supply of clean water are major challenges.

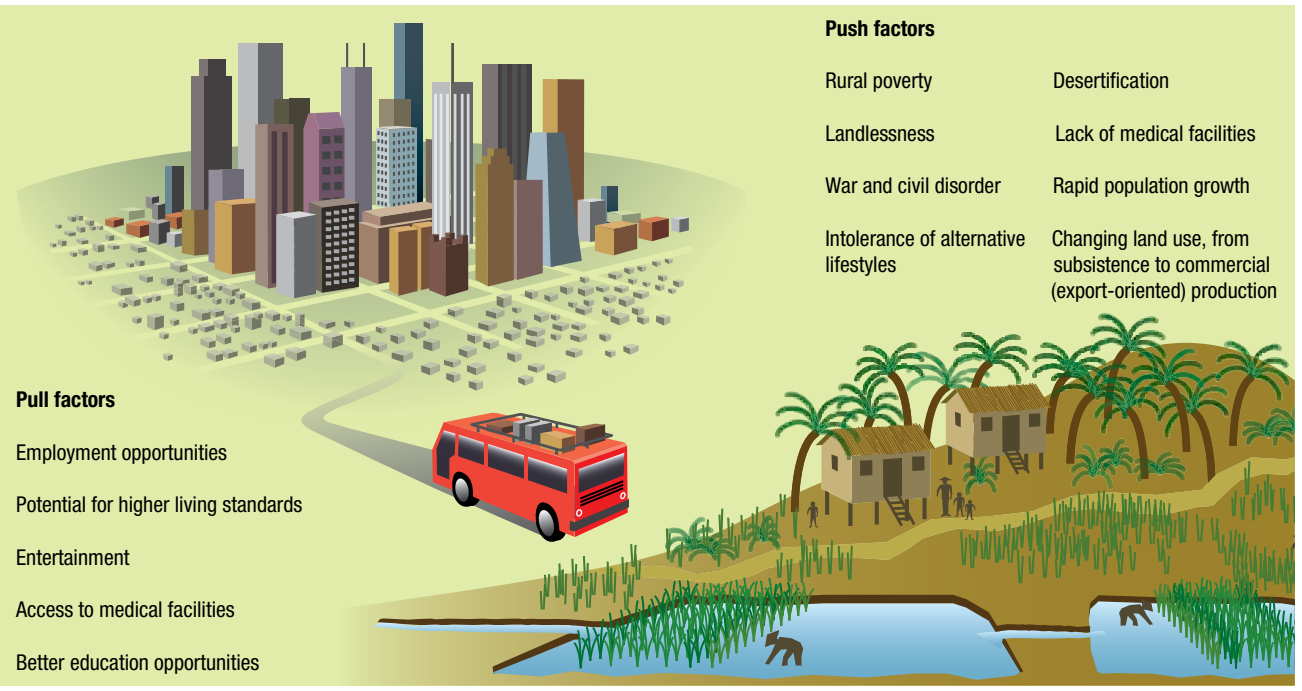

Figure 4.3o Factors in the process of urbanisation.

Figure 4.3p Manhatten skyline, New York.

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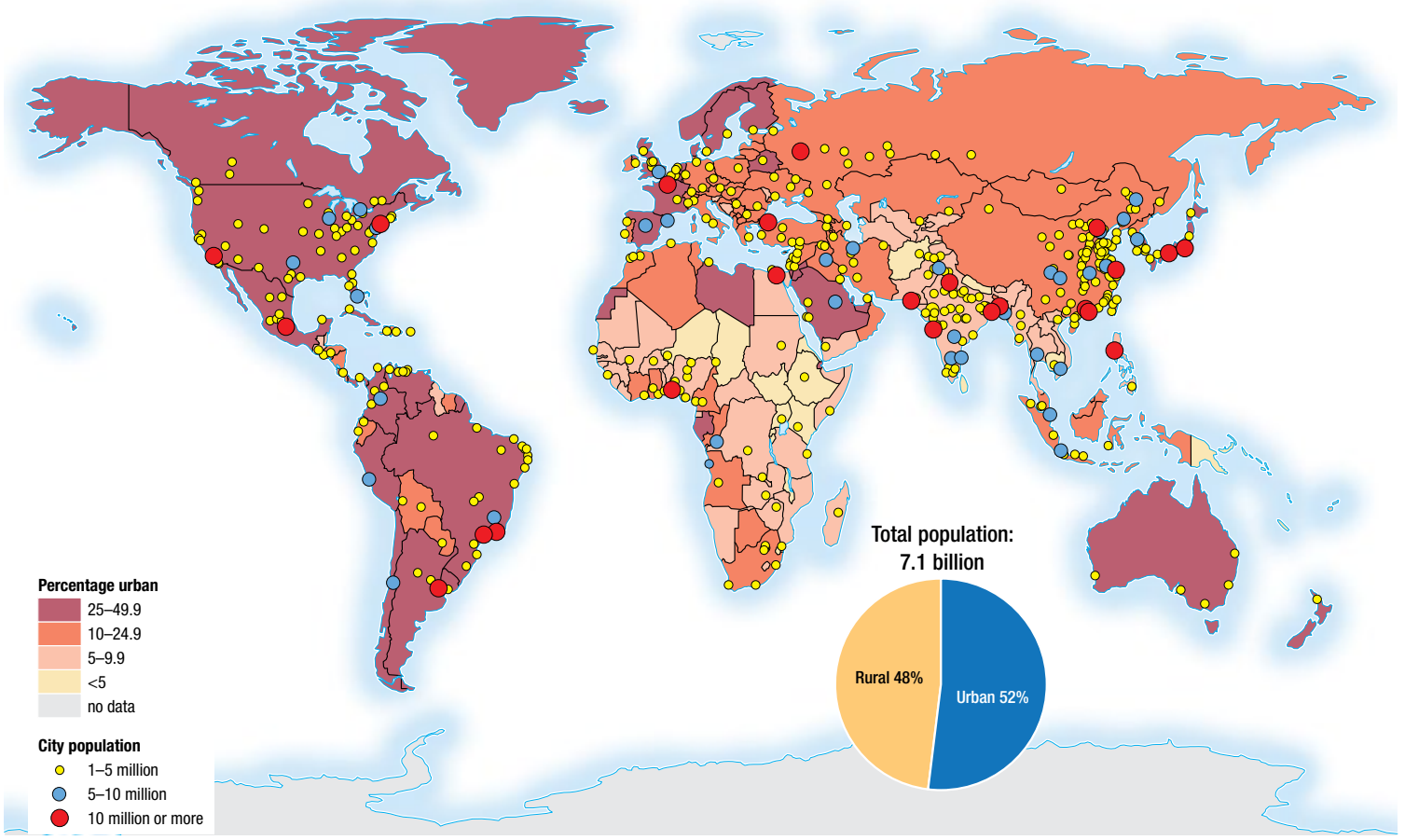

Figure 4.3q Urbanisation, 2011. The inset graph shows the percentages of urban and rural populations, 2011.

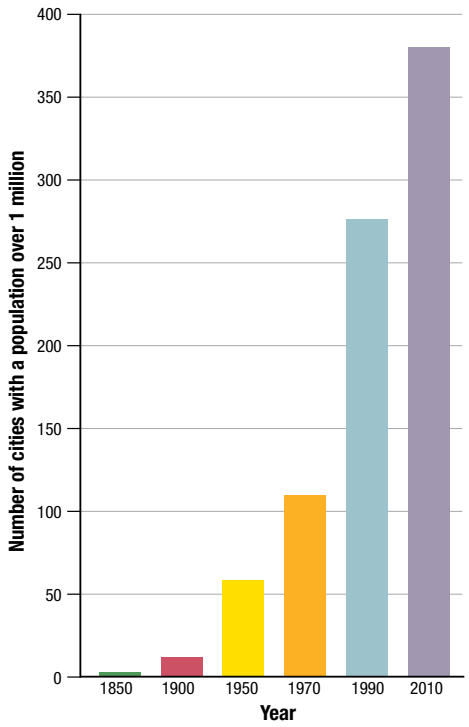

Figure 4.3r Number of cities with a population over 1 million, 1850–2010.

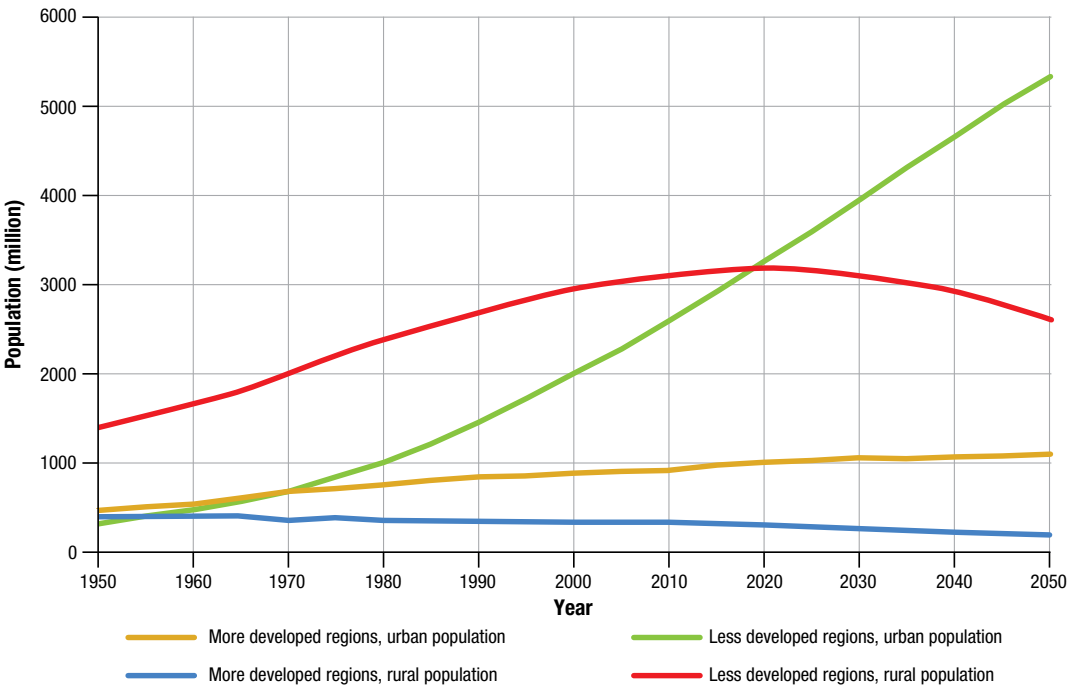

Figure 4.3s Urban and rural population by development group, 1950–2050.

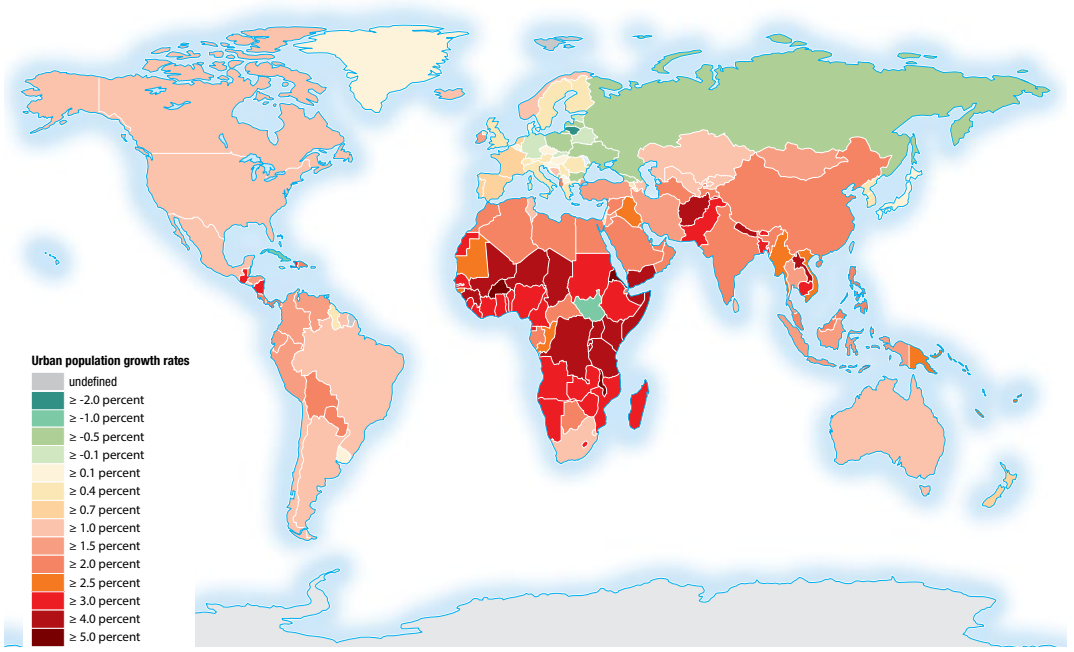

Figure 4.3t Urban population growth rates, 2010–15.

Figure 4.3u Polluted urban waterway, Delhi, India.

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Table 4.3a Population of urban areas with more than 10 million people, 2011 and 2025 (projected)

Rank	*Urban area*	*2011*	*Rank*	*Urban area*	*2025*
1	Tokyo, Japan	37.2	1	Tokyo, Japan	38.7
2	Delhi, India	22.7	2	Delhi, India	32.9
3	Mexico City	20.4	3	Shanghai, China	28.4
4	New York–Newark, United States	20.4	4	Mumbai (Bombay), India	26.6
5	Shanghai, China	20.2	5	Mexico City	24.6
6	São Paulo, Brazil	19.9	6	New York–Newark, United States	23.6
7	Mumbai (Bombay), India	19.7	7	São Paulo, Brazil	23.2
8	Beijing, China	15.6	8	Dhaka, Bangladesh	22.9
9	Dhaka, Bangladesh	15.4	9	Bejing, China	22.6
10	Kolkata (Calcutta), India	14.4	10	Karachi, Pakistan	20.2
11	Karachi, Pakistan	13.9	11	Lagos, Nigeria	18.9
12	Buenos Aires, Argentina	13.5	12	Kolkata (Calcutta), India	18.7
13	Los Angeles, United States	13.4	13	Manila, Philippines	16.3
14	Rio de Janeiro, Brazil	12.0	14	Los Angeles, United States	15.7
15	Manila, Philippines	11.9	15	Shenzhen, China	15.5
16	Moscow, Russia	11.6	16	Buenos Aires, Argentina	15.5
17	Osaka–Kobe, Japan	11.5	17	Guangzhou, China	15.5
18	Istanbul, Turkey	11.3	18	Istanbul, Turkey	14.9
19	Lagos, Nigeria	11.2	19	Cairo, Egypt	14.7
20	Cairo, Egypt	11.2	20	Kinshasa, Dem. Rep. of the Congo	14.5
21	Guangzhou, China	10.8	21	Chongqing, China	13.6
22	Shenzhen, China	10.6	22	Rio de Janeiro, Brazil	13.6
23	Paris, France	10.6	23	Bangalore, India	13.2
			24	Jakarta, Indonesia	12.8
			25	Chennai (Madras), India	12.8
			26	Wuhan, China	12.7
			27	Moscow, Russia	12.6
			28	Paris, France	12.2
			29	Osaka–Kobe, Japan	12.0
			30	Tianjin, China	11.9
			31	Hyderabad, India	11.6
			32	Lima, Peru	11.5
			33	Chicago, United States	11.4
			34	Bogotá, Colombia	11.4
			35	Bangkok, Thailand	11.2
			36	Lahore, Pakistan	11.2
			37	London, United Kingdom	10.3

Figure 4.3v Squatter settlement in the Philippines.

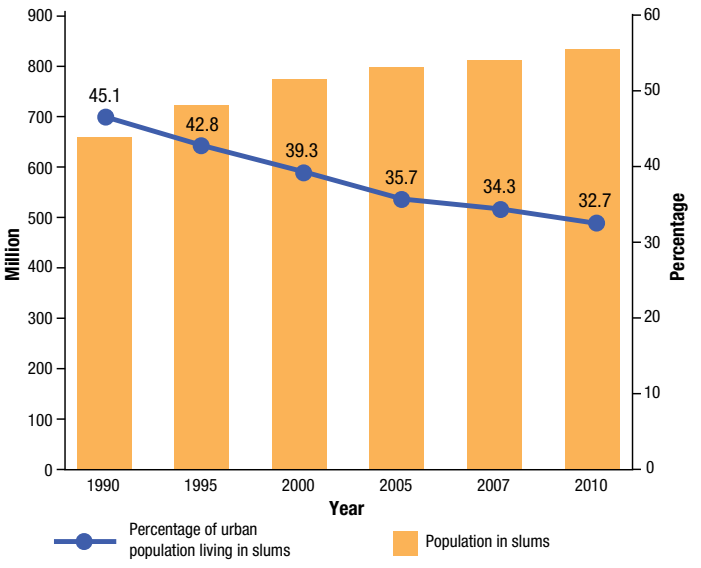

Figure 4.3w Population living in slums and proportion of the urban population living in slums, developing regions, 1990–2010.

ACTIVITIES

1. Study Figure 4.3a (page 86) and then, with the aid of an atlas, identify those parts of the world that have the highest and lowest population densities.
2. Study Figure 4.3b (page 86) and then answer the following questions:
   - **a** In what year did the world's population exceed 6 billion?
   - **b** In what year is the world's population expected to exceed 9 billion?
   - **c** How many years did it take for the population of the world to double from 3 billion to 6 billion people?
3. Study Figure 4.3c (page 86) and then answer the following questions:
   - **a** In what year did world population growth rates peak?
   - **b** What has been the general trend in world population growth rates since the mid-1960s?
   - **c** What was the world population growth rate in 2000?
4. Study Figure 4.3d (page 86) and then answer the following questions:
   - **a** In what year did the annual growth of world population peak? How many people were added to the world's population in that year?
   - **b** In what year is the annual growth of the world's population expected to begin its long-term decline?
   - **c** What is the level of annual world population growth expected to be in 2050?
5. Study Figure 4.3e (page 86) and then answer the following questions:
   - **a** On which continent is the greatest share of the world's population located?
   - **b** How many people live in Asia?
   - **c** What percentage of the world's population lives in Africa?
6. Study Figure 4.3f (page 86). Which region is projected to have the greatest percentage change in its population between 2010 and 2050? Which continent will experience a decline in its population?
7. Study Figure 4.3g (page 87). Identify the regions with an increasing share of the world's population and those with a declining share between 2000 and 2150. Which regions share of the world's population will increase most rapidly?
8. Study Figure 4.3h (page 87). Which countries will increase their ranking between 2012 and 2050?
9. Study Figure 4.3j (page 87). With the aid of an atlas, identify those parts of the world with the highest total fertility rate.
10. Compare Figure 4.3l (page 87), which shows the pattern of population growth, with Figure 4.4a (page 91), which shows gross national income per capita. Describe the nature of the relationship.
11. Study Figure 4.3m (page 88) and then answer the following questions:
    - **a** What percentage of the world's population was aged 60 years and over in 2000?
    - **b** What percentage of the world's population is projected to be over 60 years in 2050?
    - **c** In what part of the world is the rate of population ageing projected to be fastest in the period 2000–50?
12. Study Figure 4.3n (page 88) and then answer the following questions:
    - **a** What percentage of Italy's population was under the age of 15 years in 2013?
    - **b** What percentage of Italy's population was over the age of 65 years in 2013?
    - **c** What percentage of Nigeria's population was under the age of 15 years in 2013?
    - **d** What percentage of Nigeria's population was over the age of 65 years in 2013?
    - **e** How may Italians are there under the age of 15 years?
    - **f** How many Nigerians are there under the age of 15 years?
13. Study Figure 4.3o (page 88). Write two to three paragraphs outlining the factors driving the process of urbanisation.
14. Study Figure 4.3q (page 89) and, with the aid of an atlas, identify those regions of the world that have the highest and lowest rates of urbanisation.
15. Study the inset graph in Figure 4.3q (page 89). What was the size of the world's urban population in 2012?
16. Study Figure 4.3r (page 89). In which period did the number of 1 million-plus cities increase most rapidly?
17. Study Figure 4.3s (page 89) and consider the following questions:
    - **a** Which population is growing most rapidly?
    - **b** In what year will the rural population of less developed regions start declining?
18. Study Figure 4.3t (page 89). With the aid of an atlas, identify the regions with the highest and lowest urban population growth rate in 2010–15.
19. Study Table 4.3a. Construct a column graph showing the population of the world's 10 largest urban areas in 2012 and 2025.
20. Study Figures 4.3u (page 89) and 4.3v. Write a paragraph describing the nature of the urban environment shown in the photographs. As a class, discuss the reasons people are forced to live in such conditions.
21. Study Figure 4.3w. Describe the trends in the world's slum population.

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4.4 Global inequalities

The differences in people's quality of life largely depend on whether they live in one of the world's developed countries or in one of its developing countries. Variations also occur within countries, but these are not apparent when we look at data that have been averaged. The differences in the quality of life in one country compared with another, and between groups within countries, are referred to as inequalities.

Sometimes they are also referred to as socio-economic inequalities because they refer to the unequal distribution of both wealth and a range of social benefits, such as health care and education.

Table 4.4a World's 20 wealthiest countries, 2011

Country	*Gross national income per capita (US$)*
Monaco	183,150
Liechtenstein	137,070
Norway	88,870
Qatar	80,440
Luxemburg	77,390
Switzerland	76,350
Denmark	60,160
Sweden	60,160
Australia	49,790
Netherlands	49,660
Kuwait	48,900
United States	48,620
Austria	48,170
Finland	47,760
Belgium	45,930
Canada	45,550
Japan	44,900
Germany	44,230
Singapore	42,930
France	42,930

Table 4.4b World's 10 poorest countries, 2011

Country	*Gross national income per capita (US$)*
Eritrea	430
Guinea	430
Madagascar	430
Ethiopia	370
Malawi	360
Niger	360
Liberia	333
Burundi	250
Dem. Rep. of the Congo	190
Somalia	150

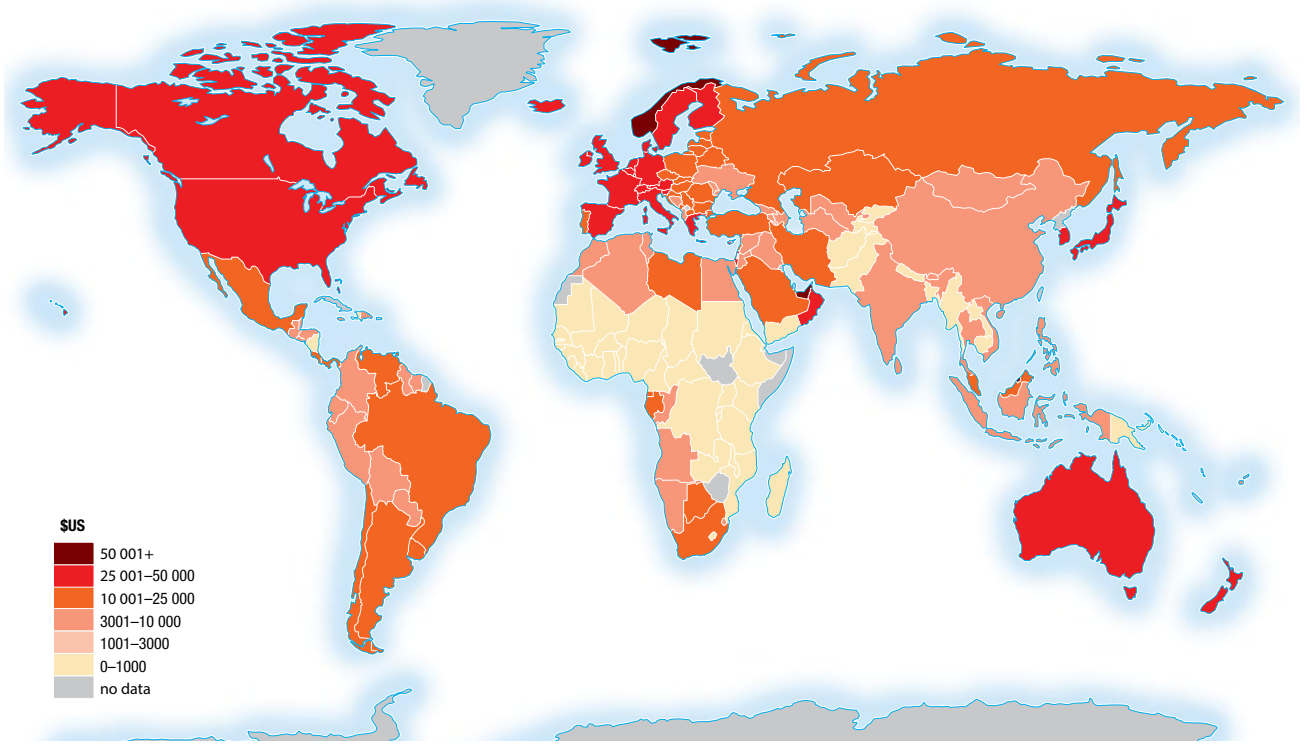

Figure 4.4a Gross national income per capita, 2012.

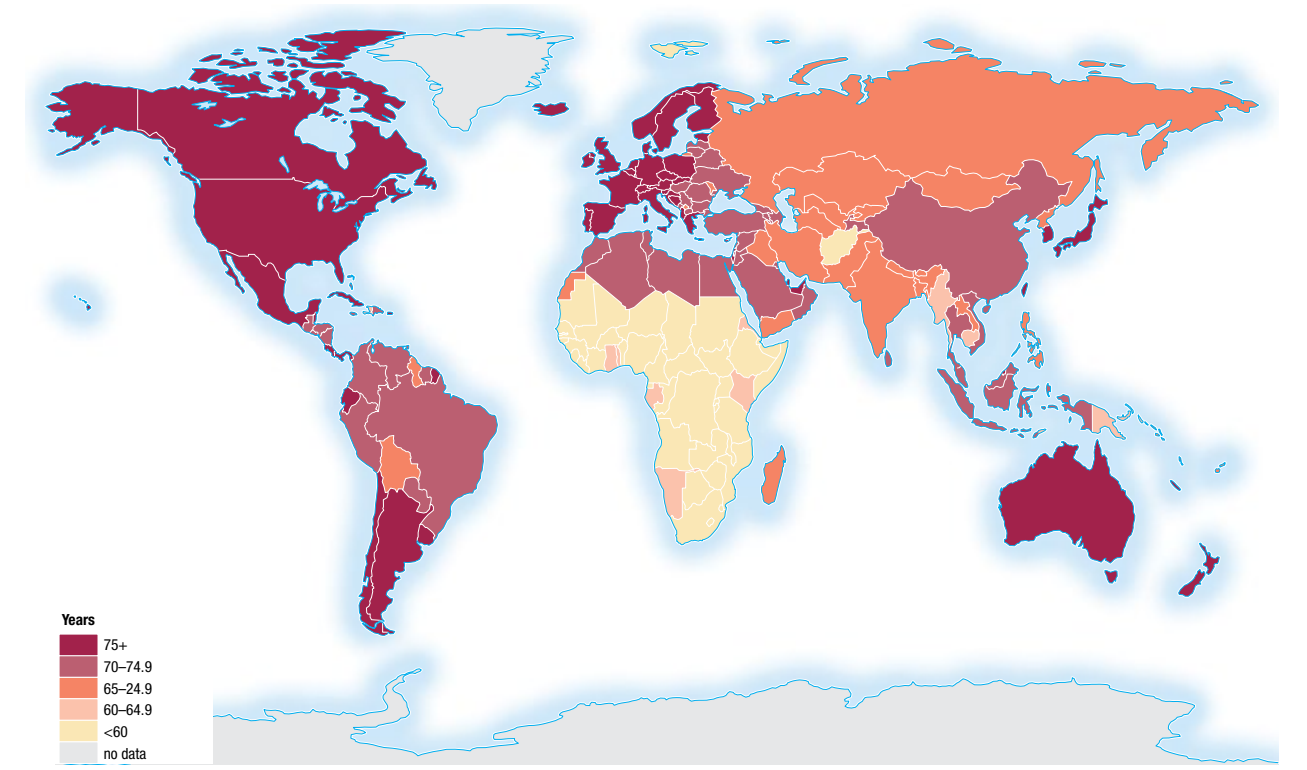

Figure 4.4b Life expectancy at birth, 2012.

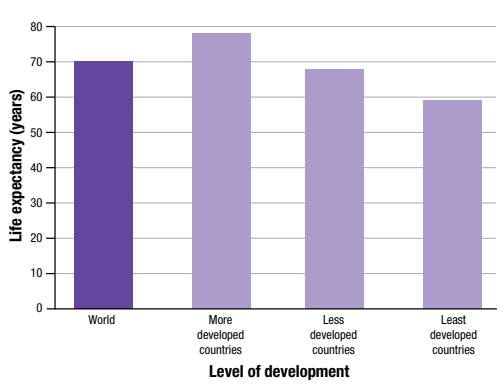

Figure 4.4c Life expectancy at birth by region, based on level of development, 2012.

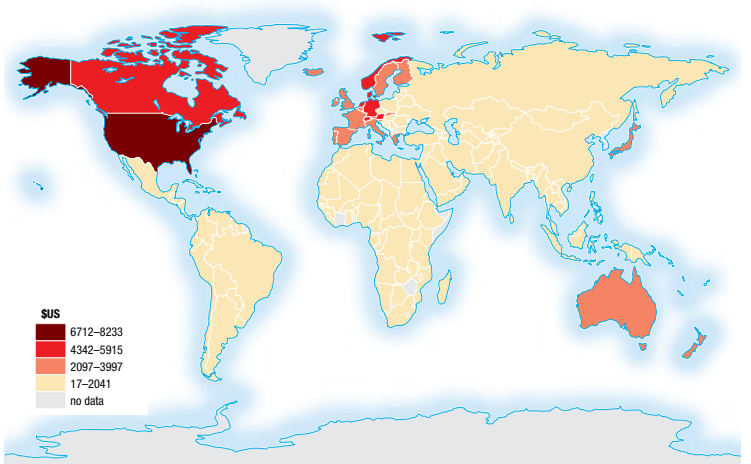

Figure 4.4d Health expenditure per capita, 2010.

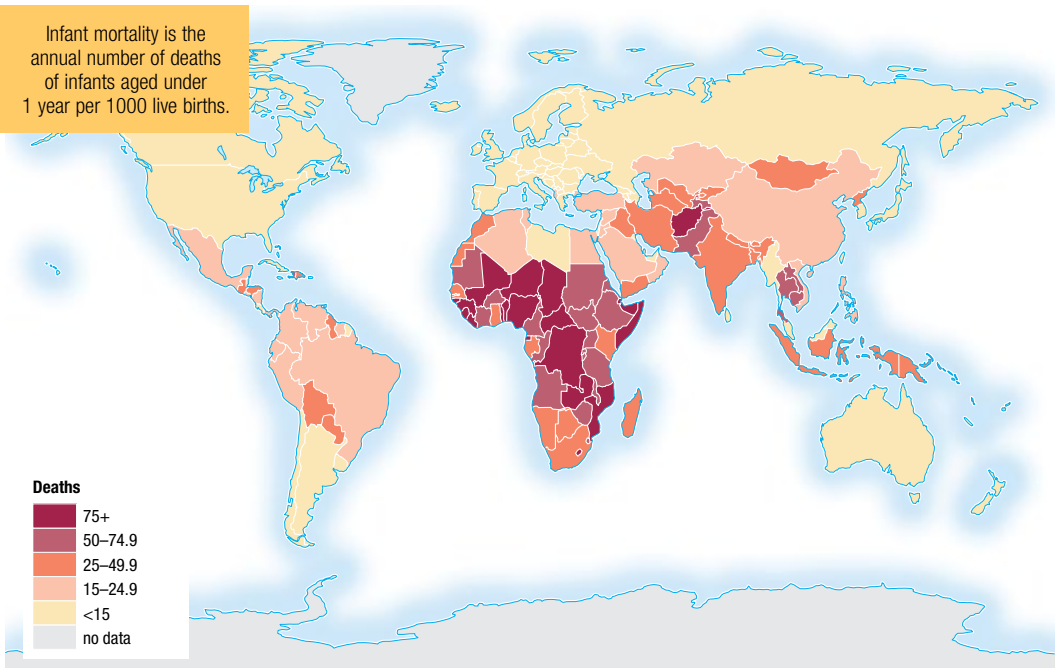

Figure 4.4e Infant mortality per 1000 live births, 2012.

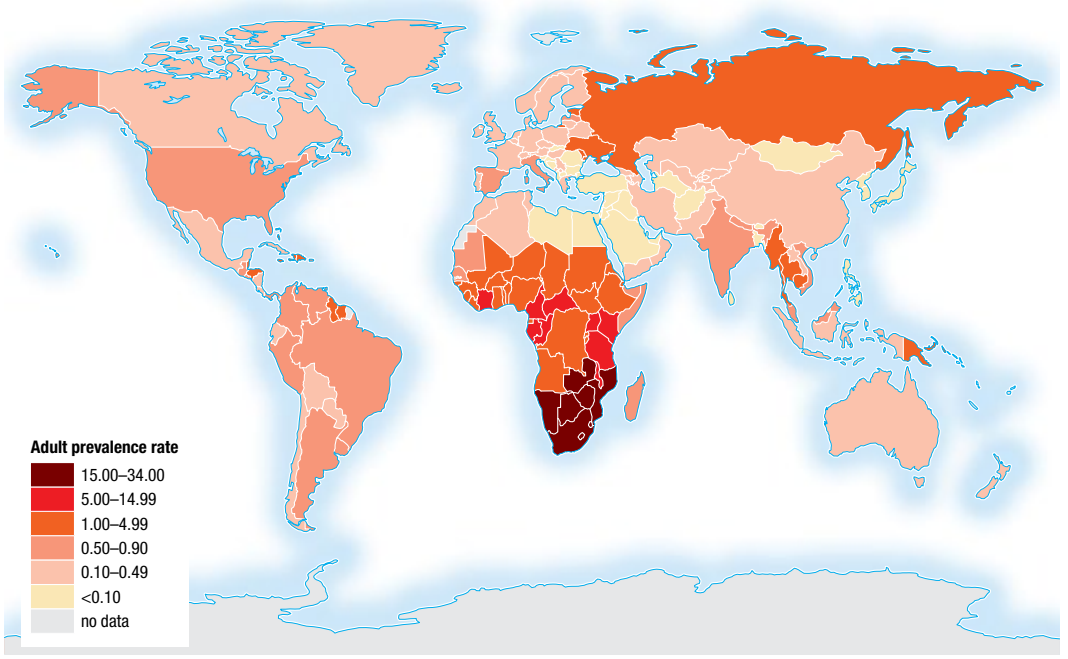

Figure 4.4g Adult HIV/AIDS infection rate, 2011. There were 34 million people living with HIV/AIDS worldwide in 2011 and 1.7 million of them died of AIDS-related illnesses.

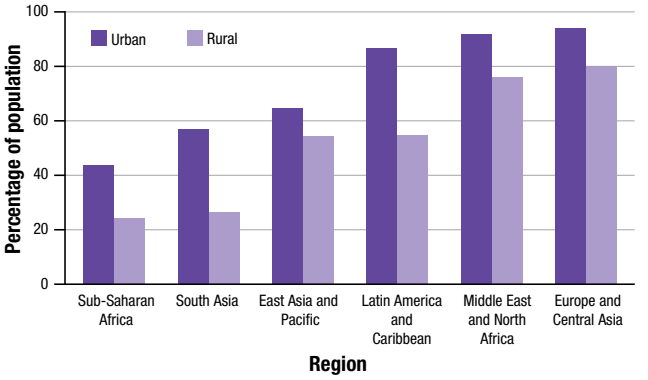

Figure 4.4f Percentage of the urban and rural population with access to improved sanitation, 2008.

HIV/AIDS

The AIDS epidemic may well be the greatest health disaster in human history. It continues to devastate families and communities throughout the world. In addition to the 1.7 million people who had died of AIDS in 2011, at least 34 million people are now living with the disease. Ninety-five per cent of new AIDS victims live in sub-Saharan Africa, Asia and Eastern Europe.

Figure 4.4h Children orphaned as a result of HIV/AIDS, Malawi, Africa.

ACTIVITIES

1. Study Figure 4.4a (page 91). Identify the regions of the world with the highest and lowest gross national income per capita.
2. Study Table 4.4a (page 91). Construct a column graph featuring the gross national income per capita of the world's 20 wealthiest countries. Shade Australia's column with a contrasting colour.
3. Study Table 4.4b (page 91). With the aid of an atlas, locate the countries listed in the table. What do they all have in common?
4. Study Figure 4.4b (page 91). With the aid of an atlas, identify those regions of the world that have the lowest life expectancy.
5. Study Figure 4.4c (page 91). By how many years does the average life expectancy of the more developed world exceed that of the least developed world?
6. Study Figures 4.4b (page 91) to 4.4e. Explain the link between the data presented in Figure 4.4d and the information provided in Figures 4.4b, 4.4c and 4.4e.
7. Study Figure 4.4e. With the aid of an atlas, identify those parts of the world that have an infant mortality rate greater than 50 per 1000 live births.
8. Study Figure 4.4f and then complete the following questions:
   - a Which region of the world has the lowest proportion of its population able to access improved sanitation?
   - b What percentage of East Asia's and Pacific rural population has access to improved sanitation?
   - c Which region has just under 70 per cent of its urban population able to access improved sanitation?
   - d Of the regions of the developing world, which region's people have greatest access to improved sanitation?
9. Study Figure 4.4g. With the aid of an atlas, name the countries with more than 15 per cent of its adult population infected with HIV/AIDS.
10. Write a report using data from the maps, tables and graphs in Unit 4.4 to outline and explain the relationship between gross national income per capita and factors such as life expectancy, infant mortality, access to improved sanitation and the incidence of HIV/AIDS.

4.5 Access to water and sanitation

A clean supply of water is vital for people's health. However, like many of the Earth's resources, it is unevenly distributed and stored. More than 97 per cent of the Earth's water is too salty for use. It is stored in the oceans, which cover 85 per cent of the Earth's surface. This means that only 2.5 per cent of the world's water is fresh. Of this, 68.9 per cent is stored as snow and glaciers, 30.8 per cent as groundwater and just 0.3 per cent is found in lakes and rivers.

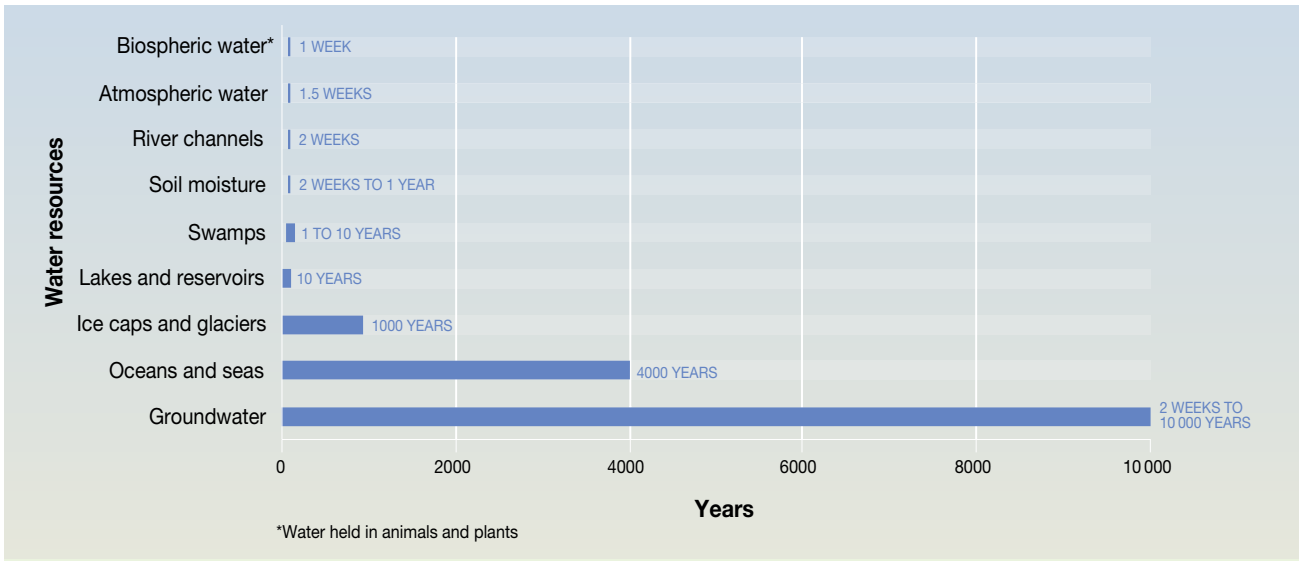

Figure 4.5a Estimated storage times of the world's water resources.

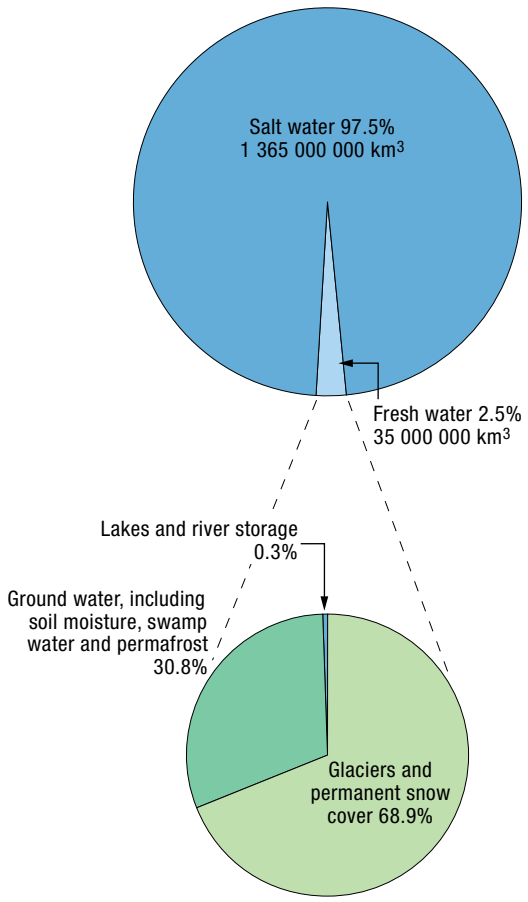

Figure 4.5b Total global saltwater and freshwater estimates.

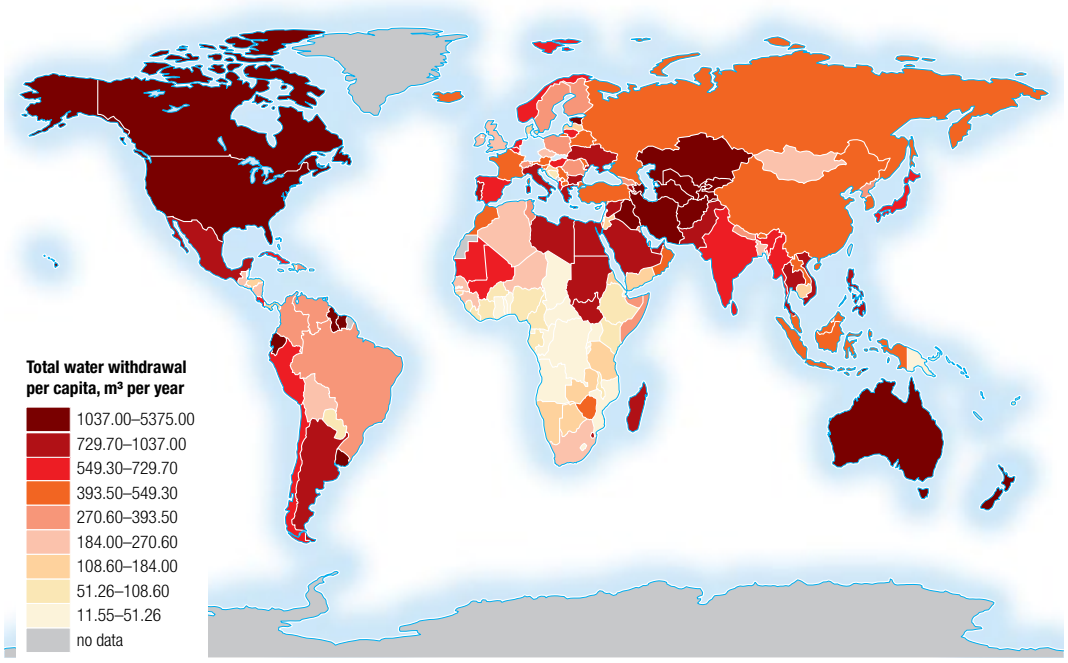

Figure 4.5c Total water use per year.

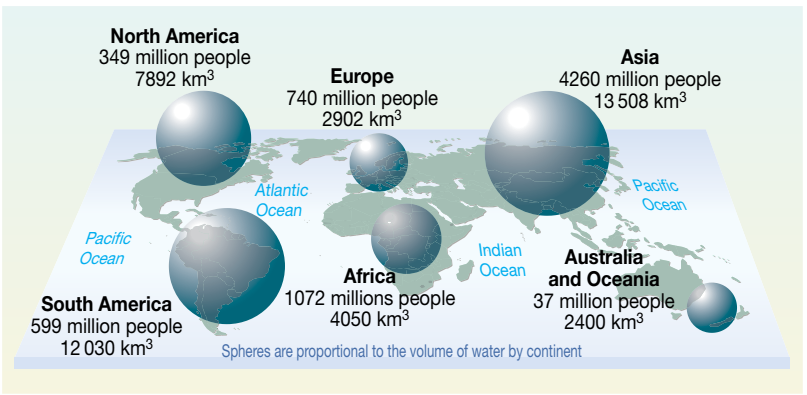

Figure 4.5d Water resources by continent, annual average volume.

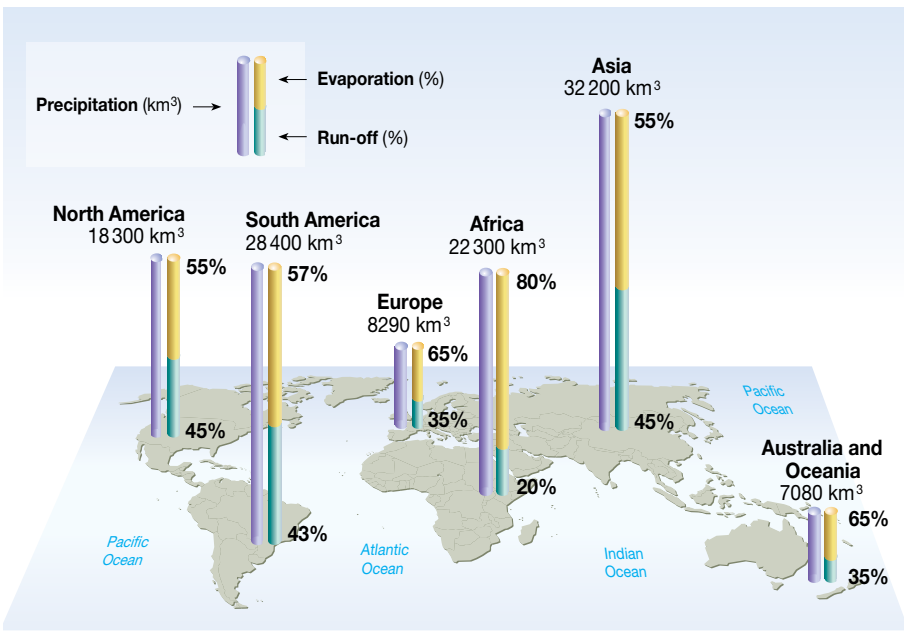

Figure 4.5e Precipitation, evaporation and run-off by region.

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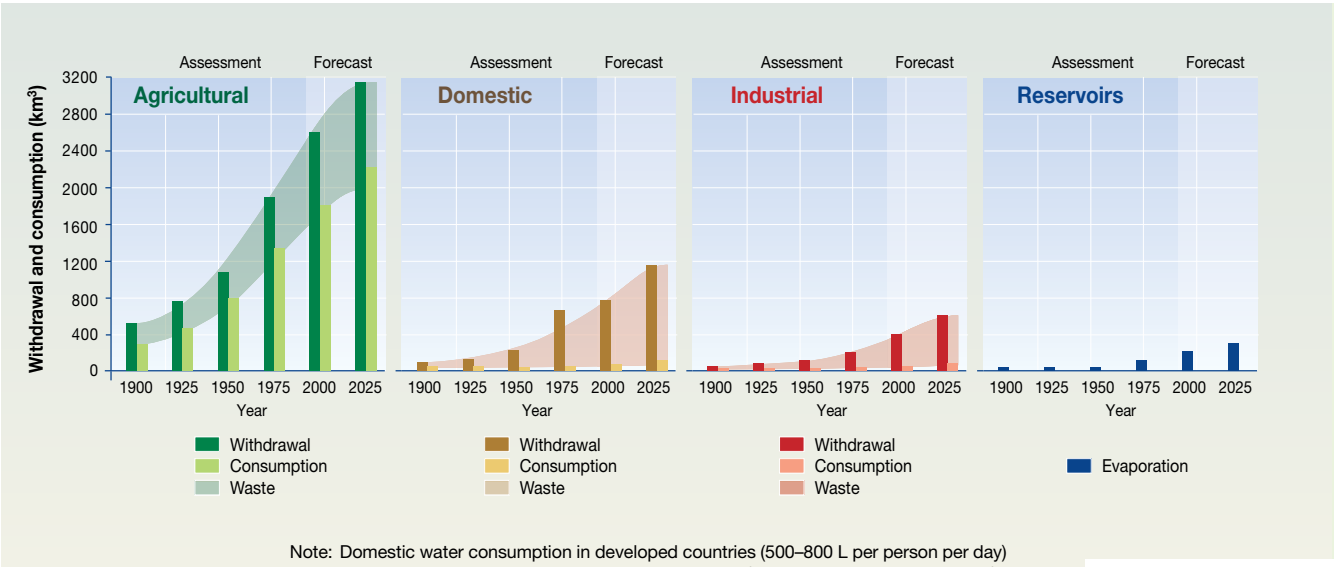

Figure 4.5f Global water use: withdrawal and consumption by sector, 1900–2025.

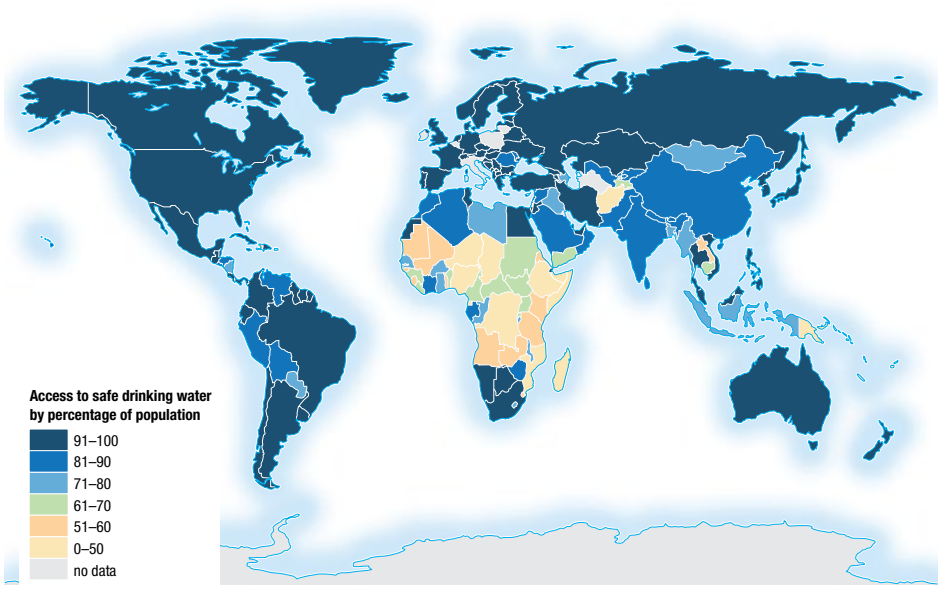

Figure 4.5g Access to safe drinking water by country, 2010.

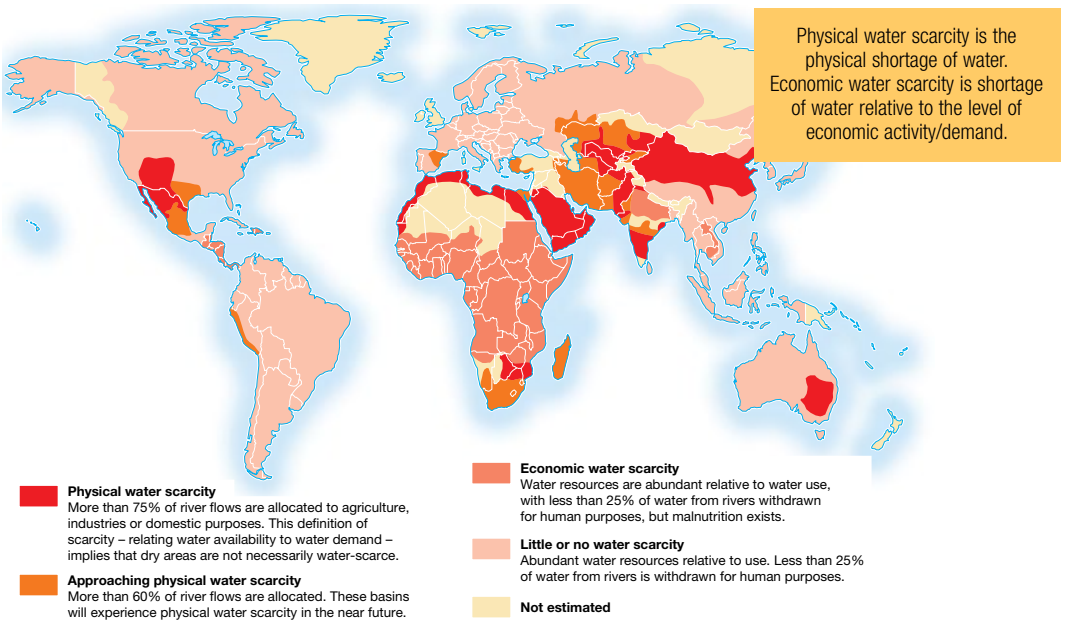

Figure 4.5h Projected water scarcity, 2025.

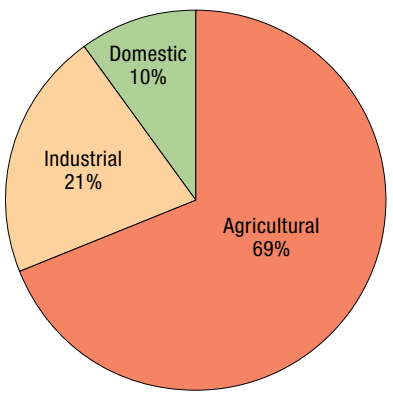

Figure 4.5i Global water use by sector.

Figure 4.5j Clean water is a scarce resource in developing countries.

Over 1.2 billion (or 18 per cent) of the Earth's people do not have access to clean, safe water. Each year between 5 and 10 million people (mostly children) die from water-related illnesses. The most serious of these are hepatitis, typhoid, cholera, hookworm, malaria and trachoma. Each person needs 5 L of water a day to survive and a further 25 L per day to stay clean and healthy.

ACTIVITIES

1. Study Figure 4.5a (page 93). Using the data in the graph, write a report outlining the estimated time water is stored in various parts of the water cycle. What are the implications of this for the availability of water for human use?
2. Study Figure 4.5b (page 93) and then complete the following tasks:
   - **a** Using the data in the graph showing the distribution of the world's freshwater, calculate the volume of the world's freshwater stored in glaciers and permanent snow cover.
   - **b** Undertake internet research to find out what permafrost is.
3. Study Figure 4.5c (page 93) and then, with the aid of an atlas, complete the following tasks:
   - **a** Identify those parts of the world that have annual per capita water use greater than 1037 m^3 a year.
   - **b** What is the annual per capita water use of China?
   - **c** On what continent are the countries with the lowest annual per capita use of water located?
4. Using data from Figure 4.5d (page 93), calculate the annual average volume of water available for each 1 million people living on each continent. Use the data to construct a bar graph showing the average annual availability of water for each 1 million people. Give your graph an appropriate title.
5. Study Figure 4.5d (page 93) and then complete the following questions:
   - **a** Which continental landmass has the largest annual average volume of water?
   - **b** What is the average annual volume of water on the driest of the continental landmasses shown in the graph?
   - **c** By how much does the average annual volume of water available in South America exceed that available in North America?
6. Study Figure 4.5e (page 93) and then complete the following questions:
   - **a** Which region receives the greatest precipitation?
   - **b** Which of the regions featured has the least precipitation?
   - **c** Which region(s) has the highest percentage of run-off?
   - **d** Which region has the greatest rate (%) of evaporation?
   - **e** What are the implications of these data for agriculture in Africa?
7. Study Figure 4.5f and then complete the following tasks:
   - **a** Rank the sectors according to the amount of water consumed in 2000.
   - **b** How much water was withdrawn for agriculture in 2000?
   - **c** What percentage of agricultural withdrawals was wasted in 2000?
   - **d** By how much did domestic withdrawal of water increase between 1950 and 2000?
   - **e** Which water use sector has the highest percentage of waste relative to consumption in 2025?
8. Study Figure 4.5g. With the aid of an atlas, identify the parts of the world where less than 70 per cent of the population have access to safe drinking water.
9. Study Figure 4.5h and then, with the aid of an atlas, complete the following tasks:
   - **a** Which parts of the world are likely to experience economic water scarcity in 2025?
   - **b** Which parts of the world are likely to experience physical water scarcity in 2025?
   - **c** Write a report outlining the water crisis facing planet Earth. Use the following websites as sources of data: UNICEF Voices of Youth and UNESCO World.

4.6 Food security

Figure 4.6a The United Nations World Food Programme's World hunger map, 2012. Credit: World Food Programme, 2012.

Food security is achieved when all people at all times have physical and economic access to sufficient, safe, nutritious food to meet dietary needs and food preferences for a healthy and active life.

To be 'food secure' means that:

- enough good quality food is available
- food is affordable and within the reach of all
- the right kind of food is available.

The threats to food security include are outlined in Figure 4.6e on page 96.

Figure 4.6b Grain harvesting.

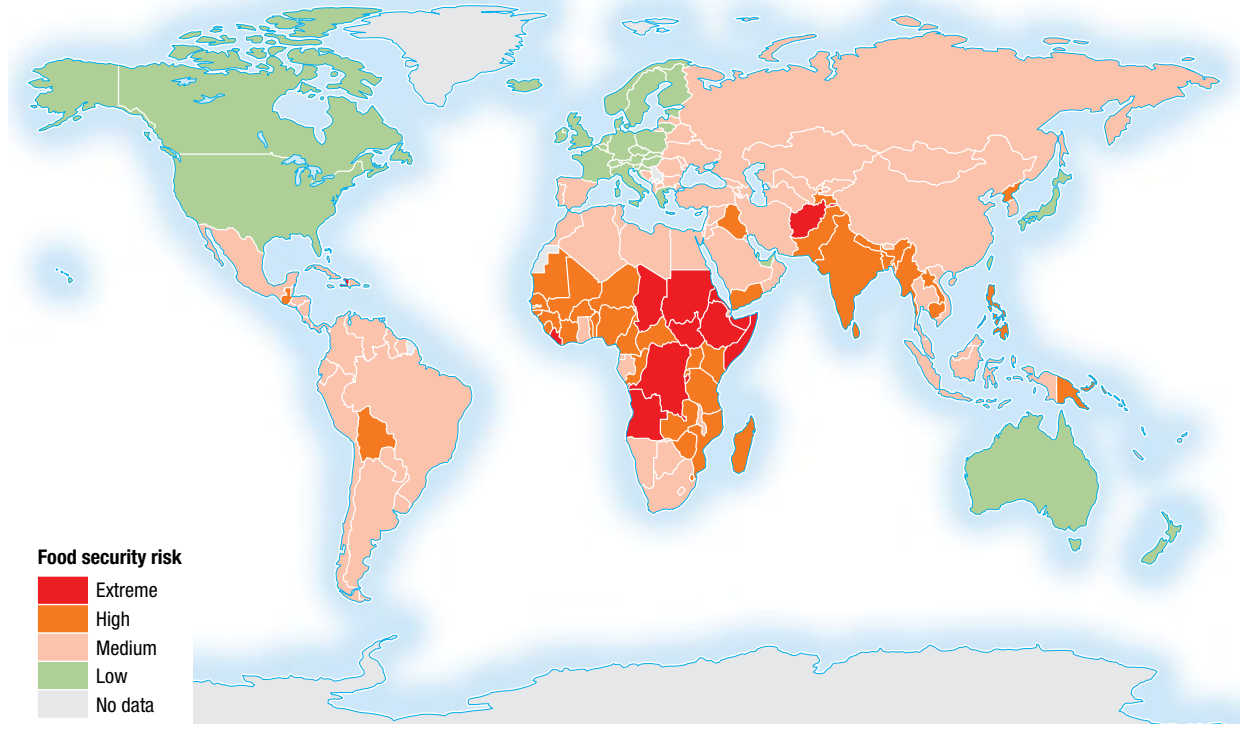

Figure 4.6c Food Security Index, 2011. The Global Food Security Index considers the core issues of affordability, availability and quality across 105 countries.

FOOD PRICE INCREASES

Rising food prices have pushed millions of people in developing countries further into hunger and poverty. However, it is not just high prices that are a problem. Prices are unpredictable and fluctuate widely, meaning that consumers cannot rely on regular prices, and producers are unable to plan their investments with certainty. The main causes of price increases are:

- reduced crop yields due to weather, possibly linked to climate change
- export restrictions and panic buying – usually caused by weather-related shocks
- increased demand, both for biofuels – which takes land away from food production – and for food (especially meat)
- increased oil prices, which have driven up the cost of agricultural inputs such as fertilisers and transport.

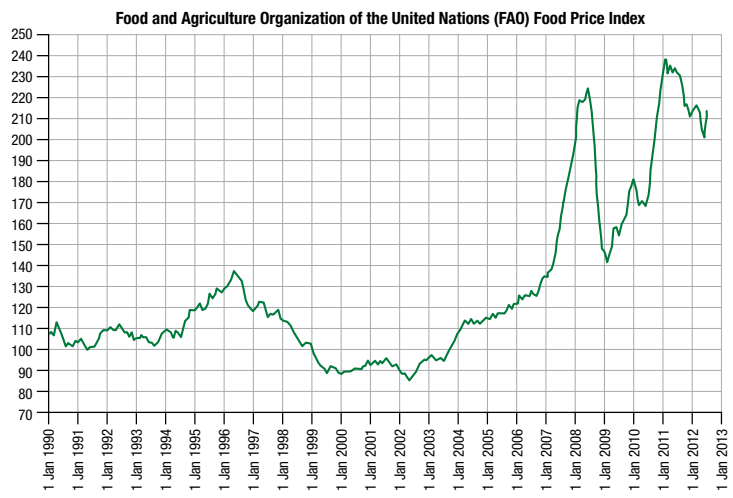

Figure 4.6d Trends in food prices, 1990–2013.

Table 4.6a Suitable land for agriculture

Region	*Cultivated area (millions of hectares)*	*Area suitable for agriculture (millions of hectares)*	*Percentage of suitable land in cultivation*
Asia	439	585	75
Latin America	203	1066	19
OECD	265	497	53
Russia	387	874	44
Sub-Saharan Africa	228	1031	22
West Asia and North America	86	99	87
World	1600	4152	39

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Population growth: World population is expected to increase from 7.08 billion in 2013 to more than 9 billion by 2050. Every 13 years the world population grows by a billion, representing an extra billion mouths that need to be fed. Much of this growth is occurring in those parts of the world already experiencing food shortages, especially Asia and Africa.

Water shortages: The world is running out of fresh water. Food production currently accounts for about 70 per cent of the world's readily available fresh water. However, the growth of cities, with their huge thirst for water, is competing with farmers for this resource. By 2050, the urban population will consume half or more of all the world's available fresh water. Unless major new sources or savings are found, farmers will have to make do with about half of the world's currently available fresh water supply while needing to grow twice as much food.

Land scarcity: The world is running out of good farmland. A quarter of all land is now so degraded that it struggles to produce food. At the same time, cities are smothering the world's most fertile soil in concrete and asphalt. Land is also lost to food production when polluted by toxic industrial wastes. The loss of the best food-producing land severely limits the possibility of increasing food production.

Nutrient loss: Soil nutrients are being lost at an accelerating rate. The annual losses resulting from soil erosion alone are enormous, and half the fertiliser used to boost nutrient levels is being wasted. The global nutrient cycle, which has sustained humanity throughout our history, has broken down.

Barriers to increasing food production

Fossil fuel dependence: Advanced farming techniques depend entirely on fossil fuels, which are rapidly increasing in cost. As the price of such fuels increases, the demand for biofuels rises. Increasing amounts of grain are being grown to produce fuel rather than food.

Technology: For three decades scientific research boosted crop yields, but the rate of innovation has slowed, leading to a decline in productivity gains.

Climate: Earth is warming. Up to half the planet may face regular drought by the end of the century. Natural hazards such as storms, floods and droughts are predicted to become more frequent and intense. This will affect food security, refugee waves and conflict.

Economics, politics and trade: Trade barriers and farm subsidies distort world markets and inflate the price of food. At the same time, the price received by farmers has been driven down. Some farmers are paid to grow fuel instead of food.

Figure 4.6e Barriers to increasing food production.

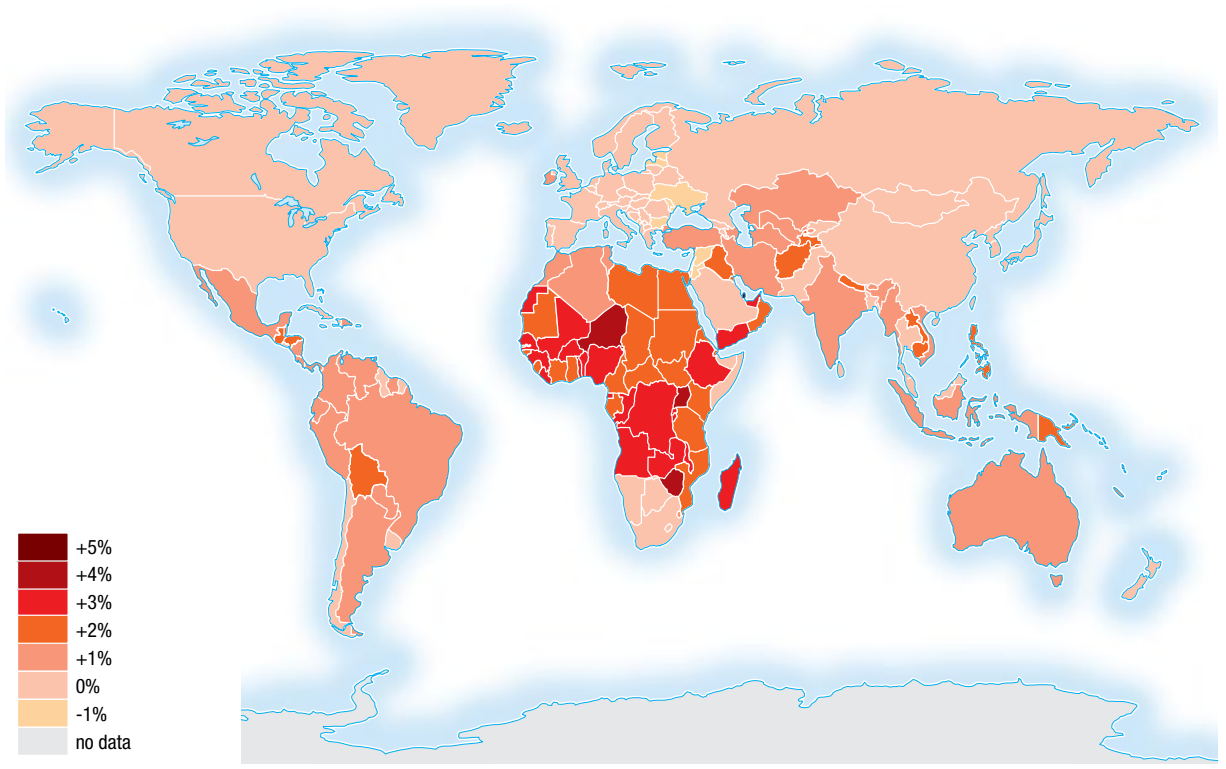

Figure 4.6f Average annual percentage change in the population, 2012.

Figure 4.6g A child scavenges for food in Maputo, Mozambique.

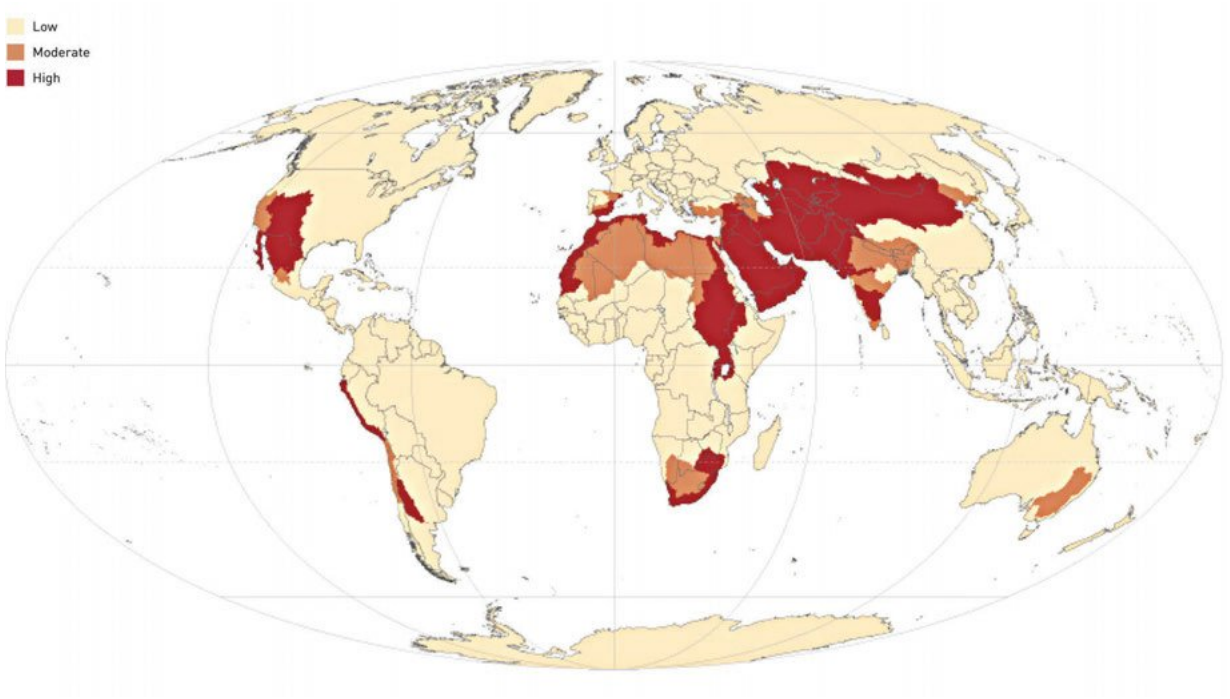

Figure 4.6h Distribution of physical water scarcity by major river basins.

WATER SCARCITY

Water is essential for human well-being and the maintenance of healthy ecosystems. However, population increases raise the demand for groundwater and surface water by domestic, agricultural and industrial land uses, leading to tensions and conflicts among users and excessive pressure on the environment. Water scarcity occurs when there is an imbalance between water availability and demand, and the degradation of water quality.

Water use has been growing at more than twice the rate of population increase over the past century, and while there is no global scarcity of water, an increasing number of regions are experiencing water shortages. By 2025, 1800 million people will be living in countries or regions with absolute water scarcity. The situation is made worse as rapidly growing urban areas place a heavy demand on neighbouring water resources.

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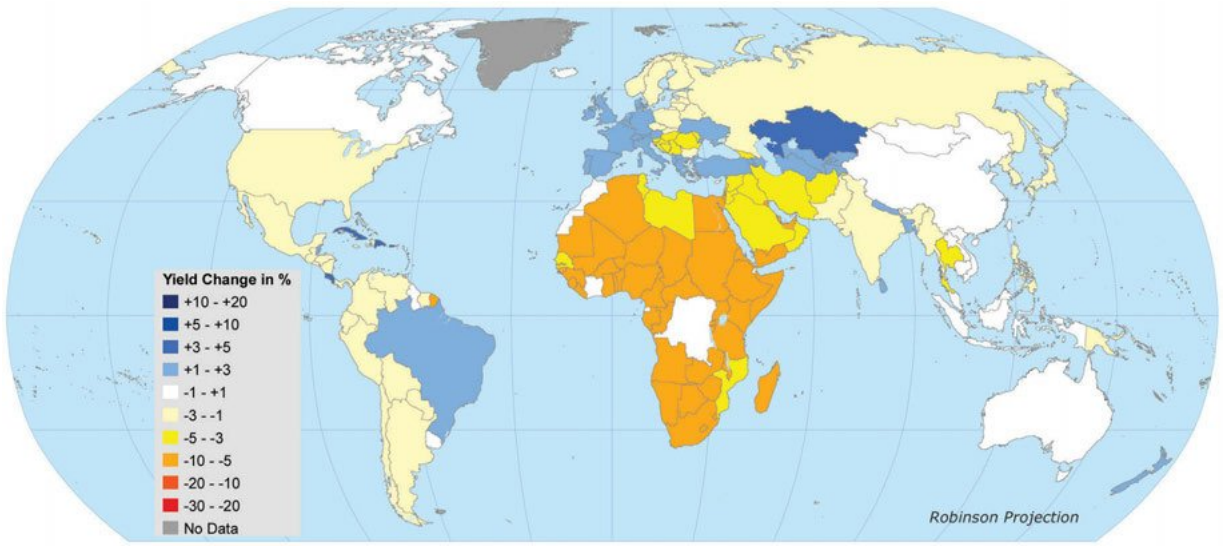

Figure 4.6i Effects of climate change on global food production (projected weighted average yield change in % for grain crops).

CLIMATE CHANGE AND FOOD SECURITY

In the latter half of the 20th century, agricultural output increased at rates unprecedented in human history. Much of the productivity increases occurred as a result of the introduction of new, high-yielding crop varieties; the use of fertilisers and pesticides; the use of irrigation; and improved, capital-intensive farming practices. People, however, have begun to question the sustainability of such practices. Also of concern are soil erosion, groundwater contamination, soil compaction and the decline of natural soil fertility. New farm management processes have been developed. These include more sustainable and efficient cropping systems and farm management techniques.

Today, climatologists point to global warming as a threat to food security. The magnitude of such climate-induced changes may affect our ability to expand food production as the world's population heads towards 9 billion.

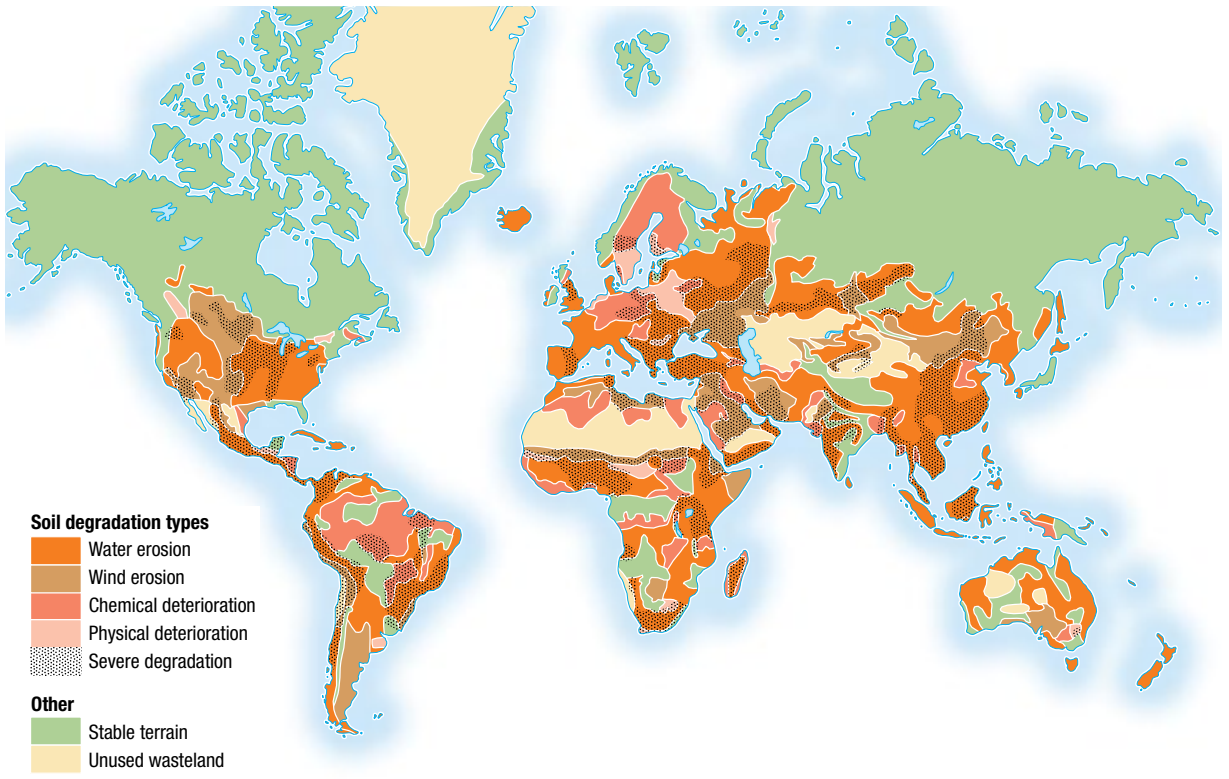

Figure 4.6j Land degradation by type.

LAND DEGRADATION

Land degradation is the process in which the biophysical environment is adversely affected by the activities of people. It is any change or disturbance to the land considered to be damaging or undesirable. It has been estimated that up to 40 per cent of the world's agricultural land has been seriously degraded.

The causes of land degradation include:

- land clearing
- depletion of soil nutrients resulting from poor farming practices
- overgrazing by livestock
- inappropriate irrigation practices
- soil contamination
- compaction by vehicles and livestock
- exposure of soil by farm machinery
- dumping of pollutants.

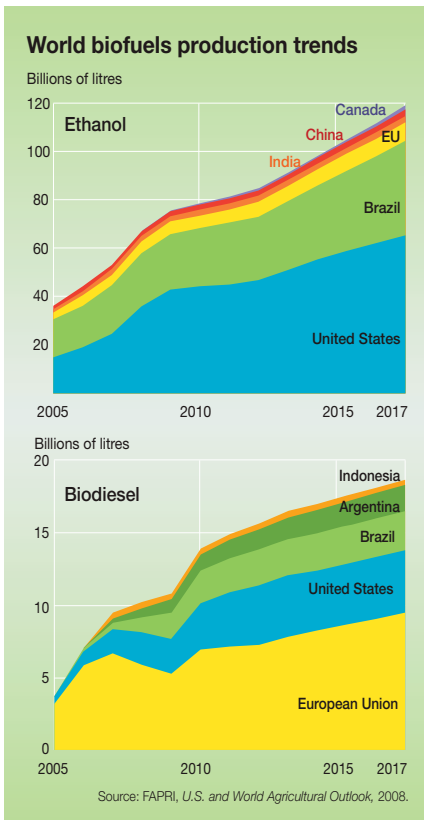

Figure 4.6k World biofuel production. Source: GRID-Arendal.

BIOFUELS

Biofuels are derived from recently dead biological material. They are different from fossil fuels, which are based on long-dead biological material. Many different plants and plant-based materials are used in biofuel production. Biofuels are commonly used to power motor vehicles.

Biofuels can produce energy without a net increase in carbon dioxide emissions because the plants used to produce the fuel have removed carbon dioxide from the atmosphere; unlike fossil fuels, which, when burnt, return carbon to the atmosphere. Biofuel is, therefore, nearly carbon neutral and less likely increase atmospheric concentrations of greenhouse gases. The use of biofuels can also reduce dependence on petroleum.

There are two main ways of producing biofuels. One is to grow crops high in either sugar or starch and then to use yeast fermentation to produce ethanol. The second is to grow plants that contain high amounts of vegetable oil, such as oil palm. These can be chemically processed to produce fuels such as biodiesel.

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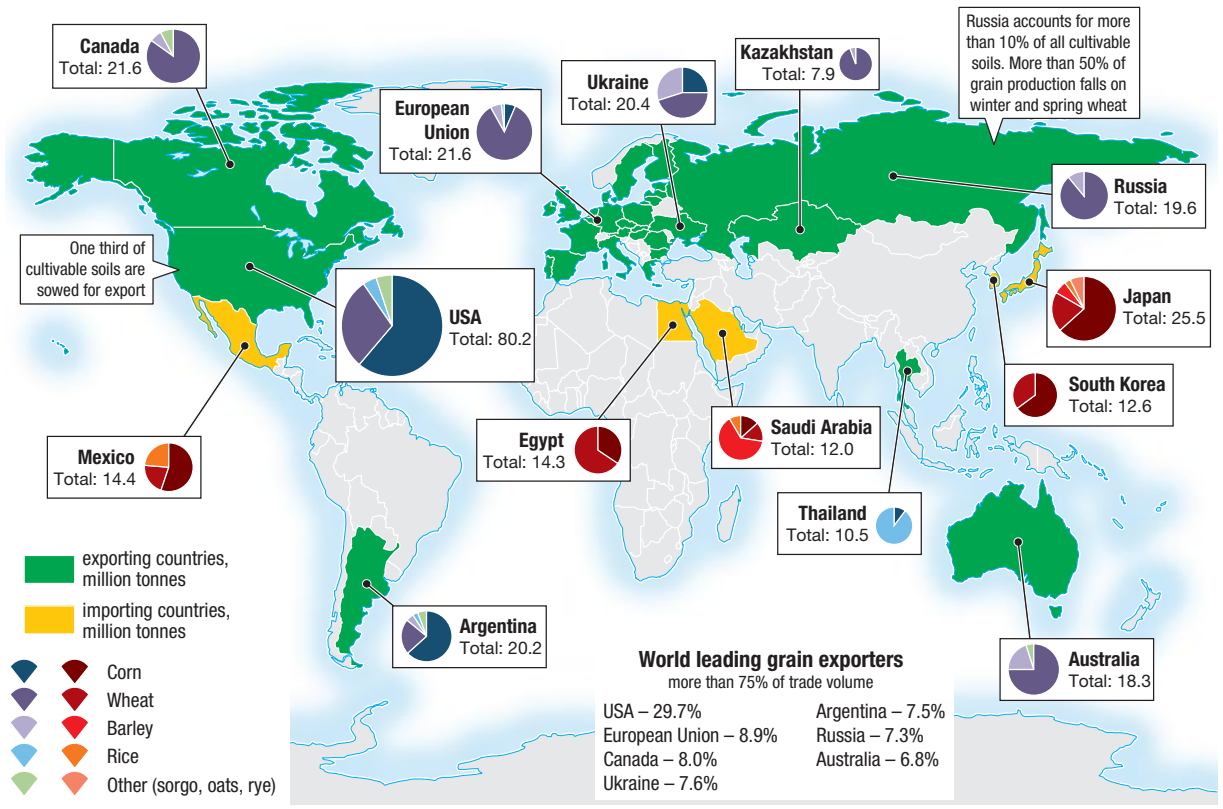

Figure 4.6l World grain exporters and importers.

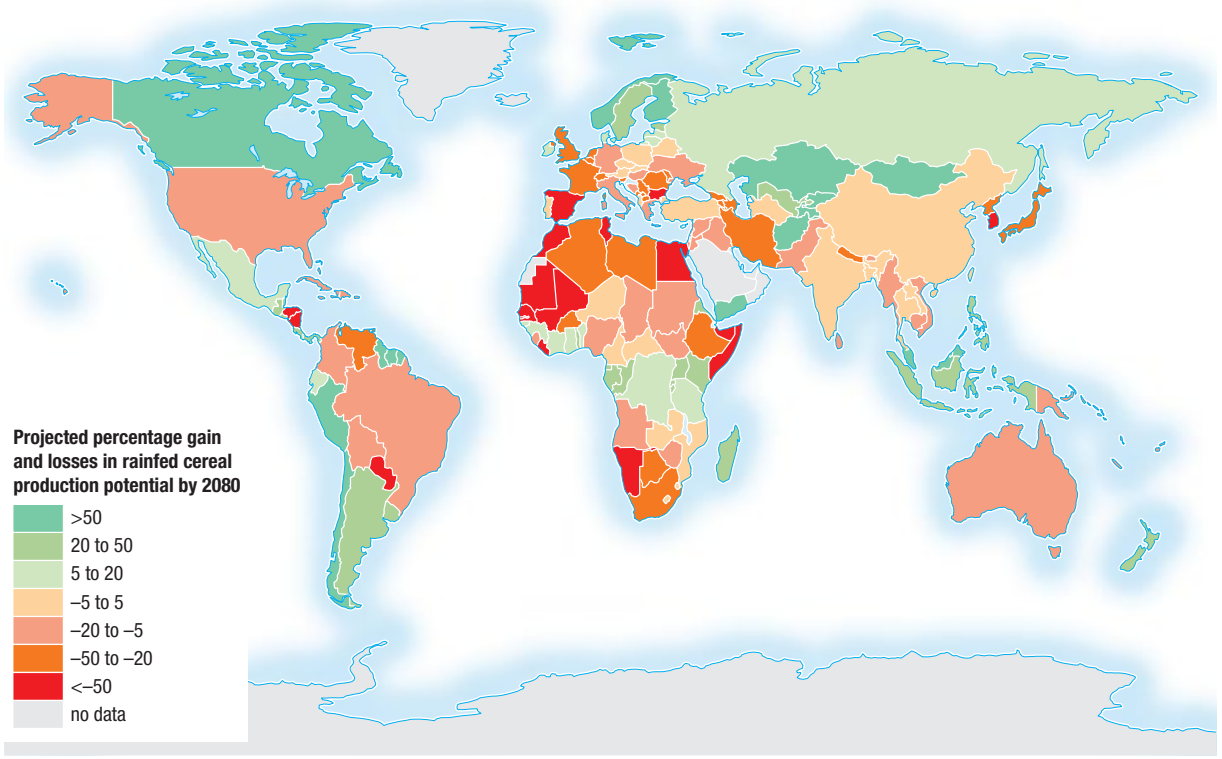

Figure 4.6m Projected global gains and losses in cereal production by 2080.

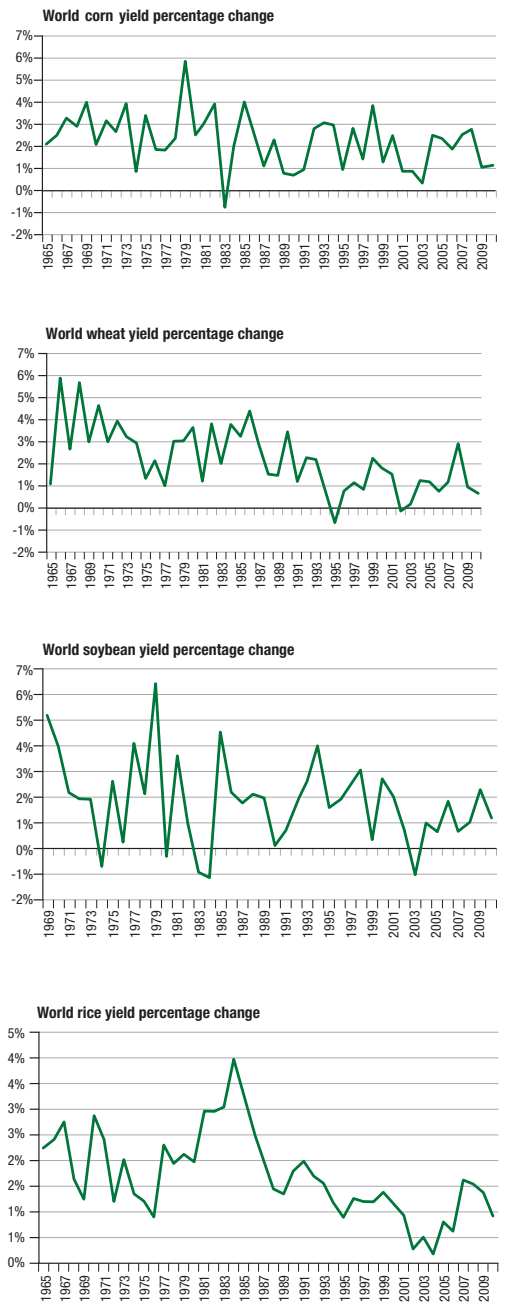

Figure 4.6n Trends in selected crop yields.

ACTIVITIES

1. Study Figure 4.6a (page 95). Identify the countries with high and very high levels of under-nourishment. What region of the world are most of these countries concentrated?
2. Study Figure 4.6c (page 95). Identify the regions of the world the Food Security Index describes as being 'high' or 'extreme' risk. To what extent does this pattern correspond with that shown in Figure 4.6k?
3. Study Figure 4.6d (page 95). Using data from the graph, describe the trends in food prices since 1990. What are the likely effects of the trend identified on the level of under-nourishment experienced by people and food security?
4. Study Figure 4.6e (page 96). Write an extended response outlining the barriers to increasing world food production. Use data from this Unit to illustrate your response.
5. Study Figure 4.6f (page 96). Identify the countries in which average annual population growth rates exceed 3.5 per cent. In which regions of the world are average annual growth rates greatest? Which of these regions also experience high levels of undernourishment?
6. Study Table 4.6a (page 95). Construct a series of proportional bar graphs showing the amount of suitable land in cultivation. Which region has the greatest potential to increase food production?
7. Study Figure 4.6h (page 96). With the aid of an atlas, identify the regions of the world with high levels of water scarcity.
8. Study Figure 4.6i (page 97). With the aid of an atlas, identify the regions of the world where crop yields are projected to decrease as a result of climate change and those areas likely to see increased yields.
9. Study Figure 4.6j (page 97). With the aid of an atlas identify those regions of the world experiencing 'severe' degradation.
10. Study Figure 4.6k (page 97) and then answer the following questions:
    - **a** Which two countries produce the largest amounts of ethanol? How much ethanol is produced by the United States?
    - **b** Which are the three largest producers of biodiesel?
    - c How much biodiesel is produced by Germany?
11. Study Figure 4.6l and then answer the following questions:
    - **a** Identify the world's largest exporter of grain.
    - **b** Name the country that is the world's largest grain importer.
    - **c** Name the principal grain export from the United States.
    - d Identify the country whose principal grain export is wheat.
    - e Identify the principal grain import of Japan.
    - f Name the principal grain export of the Thailand.
12. Study Figure 4.6m. Identify the countries in which gains in rain-fed cereal production losses are projected to exceed 50 per cent by 2080.
13. Study Figure 4.6n. Describe the trend in crop yields for corn, wheat, soybean and rice.

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4.7 Global connections

The use of technologies such as the internet and smart phones means we are now connected with other people and places in ways unimaginable to previous generations. As a result, we live in an increasingly interdependent world. Our online networks allow us to send and receive messages to and from people spread across the planet.

And, as we become more connected, information circulates more efficiently, we interact more easily, and we manage more and different kinds of social connections. Everything that now spreads from person to person will soon spread even further and faster as the nature and scale of our interactions increase.

The internet

The internet makes it possible for individuals to transfer large amounts of information around the world 24 hours a day, at high speed and at a low cost. The number of internet users worldwide increased from 242 million in 2000 to more than 2.4 billion in 2012.

The internet, and the technologies it supports, has played an important role in the process of globalisation. It has helped reshape the world's pattern of production and consumption of goods and services, and accelerated the process of cultural integration. This technology has, for example, enabled many small businesses to market their products to a global audience 24 hours a day and led to the rapid growth of online retailing.

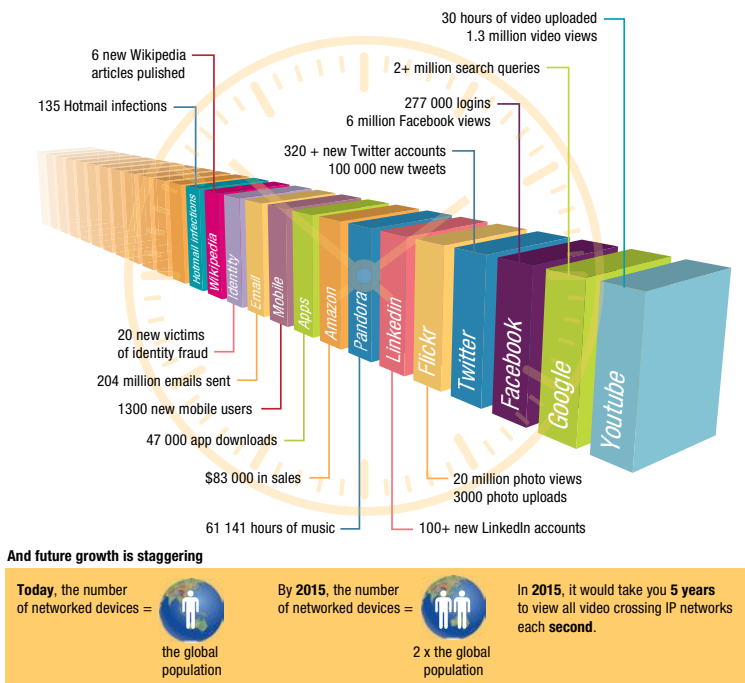

Figure 4.7a What happens in an internet minute?

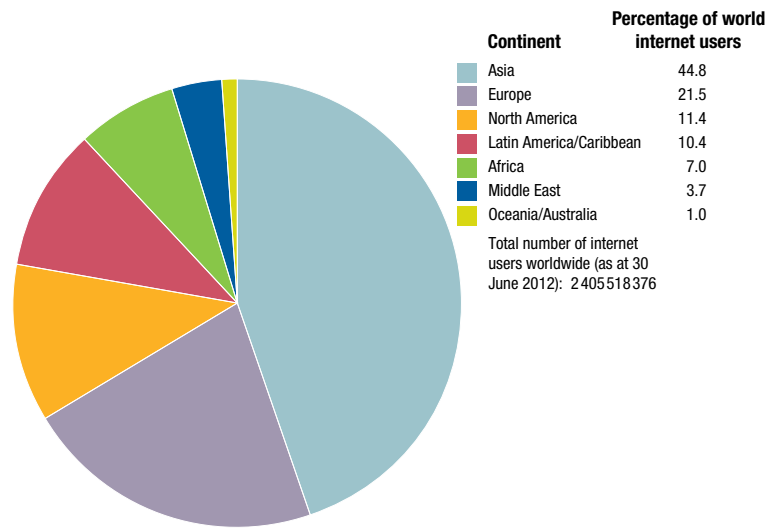

Figure 4.7c Internet users, distribution by region, 2012.

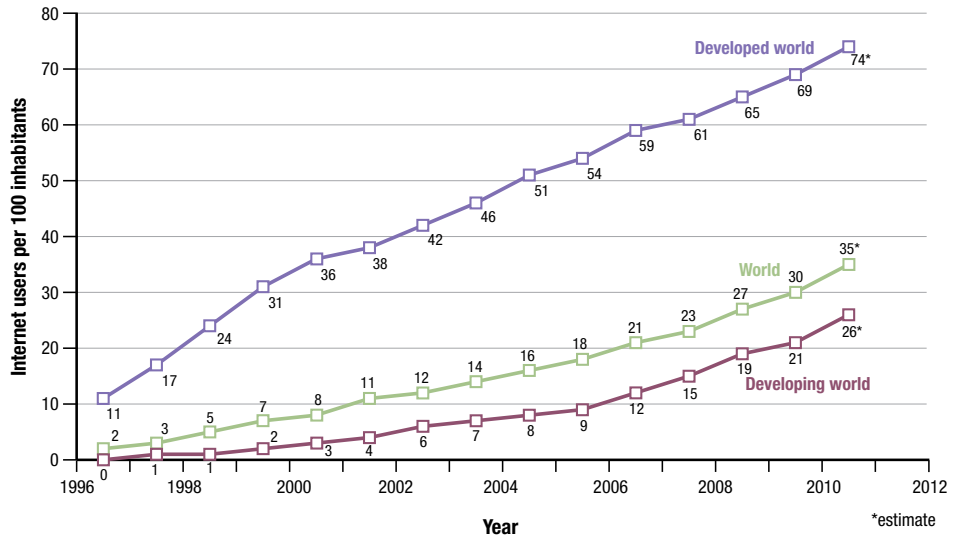

Figure 4.7b Internet users, percentage of population, 1997 to June 2010.

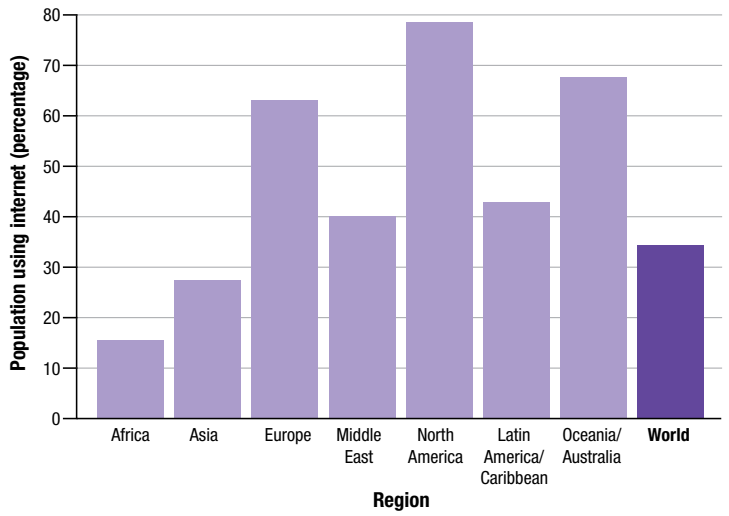

Figure 4.7d Percentage of population using the internet, by region, 2012.

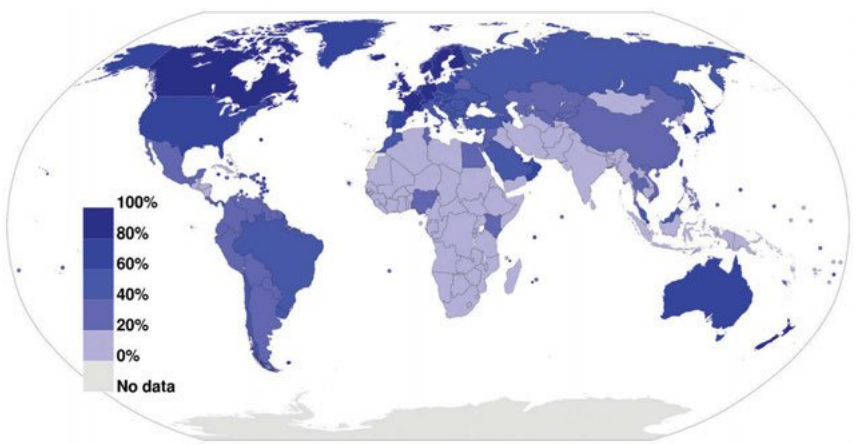

Figure 4.7e Percentage of population using the internet, 2010.

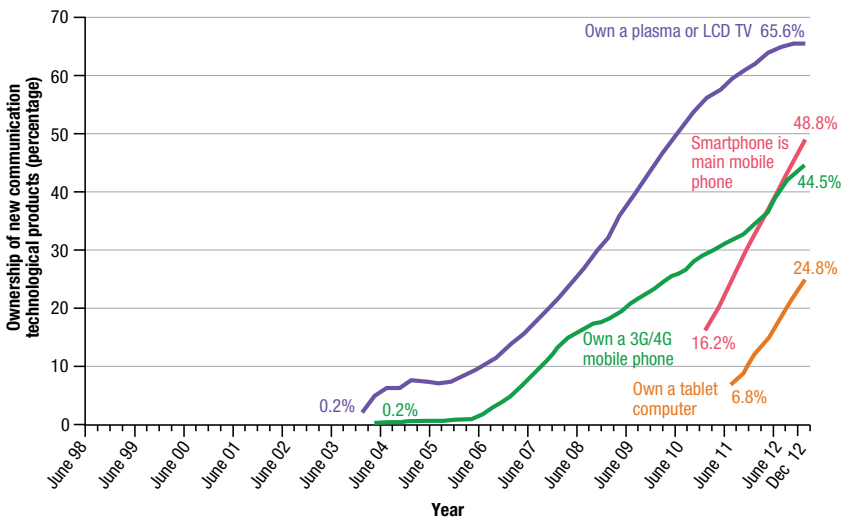

Figure 4.7f Ownership of new communication technological products, Australia, 1998–2012.

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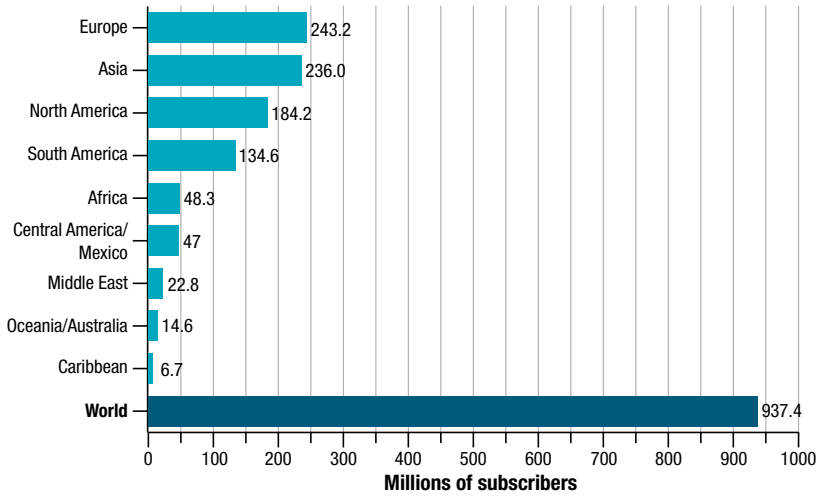


Figure 4.7g Facebook users, 2012.

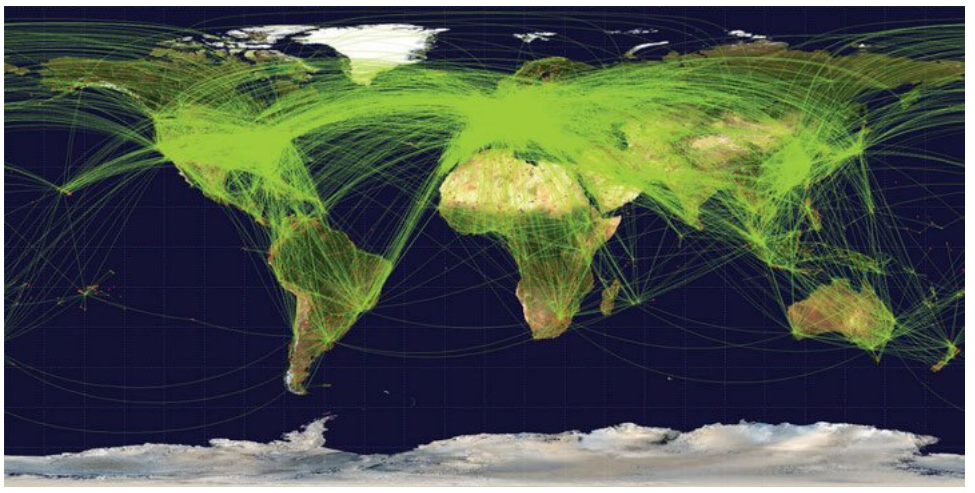
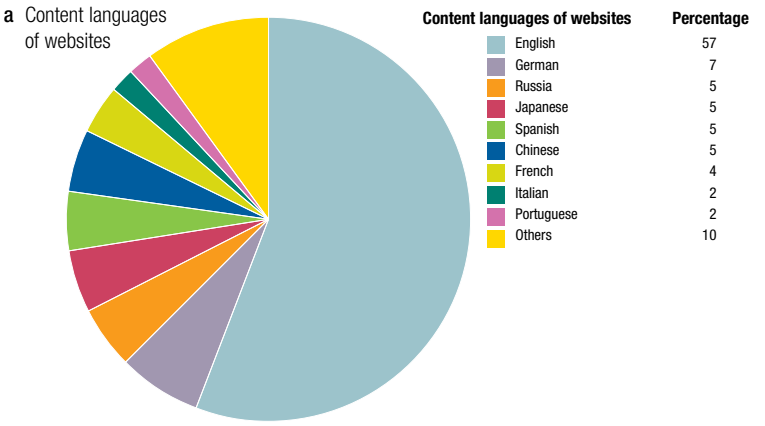


Figure 4.7i Map of world airline routes. The map shows 59 036 airline routes between 3209 airports by 531 airlines.



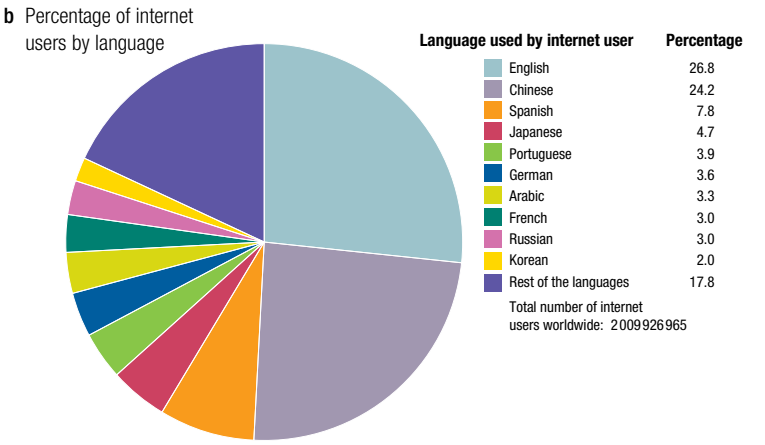


Figure 4.7h Languages of the internet.

Online retailing

In 2012, the value of e-commerce exceeded US$1 trillion in a single year for the first time. Australia's share of this was US$36.2 billion. More than 10 million Australians, or almost half the population, bought something online in 2012, spending an average of $3547 per person. This average expenditure per online consumer is 54 per cent higher than the United States and the highest in the world, except for the United Kingdom that came in at number one.

Air transport

Developments in aviation technology, especially the introduction of the Boeing 747 and more recently the Airbus A380, have helped to lower travel costs and increase the volume of international tourism and business activity. In addition to these cost savings, better coordination between different types of transportation (air, road, rail and shipping) has helped to reduce the time lost in the movement of people and goods. The result has been a rapid increase in world trade and international tourism.

This, in turn, has had an effect on cultural identity. People are increasingly exposed to new ideas, customs and traditions, and they often integrate aspects of these into their own way of life.

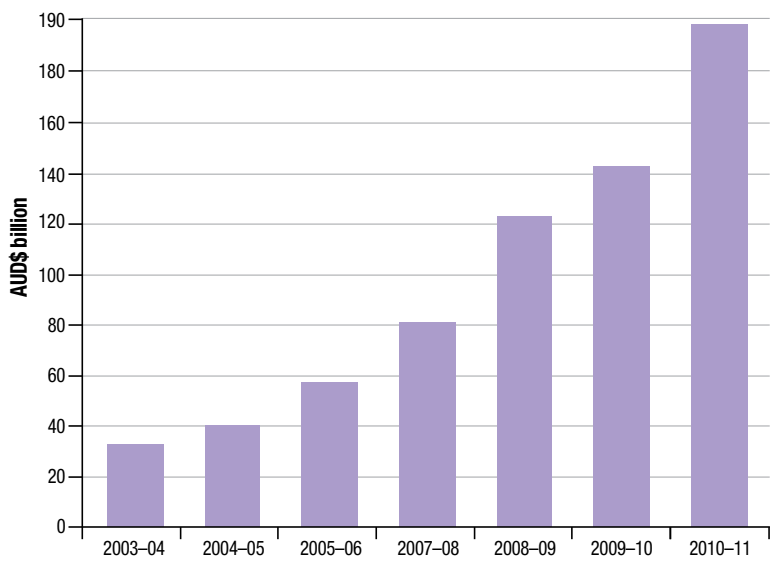


Figure 4.7j Value of internet commerce, Australia, 2003–04 to 2010–11.

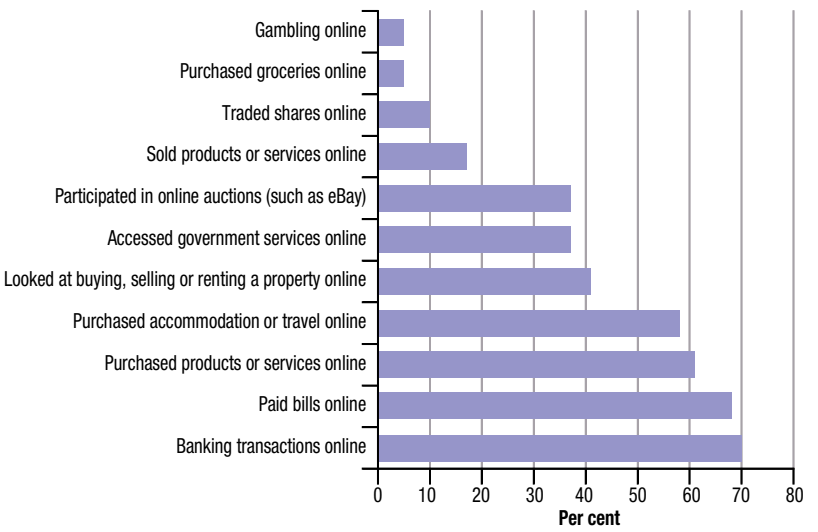


Figure 4.7k Use of internet for e-commerce activities by Australian household internet users, 2010.

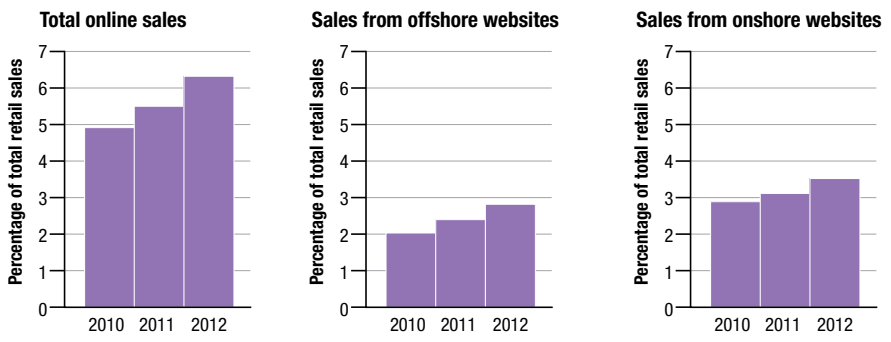


Figure 4.7l Online expenditure as a percentage of all retail sales, Australia 2012.

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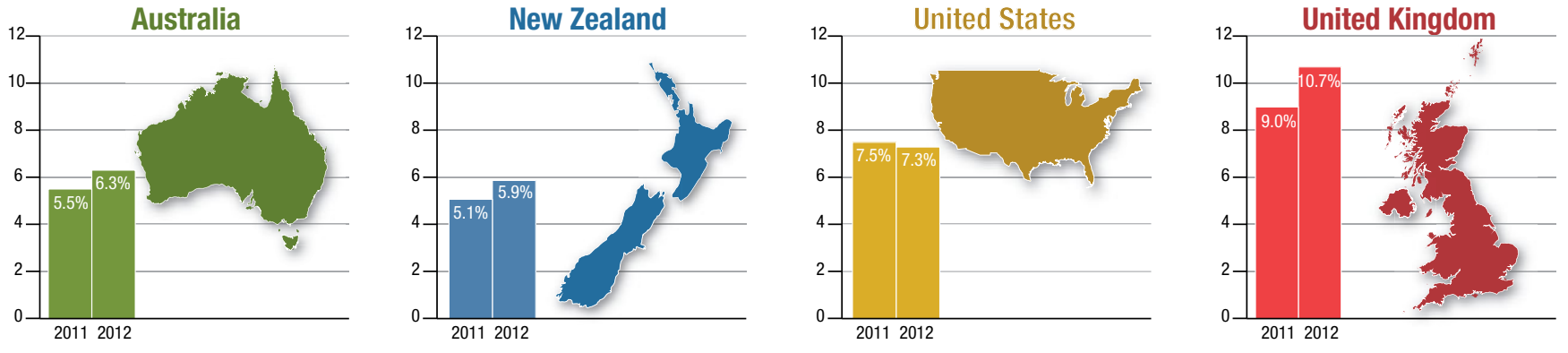

Figure 4.7m Comparison of percentage of online retail sales between selected countries, 2012.

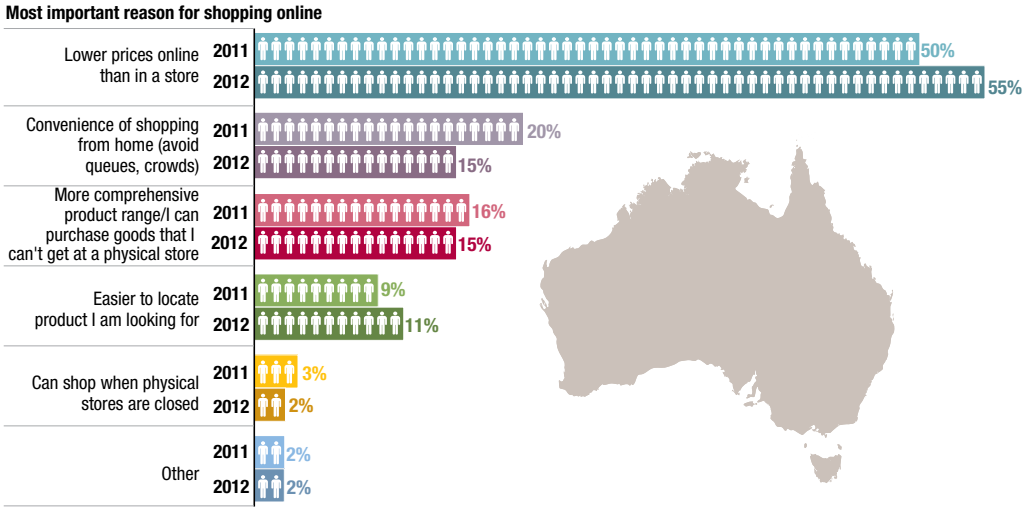

Figure 4.7n Reasons for shopping online, 2011 and 2012.

Figure 4.7o Online shopping is becoming increasingly popular

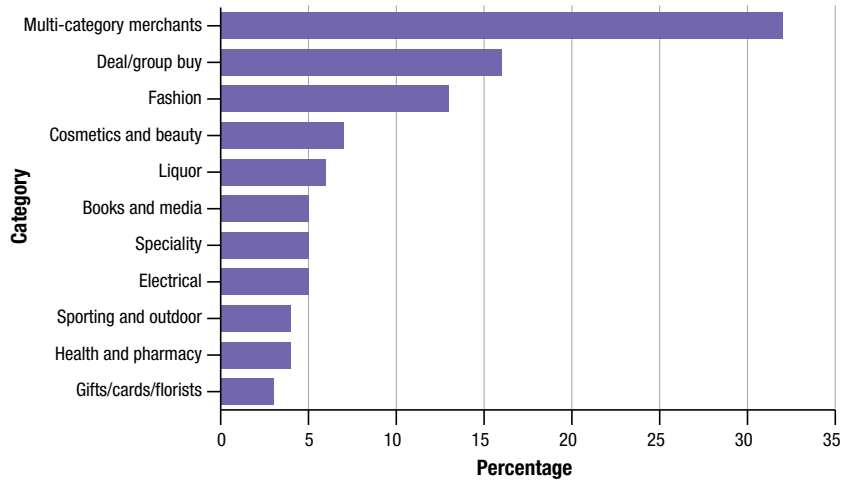

Figure 4.7p What Australian shoppers are buying online, 2012.

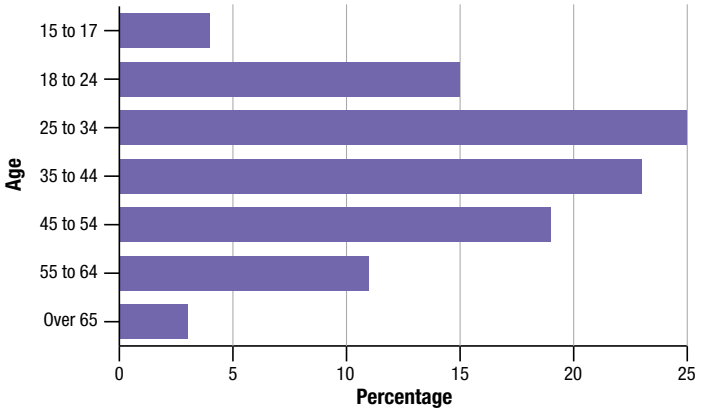

Figure 4.7q Age of Australian who shop online, 2012.

ACTIVITIES

1. Study Figure 4.7a (page 99). What does this illustration, and the data it contains, tell us about the nature of the connections that are transforming the ways in which we live our lives?
2. Study Figure 4.7b (page 99) and then answer the following questions:
   - **a** When did the internet reach 50 per cent of the inhabitants in the developed world?
   - **b** What rate was achieved in the developing world in that year?
   - **c** What was the gap in internet users per 100 inhabitants between the developed and developing world in mid-2010?
3. Study Figure 4.7c (page 99) and then answer the following questions:
   - **a** Which region has the largest number of internet users?
   - **b** How many internet users were there in Europe in 2012?
4. Study Figure 4.7d (page 99). Which region had the highest internet penetration rate in 2012? Which had the lowest?
5. Study Figure 4.7e (page 99) and then answer the following questions:
   - **a** Which countries had an internet use rate greater than 80 per cent in 2010?
   - **b** In which region was the rate of internet usage lowest?
6. Study Figure 4.7f (page 99). Using data from the graph, write a paragraph describing the trends in ownership rates for the new technologies included.
7. Study Figure 4.7g (page 100). Using the data from bar graph, construct a pie graph showing the regional distribution of Facebook users in 2010.
8. Study Figure 4.7h (page 100) and then answer the following questions:
   - **a** Which are the two content languages most commonly found on the internet?
   - **b** What percentage of internet users speak:
     - **i** English
     - **ii** Chinese?
9. Study Figure 4.7i (page 100). With the aid of an atlas, identify the world's main concentrations of airline activity.
10. Study Figures 4.7j to 4.7q (pages 100–1) and then answer the following questions:
    - **a** By how much has the value of e-commerce increased in the period 2003–04 to 2010–11?
    - **b** What are the three principal types of e-commerce in which people engage?
    - **c** What proportion of total retail transactions were conducted online in 2012? What was the division between onshore and offshore websites?
    - **d** Using data from Figure 4.7m describe how Australia compares with the other countries shown in terms of online shopping.
    - **e** What is the principal reason people shop online? Which factors have declined in relative importance since 2011?
    - **f** What are the main types of specific goods and services people purchase online?
    - **g** Which age group is most likely to be buying goods and services online? Describe the general demographics of the online shopper.

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4.8 Global tourism

The UN's World Tourism Organization defines a tourist as a person 'traveling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes'. International tourist movements surpassed the one billion people for first time in in 2012. The income generated by tourism exceeded US$1.03 trillion in 2011. The Chinese are now the world's biggest tourism spenders. In 2012, 56.7 million Chinese tourists spent $72.6 billion.

Because tourism is a 'discretionary' expenditure, the industry is subject to shifts in consumer confidence. In time of economic uncertainty, people will postpone or even cut back on such spending.

Figure 4.8a Almost one in six of the world's people travel internationally each year.

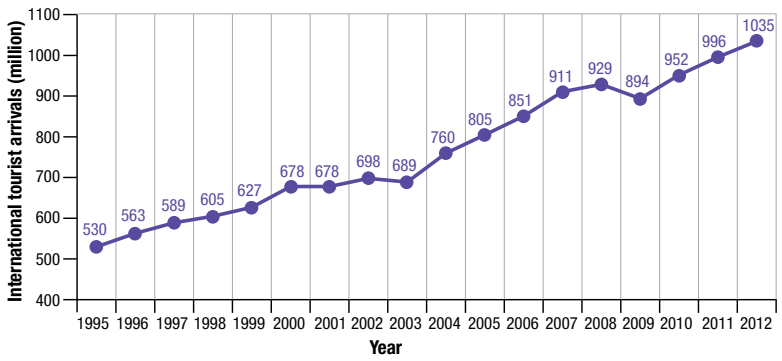

Figure 4.8b Growth of world tourism, 1995–2012.

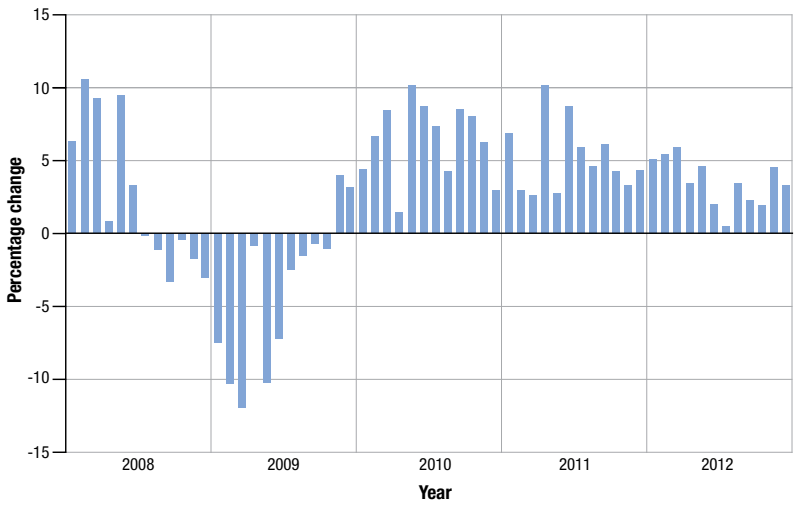

Figure 4.8c International tourist arrivals, monthly movements (% change), 2008–12.

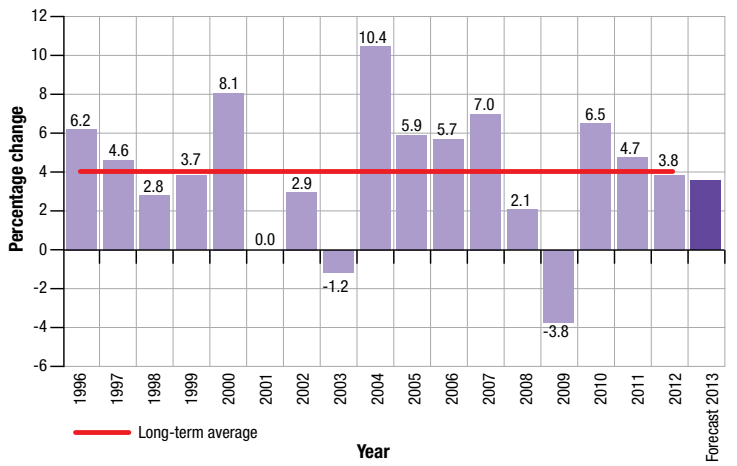

Figure 4.8d International tourist arrivals, monthly movements (% change), 1996–2013.

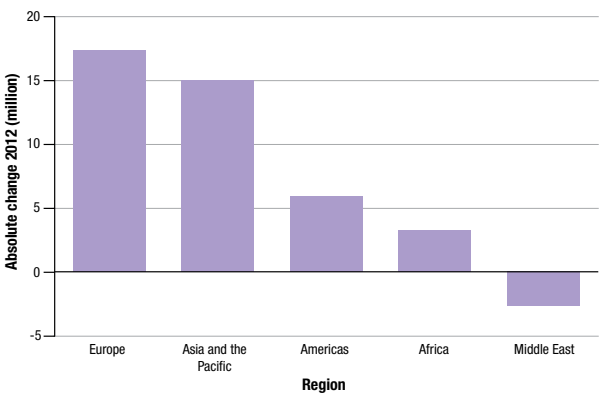

Figure 4.8e International tourist arrivals, change by regions (millions), 2012.

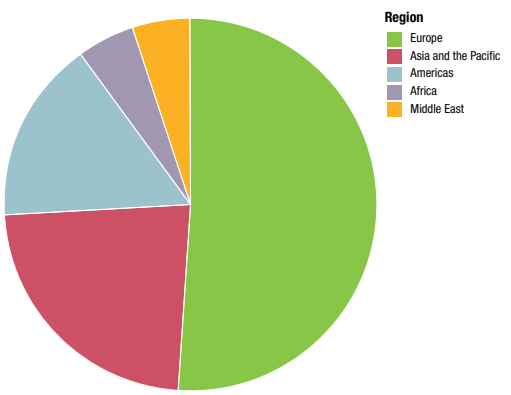

Figure 4.8f International tourist arrivals, by region, 2012.

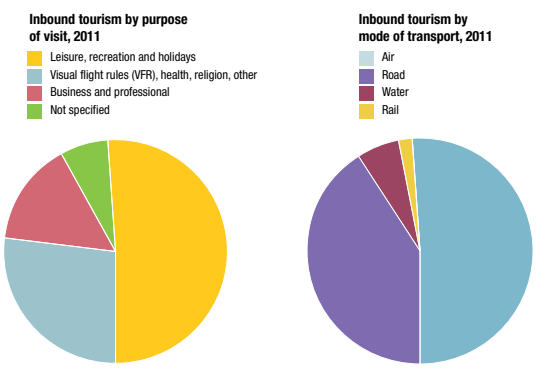

Figure 4.8g Purpose and mode of travel, 2012.

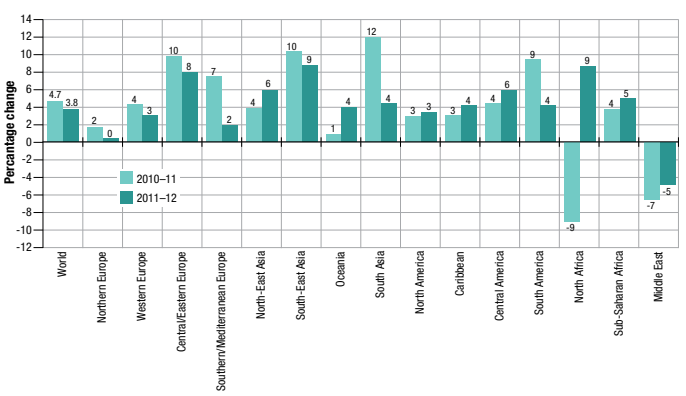

Figure 4.8h International tourist arrivals, change over the previous period.

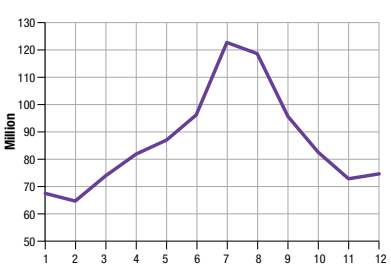

Figure 4.8i International tourist arrivals, monthly change, 2012.

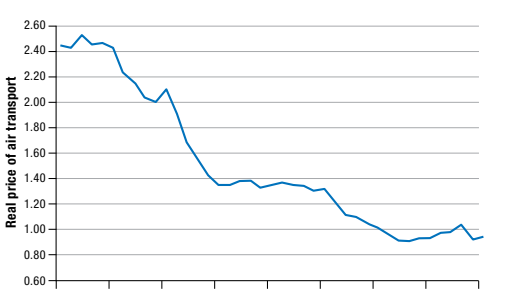

Figure 4.8j The real price of air travel, 1970–2010.

AUSTRALIAN TOURISM

Tourism is an important Australian industry. It accounts for 2.5 per cent of Australia's gross domestic product (GDP) and is worth around $35 billion a year to the national economy. Domestic tourism accounts for 73 per cent of all tourism-related GDP. International tourism accounts for the rest. The industry employed 513 700 in 2010–11, of which 43.7 per cent were employed casually or part-time.

In 2012, more than 6 million international visitors came to Australia. The 'selling' of the tourist experience contributed 8.0 per cent of Australia's total export earnings in 2010–11. Popular Australian destinations include the coastal cities of Sydney and Melbourne, and the Gold Coast and the Great Barrier Reef in Queensland. Uluru and the Australian outback are also popular destinations.

By 2020, Australia's tourism industry is expected to be worth $115 billion a year. Australia currently ranks 42nd for international tourist arrivals.

Figure 4.8k Tourism is one of Australia's most important industries.

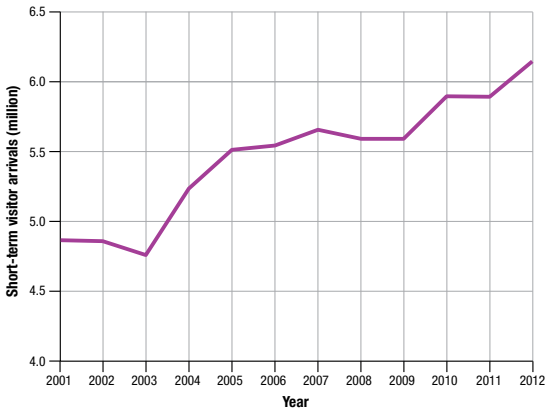

Figure 4.8l Short-term visitor arrivals, Australia, 2001–2012.

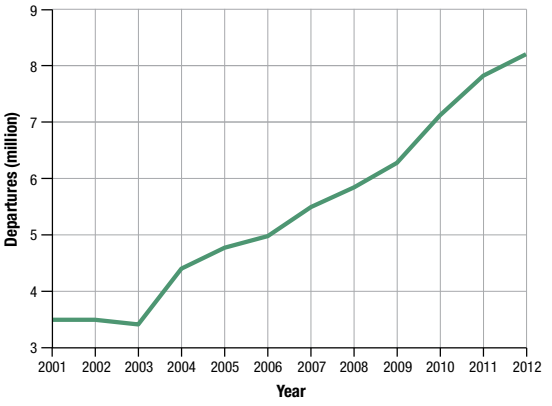

Figure 4.8m Short-term visitor departures, Australia, 2001–2012.

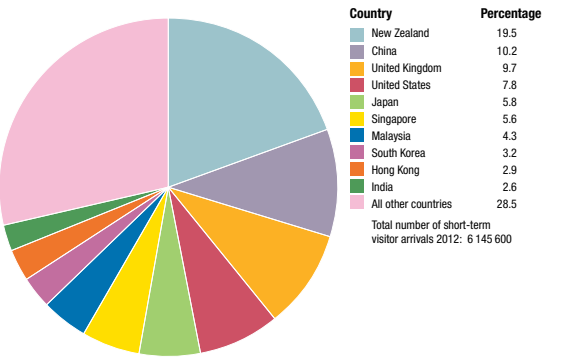

Figure 4.8n Where are they coming from? Country of origin, short-term visitor arrivals to Australia, 2012.

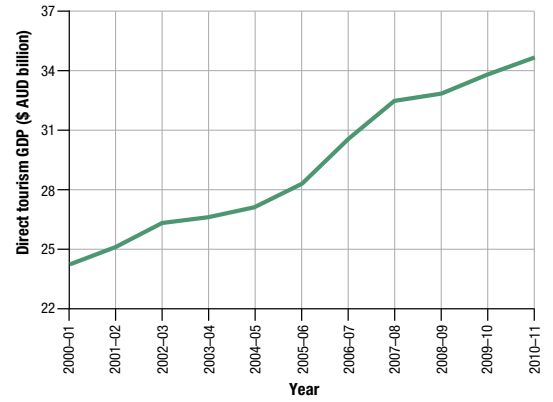

Figure 4.8p Tourism's contribution to Australia's gross domestic product.

Figure 4.8q Tourism related employment in Australia, 2000–01 to 2010–2011.

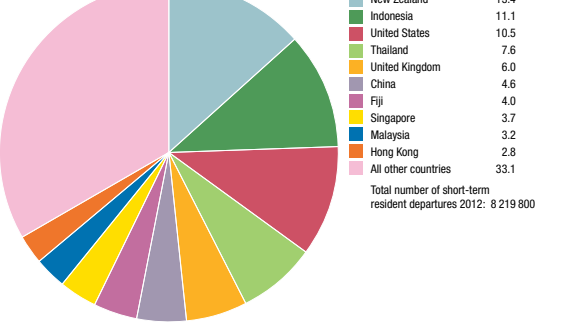

Figure 4.8o Where are we going? Destination of short-term departures from Australia, 2012.

ACTIVITIES

1. Study Figure 4.8b (page 102) and then answer the following questions:
   - **a** What was the percentage increase in international tourist arrivals between 1995 and 2012?
   - **b** What was the absolute growth in international tourist movements between 1995 and 2012?
2. Study Figure 4.8c (page 102). Describe the trend in international tourist arrivals since 2008 using data from the graph.
3. Study Figure 4.8d (page 102) and then answer the following questions:
   - **a** What years experienced below-average percentage changes in international tourist arrivals?
   - **b** In what year was the percentage change in international arrivals greatest?
   - **c** Account for the 6.5 per cent growth in 2009.
4. Study Figure 4.8e (page 102) and then answer the following questions:
   - **a** Which region of the world had the largest absolute change in international tourist arrivals in 2012?
   - **b** What percentage increase in arrivals did the Americas experience in 2012?
5. Study Figure 4.8f (page 102) and then answer the following questions:
   - **a** What proportion of international in-bound tourists did Europe account for in 2012?
   - **b** How many international in-bound tourists did the Americas account for in 2012?
6. Study Figure 4.8g (page 102) and then answer the following questions:
   - **a** What is the principal reason for travel?
   - **b** What percentage of travel is for the purpose of business?
   - **c** What is the principal mode of travel?
   - **d** What percentage of travel is by road?
7. Study Figure 4.8h (page 102) and then answer the following questions:
   - **a** What regions experienced the greatest change in the flow of tourists from 2010–11 to 2011–12?
   - **b** Which regions experienced the biggest proportional fall in international tourist arrivals in the period 2010–11 to 2011–12?
8. Study Figure 4.8i (page 102). Account for the seasonal pattern of international tourist arrivals.
9. Study Figure 4.8j (page 102). Describe the trends in the real cost of air travel. What might the implication of this trend be?
10. Study Figure 4.8l. Using data from the graph, describe the trend in short-term visitor arrivals to Australia.
11. Study Figure 4.8m. Using data from the graph, describe the trend in short-term departures from Australia.
12. Study Figures 4.8n and 4.8o and then answer the following questions:
    - **a** What is the largest source of in-bound short-term visitor arrivals in 2012?
    - **b** What percentage of short-term arrivals came from China?
    - **c** How many tourists came from the United States?
    - **d** What are the three most popular destinations for Australians travelling overseas?
    - **e** What percentage of departing Australians went to the United States?
    - **f** How many departing Australians travelled to New Zealand?
13. Study Figures 4.8o, 4.8p and 4.8q and then answer the following questions:
    - **a** Using data from the graphs, describe tourism's contribution to Australia's GDP.
    - **b** Describe the trend in tourism-related employment.
    - **c** What are the three most popular destinations for departing Australians?

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4.9 Global cruise industry

The cruise industry is one of the fastest growing sectors of the global tourism industry. In 2013 the industry generated revenues of $36.2 billion and the growing fleet of cruise ships carried 20.9 million passengers. The world's fleet of 283 ships carried 438 595 passengers in 2013.

The cruise industry has had an average annual passenger growth rate of 7 per cent since 1990. This growth, at least in part, has been driven by the ageing of the baby boomer generation. As people age, cruising becomes one of the few holidays available to those with mobility ailments. Rising disposable incomes has also increased demand for cruise-based holidays.

A total of six new ships were added to the world's fleet of cruise ships in 2013, with a total passenger capacity of 14 074 passengers. From 2014 to 2015, a net of 13 more new cruise ships will come into service, adding 39 297 berths (an 8.7 per cent increase in passenger capacity). They will also add an additional $3.2 billion in annual revenue of the cruise industry.

There is, however, considerable potential for further growth in the industry. If all the world's cruise ships were filled to capacity all year long, the number of people involved would still only equal less than half the number of tourists that visit Las Vegas (more than 40 million a year).

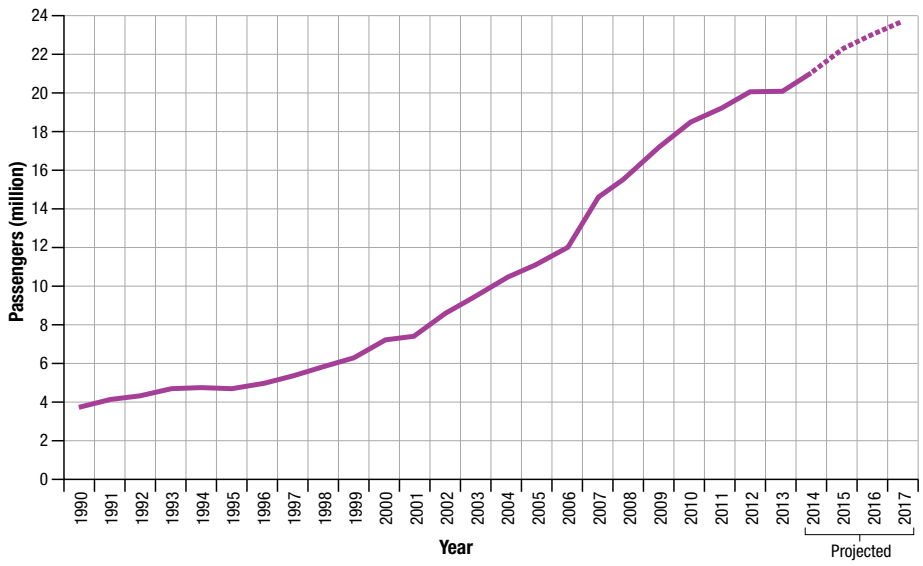

Figure 4.9a Growth in the global cruise industry, passengers carried, 1990–2013.

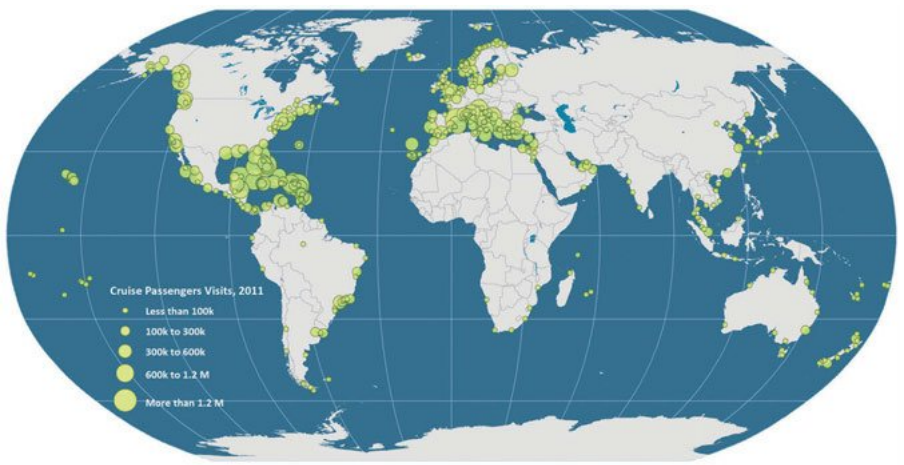

Figure 4.9b Cruise passenger port visits, 2011.

Table 4.9a Cruise passengers by origin, 2013

Source region	*(%)*
North America	60.5
Europe	27.0
Asia	6.5
South America	2.9
Australia–New Zealand	2.9
Middle East/Asia	0.2
Total	100.0

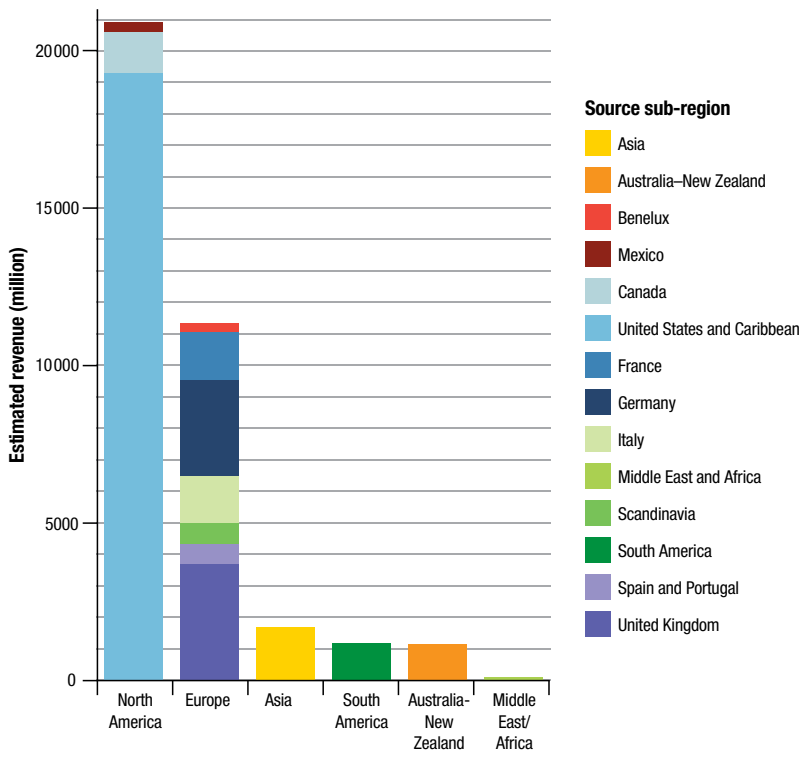

Figure 4.9c Cruise revenues by source, 2013.

Figure 4.9d *The Oasis of the Seas* and its sister ship, *The Allure of the Seas*, are the largest cruise ships afloat.

ACTIVITIES

1. Study Figure 4.9a and then answer the following questions:
   - **a** By how much did the number of passengers carried by the world's cruise industry increase between 1990 and 2013?
   - **b** In what year did the number of passengers carried exceed 12 million?
   - **c** Which period experienced the greatest rate of increase in passenger numbers?
2. Study Table 4.9a. Construct a pie graph showing cruise passengers by source in 2013.
3. Study Figure 4.9b. With the aid of an atlas, identify the regions of the world most intensively visited by cruise ships.
4. Study Figure 4.9c and then answer the following questions:
   - **a** How much revenue does the North American cruise market generate? How much of this revenue came from passengers originating in the United States and Caribbean?
   - **b** What are the four largest sources of revenue in the European region?

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4.10 Liveability of places

The term 'liveability' refers to the characteristics of a city that contribute to the quality of life experienced by those who live in, or visit, the place. Indicators of liveability typically include: political stability, availability of goods and services including health care and education, low personal risk and efficient infrastructure.

LIVEABILITY SURVEYS

There are three liveability rankings published each year.

1. THE LONDON-BASED ECONOMIST INTELLIGENCE UNIT (EIU)

The EIU allocates a rating to 30 criteria grouped into five broad categories: stability; health care; culture and environment; education; and infrastructure. The ratings are then tallied to give a score of 1–100, where 1 is considered intolerable and 100 is considered ideal.

The EIU's 2012 liveability report ranked cities in Australia, Austria, Canada, Finland and New Zealand as the most liveable cities in the world. For the most part, people living in these country's cities have access to a wide variety of goods and services, low personal risk and quality infrastructure. The index does not, however, take into account climate or the cost of living.

2. MERCER QUALITY OF LIVING SURVEY

European cities dominate the Mercer Quality of Living survey, with cities in Australia, New Zealand and Canada also ranked highly. Vienna, the capital of Austria, was Mercer's top-ranked city in 2012. Sydney was ranked number 10.

The Mercer survey compares 221 cities on 39 measures, which include criteria related to personal safety, education, hygiene, health care, culture, environment, recreation, political-economic stability and public transportation.

3. MONOCLE'S MOST LIVEABLE CITIES INDEX

Monocle, a London-based lifestyle magazine, publishes an annual list of the most liveable cities. Switzerland's capital, Zurich, was ranked the most liveable city in 2012, followed by Helsinki in Finland. Melbourne was ranked sixth and Sydney eighth. The criteria used in this survey include safely/crime, international connectivity, climate/sunshine, quality of architecture, public transport, tolerance, environmental issues and access to nature, urban design, business conditions and medical care.

Table 4.10a Economist Intelligence Unit Global Liveability Ranking, 2012

Rank	*City*	*Country*
1	Melbourne	Australia
2	Vienna	Austria
3	Vancouver	Canada
4	Toronto	Canada
5	Adelaide	Australia
	Calgary	Canada
7	Sydney	Australia
8	Helsinki	Finland
9	Perth	Australia
10	Auckland	New Zealand

Table 4.10b Mercer Quality of Living Survey, 2012

Rank	*City*	*Country*
1	Vienna	Austria
2	Zurich	Switzerland
3	Auckland	New Zealand
4	Munich	Germany
5	Vancouver	Canada
6	Dusseldorf	Germany
7	Frankfurt	Germany
8	Geneva	Switzerland
9	Copenhagen	Denmark
10	Bern	Switzerland
10	Sydney	Australia

Table 4.10c Monocle's Most Liveable Cities Index, 2012

Rank	*City*	*Country*
1	Zurich	Switzerland
2	Helsinki	Finland
3	Copenhagen	Denmark
4	Vienna	Austria
5	Munich	Germany
6	Melbourne	Australia
7	Tokyo	Japan
8	Sydney	Australia
9	Auckland	New Zealand
10	Stockholm	Sweden

Criteria	Score 1 Very poor 2 Poor 3 Satisfactory 4 Good 5 Very good
Category 1: Environment	
• Temperature/humidity	1 2 3 4 5
• Quality of urban design and architecture	1 2 3 4 5
• Access to parks and gardens	1 2 3 4 5
• Amenity of streetscapes	1 2 3 4 5
• Maintenance of public spaces	1 2 3 4 5
Category 2: Cultural	
• Quality of community recreational facilities	1 2 3 4 5
• Availability of places of worship	1 2 3 4 5
• Diversity and quality of restaurants	1 2 3 4 5
• Availability of public libraries	1 2 3 4 5
• Range of entertainment venues	1 2 3 4 5
Category 3: Economic	
• Range of employment opportunities	1 2 3 4 5
• Access to affordable housing	1 2 3 4 5
• Access to consumer goods and services	1 2 3 4 5
Category 4: Infrastructure	
• Quality of road network	1 2 3 4 5
• Quality of public transport	1 2 3 4 5
• Quality of telecommunications infrastructure	1 2 3 4 5
• Availability of good quality housing	1 2 3 4 5
• Provision of utilities—water, electricity, sewerage	1 2 3 4 5
• Availability of cycle ways	1 2 3 4 5
Category 5: Education	
• Availability of private schools	1 2 3 4 5
• Quality of public schools	1 2 3 4 5
• Access to post-school educational institutions	1 2 3 4 5
Category 6: Health care	
• Quality of private health care	1 2 3 4 5
• Quality of public health care	1 2 3 4 5
• Availability of aged-care facilities	1 2 3 4 5
Category 7: Law and order	
• Amount of petty crime	1 2 3 4 5
• Amount of violent crime	1 2 3 4 5
• Graffiti and vandalism	1 2 3 4 5
• Sense of personal safety	1 2 3 4 5

Figure 4.10a Liveability survey sheet.

Figure 4.10b Sydney is ranked as one of the world's most liveable cities by each of the ranking bodies.

ACTIVITIES

1. Study Tables 4.10a–c. Identify the cities common to all three liveability ranking surveys.
2. Individually, rank your local neighbourhood, ranking the criteria outlined in Figure 4.10a on the scale 1 to 5. Tally the score.
3. Working in groups, compare your ranking with others. Agree on a group-based ranking of the listed criteria. Compare your group's ranking with that of other groups. How similar are they?
4. Repeat the ranking in nearby neighbourhoods. Rank the neighbourhoods assessed.

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4.11 Climate change

Rising global temperatures, melting glaciers, shrinking areas of sea ice and rising sea levels: little by little the evidence is mounting to show that the Earth's climate is changing, and scientists are almost certain that human activities are to blame.

A number of human activities pump heat-trapping gases (greenhouse gases) into the atmosphere. These practices range from burning fossil fuels, which releases carbon dioxide (CO_2) into the atmosphere, to farming. Once these gases have entered the atmosphere they remain there for thousands of years. They absorb the heat that comes from the Earth and re-radiate it back to the surface, enhancing Earth's natural greenhouse effect.

Since the early 20th century (1906), Earth's mean surface temperature has increased by about 0.8 °C, with about two-thirds of the increase occurring since 1980. In March 2013, atmospheric greenhouse gas concentrations reached their highest levels in at least the past 650 000 years (397.34 parts per million). Scientists believe that if this trend continues, temperatures are likely to go up 2– 6°C by the end of this century. While this might seem like a small change, it will probably lead to big changes in our environment.

Global climate change is likely to lead to more frequent heat waves, more widespread drought and bigger storms, including more intense tropical cyclones (or hurricanes). Just small increases in average temperatures can threaten entire ecosystems. The world's coral reefs and animal species such as the polar bear are threatened with extinction. Higher sea levels (a result of melting of glaciers and the polar ice caps) increase coastal erosion. As much as 10 per cent of the world's population lives in vulnerable coastal regions that have an elevation less than 10 metres above sea level.

Rising sea levels will flood these low-lying areas, forcing people to flee their homes.

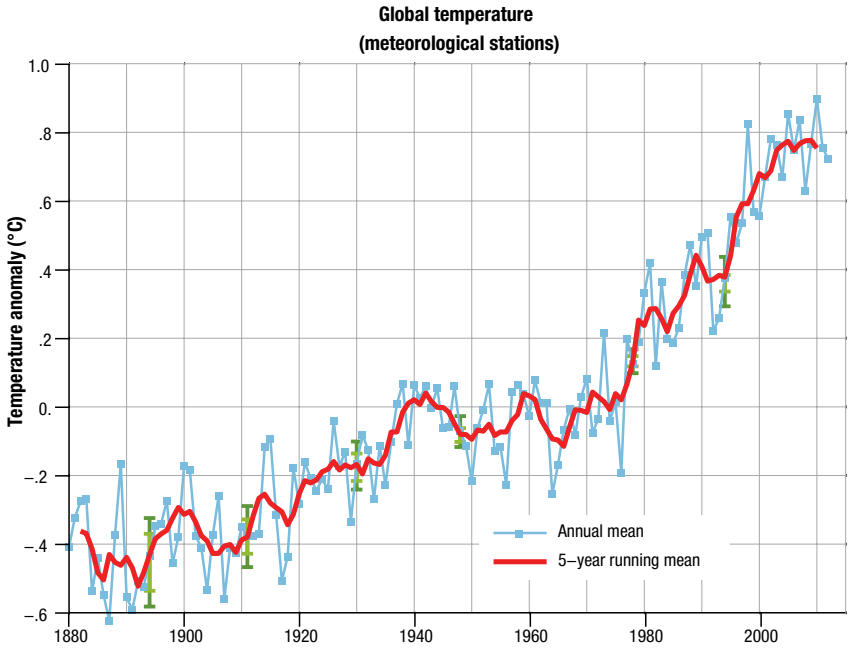

Figure 4.11a Trends in global temperatures, 1880–2012; how much warmer or colder a year was compared with the average temperature between 1951 and 1980.

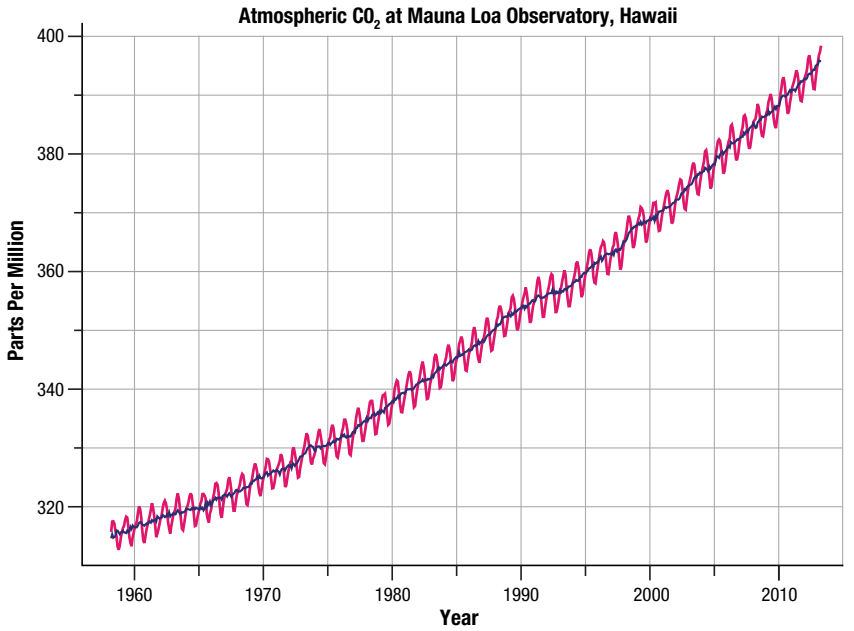

Figure 4.11b Atmospheric CO_2 concentrations, 1958–2013. In 1850, about 280 out of every 1 million air molecules were carbon dioxide. By 2012, the concentration exceeded 397 parts per million. Scientists predict that if no steps are taken to slow this trend, the concentration will increase to 700 parts per million by 2100.

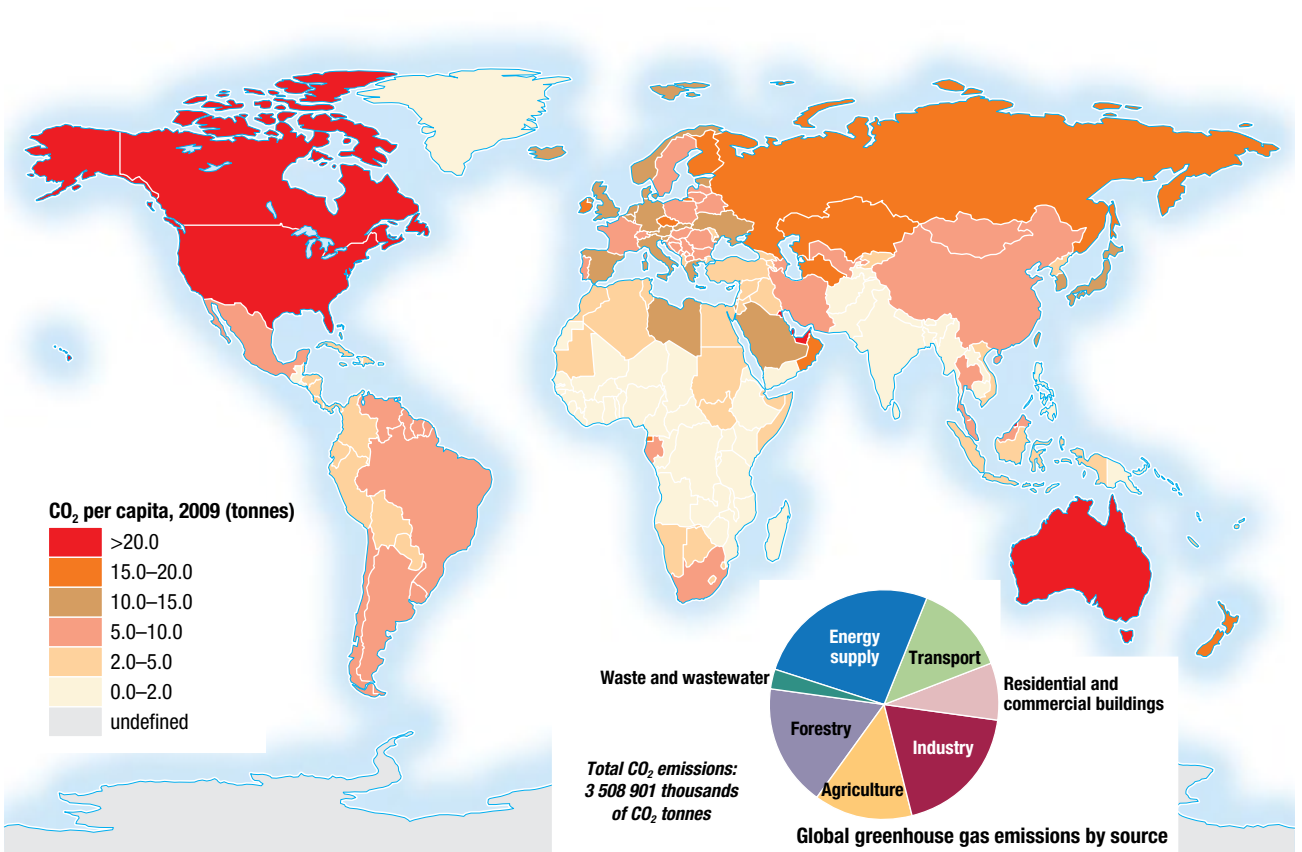

Figure 4.11c CO_2 emissions per capita, 2009. The inset graph shows the sources of CO_2 emissions.

Table 4.11a Top 10 CO_2 emitting countries, 2009

Rank	*Country*	*Emissions ('000 metric tonnes of carbon)*
1	China	2 096 295
2	United States	1 445 204
3	India	539 794
4	Russia	429 339
5	Japan	300 282
6	Germany	200 327
7	Iran	164 182
8	Canada	140 152
9	South Korea	138 908
10	South Africa	136 083
16	Australia	109 134

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Going, going … the Arctic ice sheet in retreat

Average temperatures in the Arctic region are rising twice as fast as they are elsewhere in the world. The region's ice sheet is shrinking and becoming thinner. Images from NASA satellites show that the area of permanent ice cover in the Arctic is now contracting at a rate of 9 per cent each decade. If this trend continues, summers in the Arctic could become ice-free by the end of the 21st century.

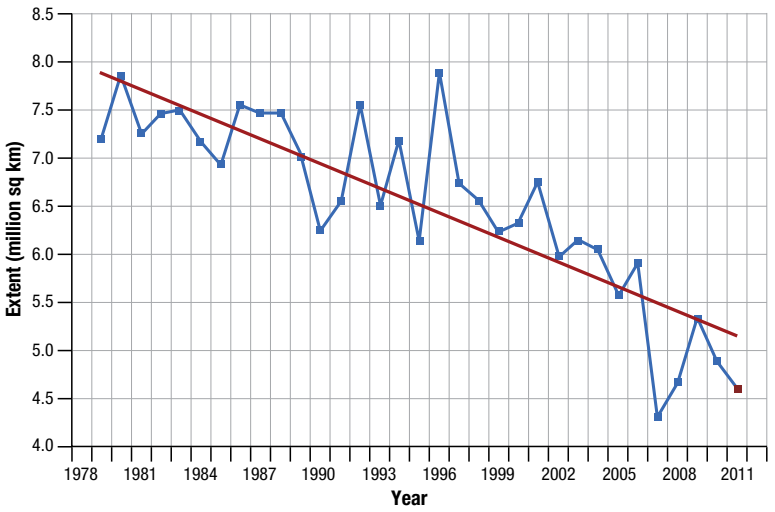

Figure 4.11d Extent of Arctic sea ice, 1978–2011. September Arctic sea ice extent has declined by approximately 35 per cent over the past 33 years.

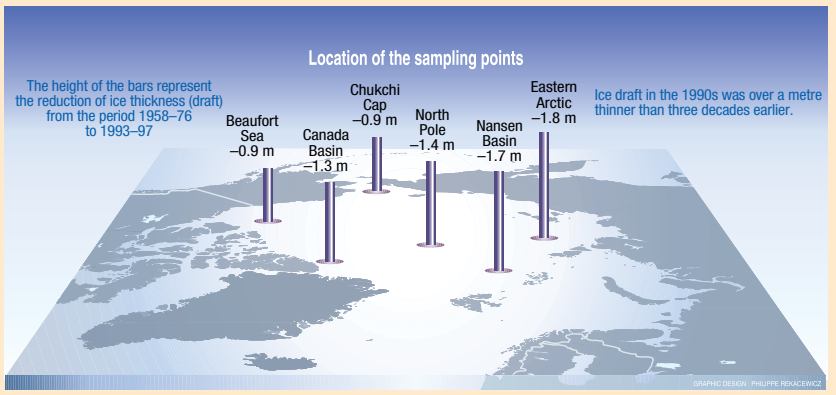

Figure 4.11e Thinning of the Arctic sea ice.

Figure 4.11f Arctic sea ice extent, September 2007. Arctic sea ice reached a record low in September 2007, below the previous record set in 2005 and substantially below the long-term average.

Rising sea levels

Sea levels are rising for two reasons. First, with increasing average global temperatures, the water in the Earth's oceans expands in volume. This occurs because, when heated, the molecules that make up a body of water move more rapidly and collide more often.

Second, when glaciers and ice sheets melt, the water that had previously been locked up in them enters the oceans. An increase in global temperatures of 1.5–4.5°C will, scientists estimate, result in a sea level rise of 15–95 cm by the end of this century.

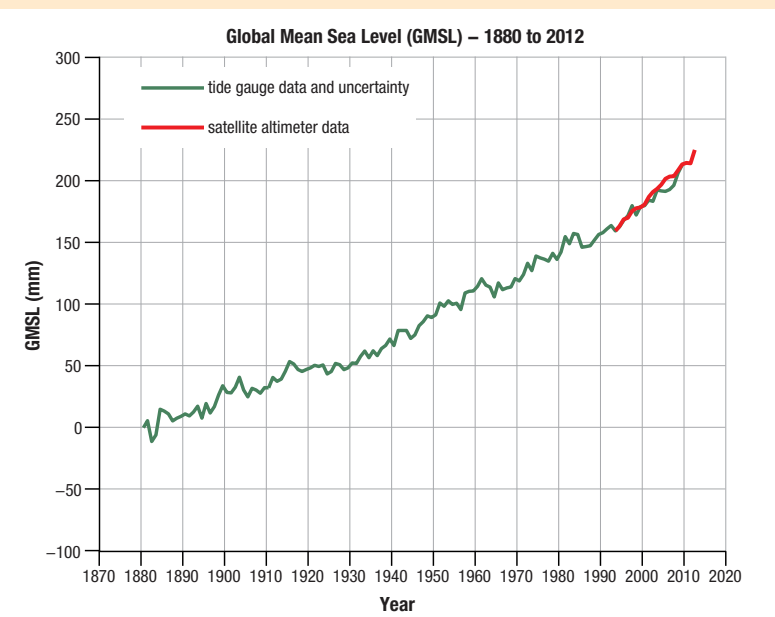

Figure 4.11g Sea level change, 1880–2012.

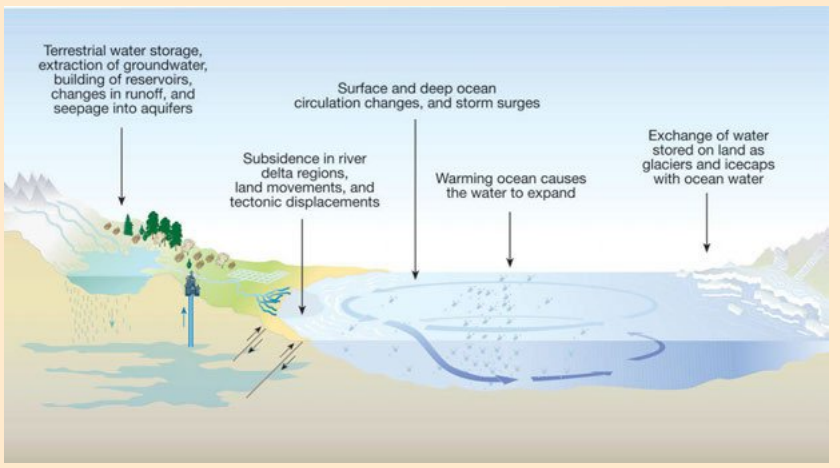

Figure 4.11h Causes of sea-level change. Source: GRID-Arendal.

Figure 4.11i Rising sea levels pose a threat to coastal settlements.

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There are approximately 160 000 glaciers throughout the Earth's polar regions and high mountain environments. Like great rivers of ice, these glaciers have sculpted mountains and carved out great valleys. Since 1980, however, glacial retreat has become increasingly rapid and widespread. This process has sped up markedly since 1995. In the past three decades, Peru's glaciers have lost almost one-quarter of their surface area. This trend is most apparent in the mid-latitude mountain ranges, such as the Himalayas.

More than 110 glaciers have disappeared from the United States' Glacier National Park over the past 150 years, and researchers estimate that the park's remaining 37 glaciers may be gone in another 25 years.

Half a world away, on the African equator, the snows of Kilimanjaro are steadily melting and could completely disappear in the next 20 years. And in the European Alps, glaciers are retreating and disappearing every year, much to the dismay of mountain climbers, tourism agencies and environmental researchers.

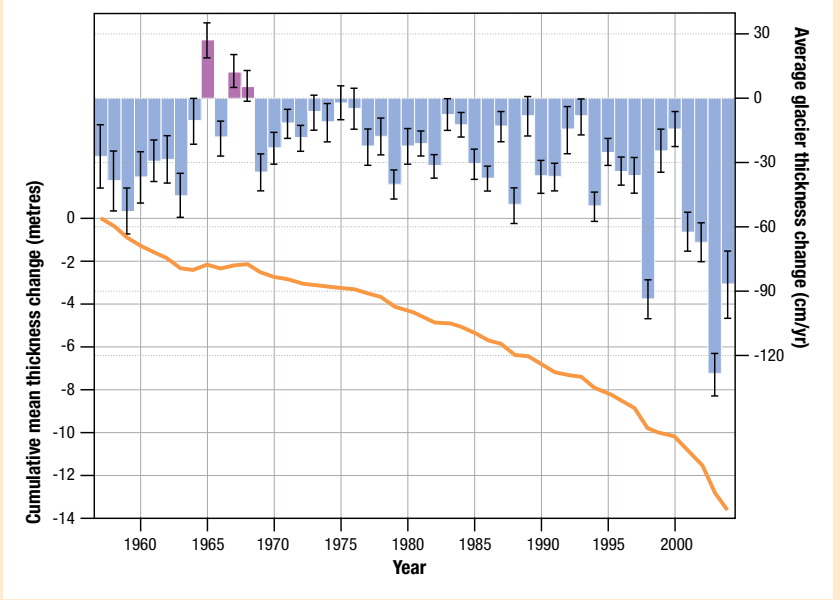

Figure 4.11j Change in glacial volume worldwide, 1955–2009.

Figure 4.11k NASA image showing the formation of numerous glacial lakes at the termini of receding glaciers in Bhutan-Himalaya.

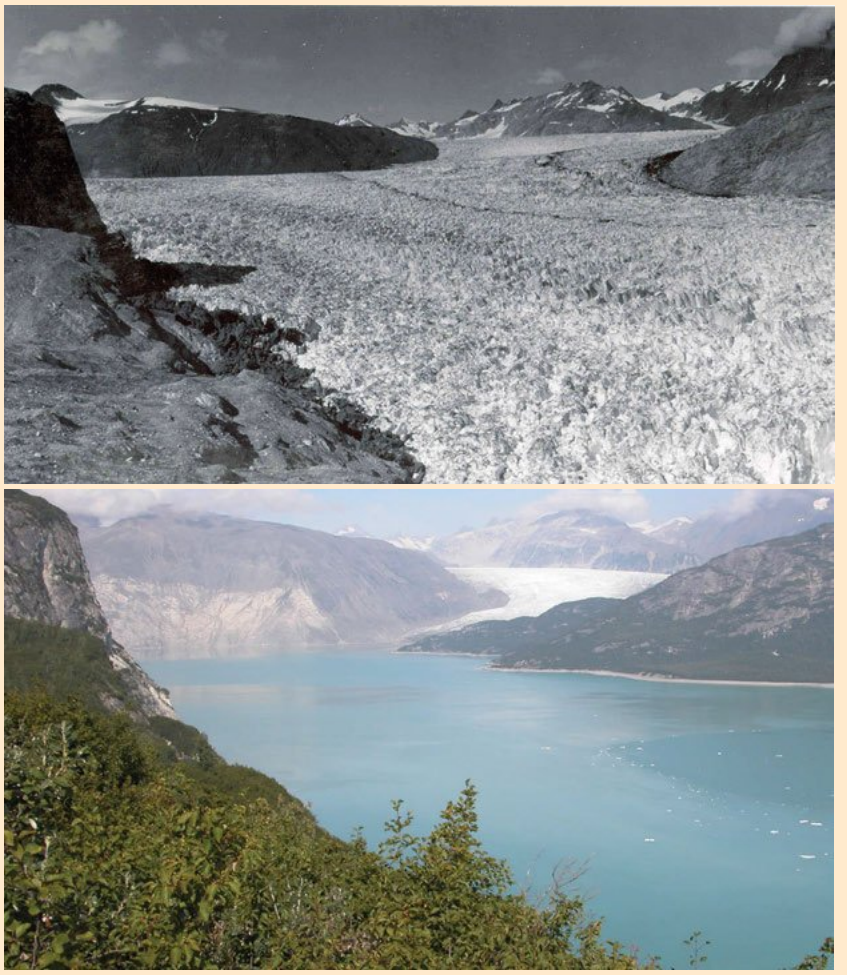

Figure 4.11l Muir Glacier, United States, photographed from the same vantage point in 1941 (top) and 2004 (bottom). Between 1941 and 2004 the glacier retreated more than 12 km and thinned by more than 800 m. During this time, ocean water has filled the valley, replacing the glacier ice. The glacier's retreat has exposed scars where the ice once scraped high up against the hillside. In 2004, vegetation grew thickly in the foreground, whereas in 1941 there was only bare rock.

ACTIVITIES

1. Study the introductory text on page 106 and then answer the following questions:
   - a What are the key signs that the global climate is changing?
   - b What effects do CO_2 emissions have on the atmosphere?
   - c What are the likely effects of global climate change?
2. Study Figure 4.11a (page 106) and then answer the following questions:
   - a How much hotter was it in 2012 than the average temperature between 1951 and 1980?
   - b In what year did the sustained upwards trend in global temperatures become established?
3. Study Figure 4.11b (page 106) and then answer the following questions:
   - a By how much did atmospheric CO_2 concentrations increase between 1960 and 2012?
   - b In what year did the atmospheric concentrations of CO_2 first exceed 360 parts per million?
4. Study Figure 4.11c (page 106) and then complete the following tasks:
   - a With the aid of an atlas, identify five countries with CO_2 emissions per capita greater than 15 tonnes.
   - b Describe the distribution of countries with CO_2 emissions per capita below 2 tonnes.
5. Study the inset of Figure 4.11c (page 106) and then complete the following questions:
   - a What is the largest single source of CO_2 emissions?
   - b What percentage of total emissions is energy related?
   - c What percentage of CO_2 emissions comes from industry?
   - d What is the total amount of CO_2 produced by agriculture?
   - e What is the total amount of CO_2 emitted by energy supply?
6. Study Table 4.11a (page 106). Construct a column graph showing the 10 largest CO_2 emitting countries. Add Australia to this graph.
7. Study Figure 4.11d (page 107) and then answer the following questions:
   - a By how much did the trend in the extent of sea ice change between 1978 and 2011?
   - b In what year did sea ice extent reach its lowest level?
   - c In what year did sea ice extent last exceed 8 million km^2?
8. Study Figure 4.11e (page 107) and then answer the following questions:
   - a By how much did the thickness of sea ice at the North Pole change between 1958–76 and 1993–97?
   - b Which sampling point experienced the greatest reduction in ice between 1958–76 and 1993–97?
9. Study Figure 4.11f (page 107). Describe the change evident in the spread of the Arctic ice sheet between the 1979–2000 median minimum and 2007.
10. Study Figure 4.11g (page 107). By how much did mean sea level change between 1980 and 2012?
11. Study Figure 4.11h (page 107). Write a report outlining the factors that cause sea level to change.
12. Study Figure 4.11j and then complete the following tasks:
    - a By how much has thickness of glacial ice changed between 1955 and 2008?
    - b Has the decline in glacial volume accelerated or slowed since the 1980? Explain how you arrived at this answer.
13. Study Figures 4.11k and 4.11l. Construct a series of comparative photo sketches to highlight the trends in glacial retreat shown in the photographs.

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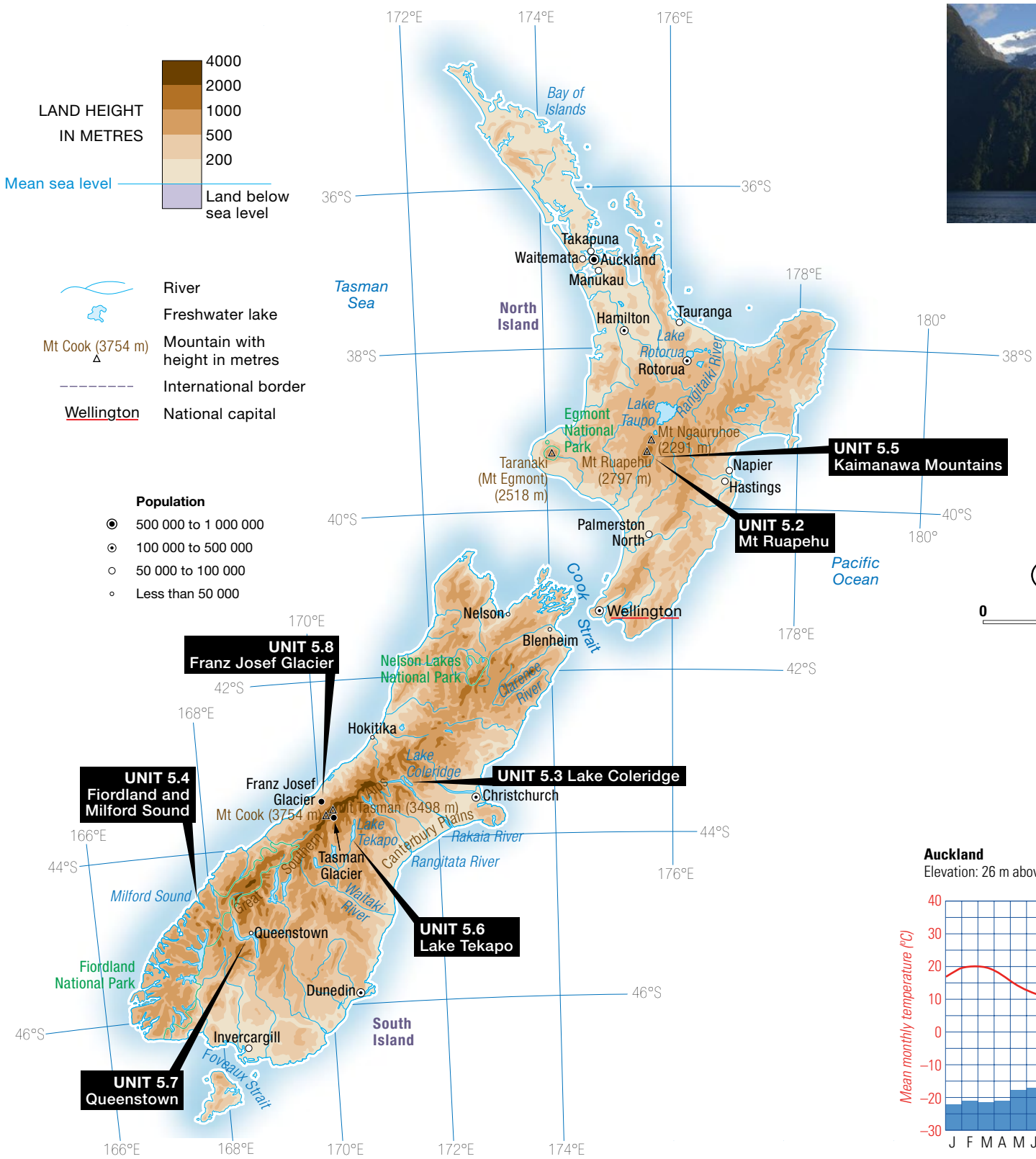
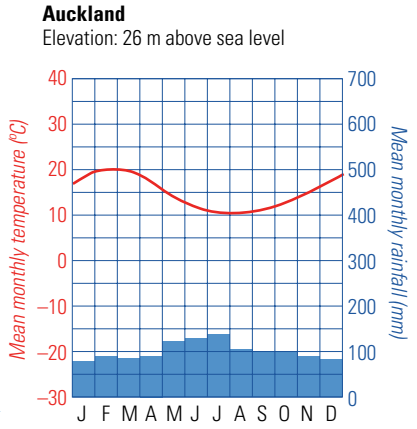
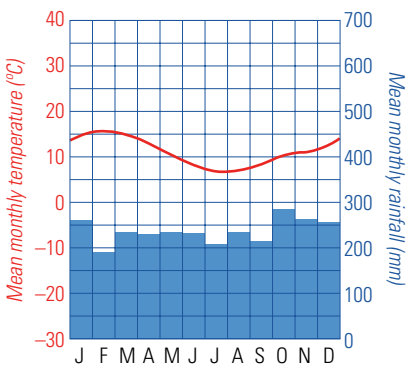
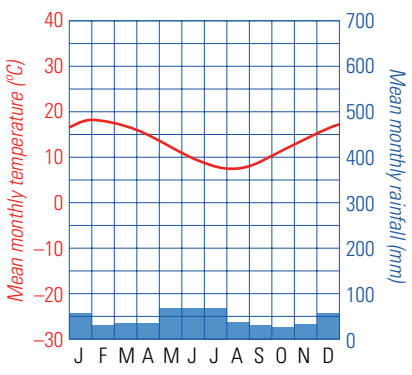
NEW ZEALAND

5.1 New Zealand









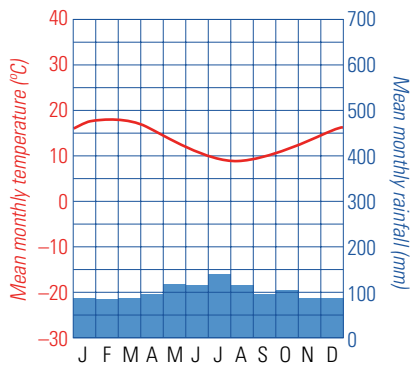


Figure 5.1a New Zealand: physical features and climate graphs.

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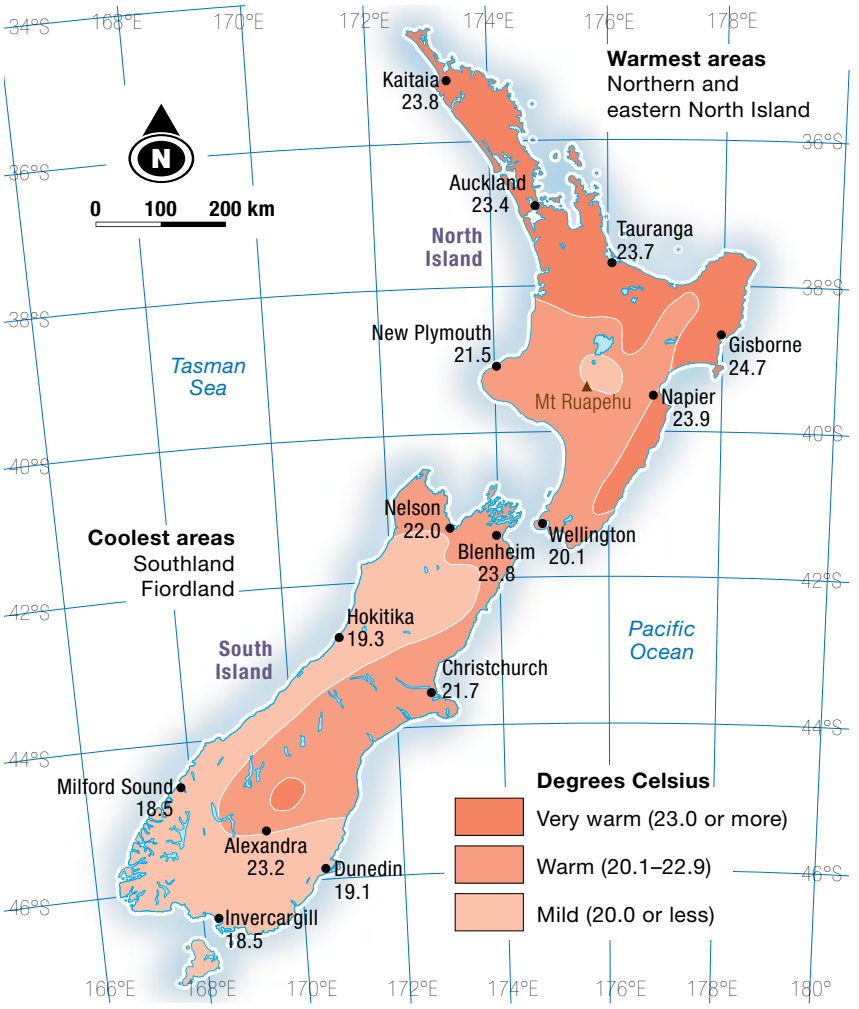

Figure 5.1b Maximum temperature (mid-summer daily average).

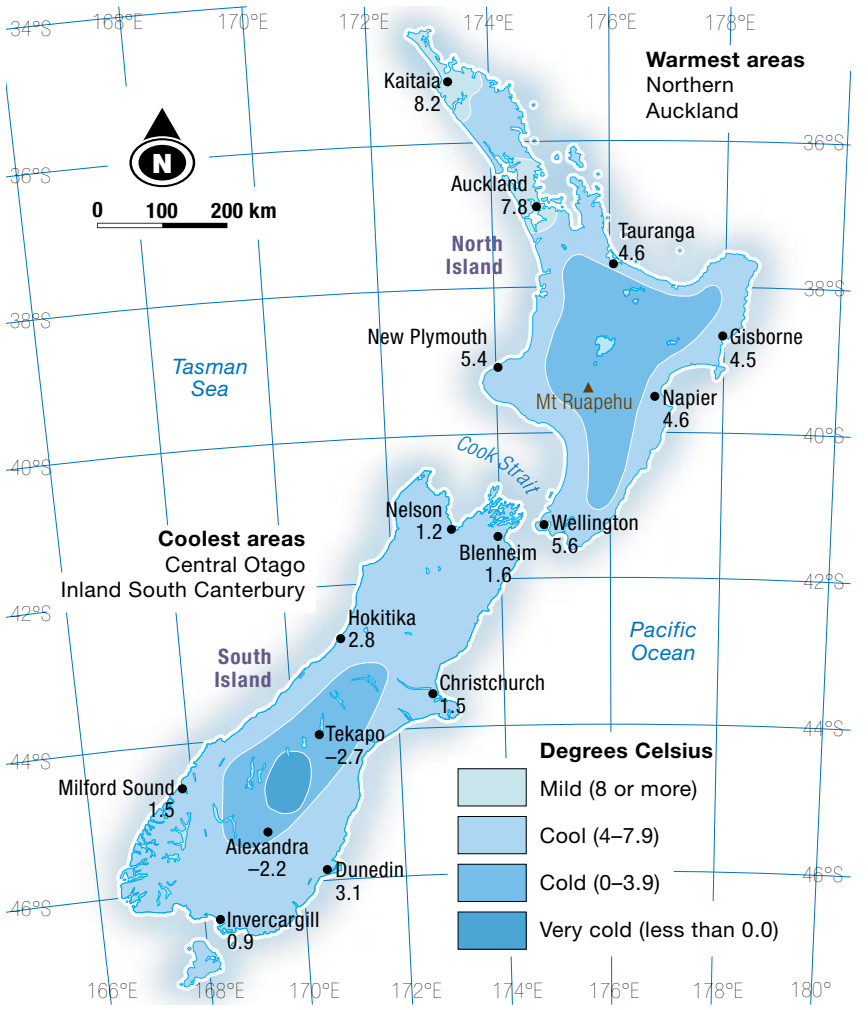

Figure 5.1c Minimum temperature (mid-winter daily average).

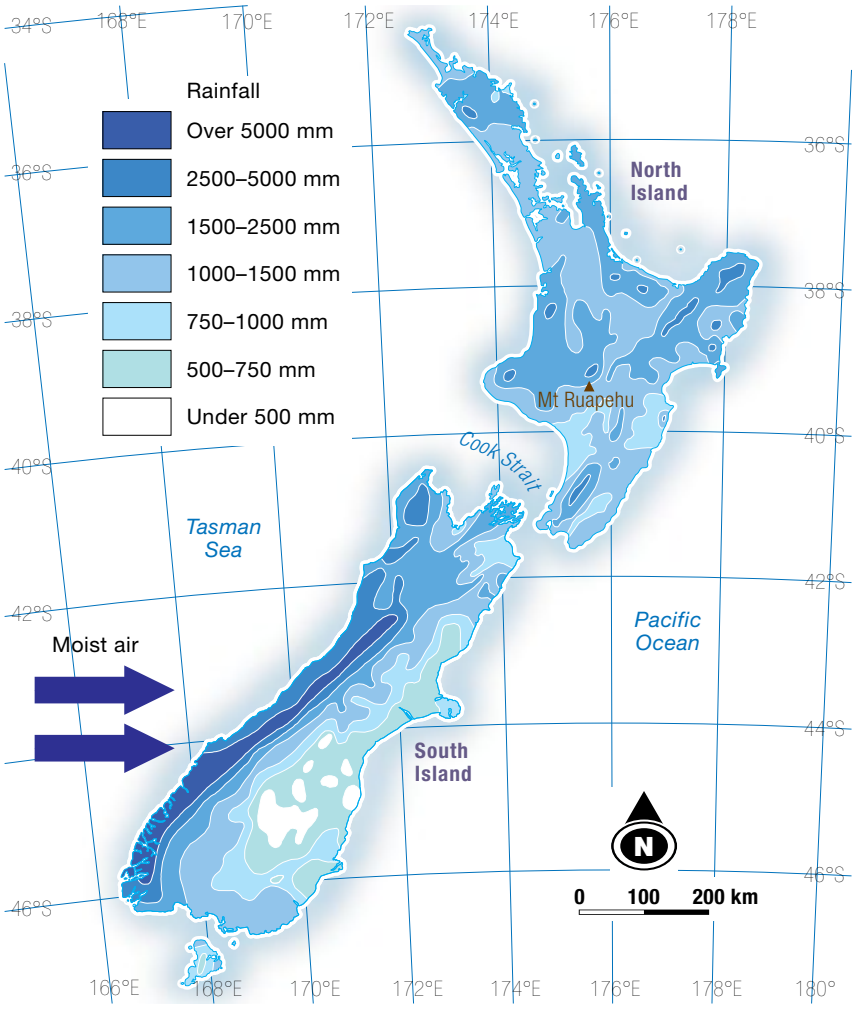

Figure 5.1d Annual average rainfall.

ACTIVITIES

1. Study an atlas map of New Zealand and then complete the following tasks:
   - **a** What is the capital city of New Zealand?
   - **b** What is New Zealand's largest city?
   - **c** List the New Zealand cities with a population greater than 100 000.
   - **d** What strait separates the North Island from the South Island?
   - **e** Name the highest peak on the South Island.
   - **f** Name the highest peak on the North Island.
   - **g** What mountain range runs the length of the South Island?
   - **h** Name the feature of the physical environment located at the following latitudes and longitudes:
     - **i** 39°18′S, 174°05′E
     - **ii** 43°28′S, 170°10′E
     - **iii** 43°33′S, 170°10′E
     - **iv** 44°41′S, 167°55′E
     - **v** 46°30′S, 168°00′E
     - **vi** 39°18′S, 175°34′E.
   - **i** Name the urban centre located at each of the following latitudes and longitudes:
     - **i** 38°09′S, 176°15′E
     - **ii** 46°25′S, 168°21′E
     - **iii** 45°02′S, 168°40′E
     - **iv** 45°53′S, 170°31′E
     - **v** 36°52′S, 174°45′E
     - **vi** 41°17′S, 174°47′E.
   - **j** What is the straight-line distance between:
     - **i** Auckland and Wellington
     - **ii** Dunedin and Auckland?
   - **k** What is the direction of:
     - **i** Wellington from Christchurch
     - **ii** Queenstown from Christchurch
     - **iii** Nelson from Wellington
     - **iv** Rotorua from Auckland?
2. Study the climate graphs in Figure 5.1a (page 109) and then answer the following questions.
   - **a** Which station has:
     - **i** the highest mean monthly temperature
     - **ii** the lowest mean monthly temperature
     - **iii** the highest annual rainfall
     - **iv** the lowest annual rainfall?
   - **b** What is the annual temperature range of the following?
     - **i** Auckland
     - **ii** Christchurch
     - **iii** Wellington
     - **iv** Hokitika
3. Study Figures 5.1b to 5.1d and then complete the following tasks.
   - **a** What parts of New Zealand have mid-summer daily average temperatures of more than 23.0°C (very warm)?
   - **b** What parts of New Zealand have mid-winter daily average temperatures below 0°C (very cold)?
   - **c** Explain the pattern of average temperature on New Zealand's South Island.
4. Compare Figure 5.1a (page 109) and the map showing the annual distribution of rainfall (Figure 5.1d). Explain the annual distribution of rainfall.

5.2 Mt Ruapehu topographical map extract

Mt Ruapehu (often known simply as Ruapehu) is located within Tongariro National Park on New Zealand's North Island. It is one of the world's most active volcanoes and the largest such volcano in New Zealand. It is also the highest point on the North Island and includes three major peaks: Tahurangi (the tallest at 2797 m), Te Heuheu and Paretetaitonga. A deep, active crater lies between the three peaks. Between major eruptions the crater fills with water to form a crater lake. (See Figure 5.2e, page 112.)

The North Island's major ski fields and its only glaciers are on the slopes of Mt Ruapehu.

Figure 5.2a Mt Ruapehu during an eruption.

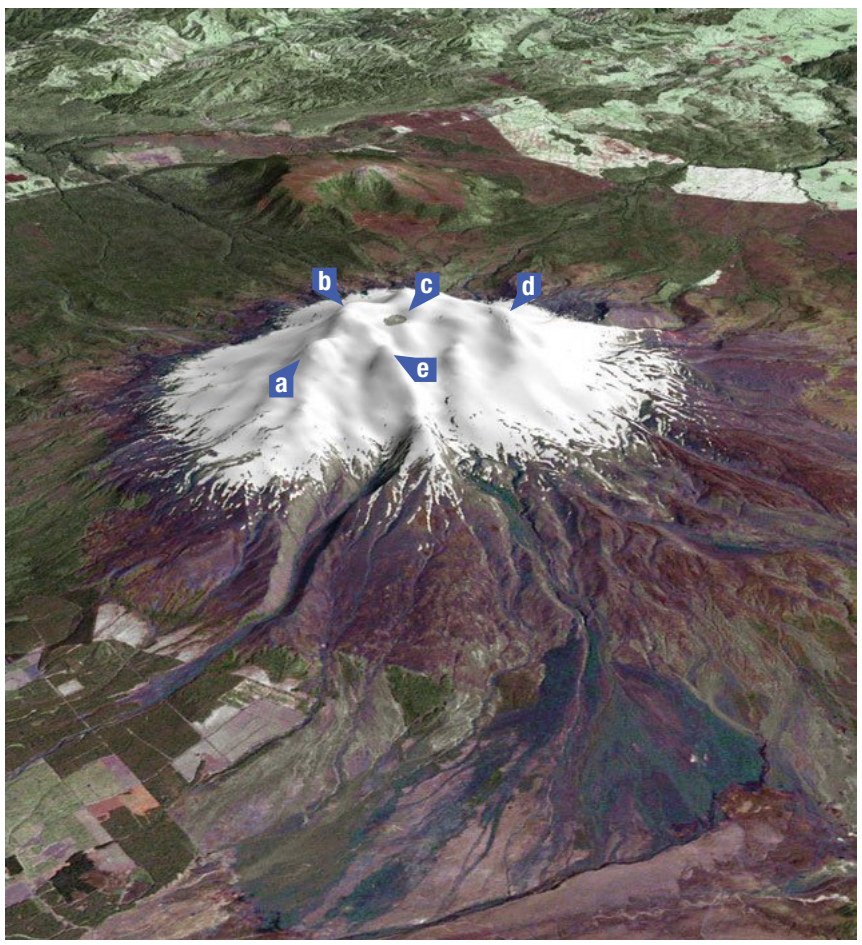

Figure 5.2b Enhanced-colour image of Mt Ruapehu, facing north-west.

Lahar event of 2007

On 18 March 2007, the Tephra dam, which had been holding back Mt Ruapehu's crater lake, burst. This sent a lahar down the mountain. (A lahar is a rapidly flowing lake breakout or flash flood of rock debris and water from a volcano.) An estimated 1.4 million m^3 of mud, rock and water thundered down the Whangaehu River. No serious damage was done and no-one was injured.

A lahar warning system that had been set up by the New Zealand Department of Conservation at Mt Ruapehu was hailed a success after it successfully alerted officials to the 18 March lahar. Fortunately, such events do not occur often.

Figure 5.2c Left: Mt Ruapehu in 2002, before the lahar event of 2007. Right: Mt Ruapehu on 25 March 2007, following the lahar event.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Study the map extract on page 113 and Figure 5.2b (page 111). Identify the topographic features labelled a–e on Figure 5.2b.
4. Read the text box 'Lahar event of 2007' on page 111 and study Figure 5.2c and then complete the following tasks:
   - **a** What is a lahar?
   - **b** Locate the path of the lahar on the map extract.
5. Identify the feature of the biophysical environment located at:
   - **a** GR 320113
   - **b** GR 316105
   - **c** GR 285182
   - **d** GR 285174
   - **e** GR 353193
   - **f** GR 341163.
6. Identify the feature of the constructed environment located at:
   - **a** GR 294194
   - **b** GR 273156
   - **c** GR 312113
   - **d** GR 348065.
7. What is the area reference of Crater Lake?
8. Name the type of biophysical feature found in AR 3010.
9. Name the type of land use found in AR 3015.
10. On what waterway is the Punaruku Falls (AR 2818) located?
11. What is the direction of the Tukino Skifield (AR 3410) from the Whakapaoa Skifield (AR 3113)?
12. What tributary joins Whakapapanui Stream in AR 2918?
13. In what direction is Whakapapaiti Stream flowing in AR 2616?
14. What is the bearing of Girdlestone Peak (AR 3108) from Cathedral Rocks (GR 320114)?
15. What is the bearing of Paretetaitonga (AR 3011) from Girdlestone Peak (AR 3108)?
16. What is the aspect of the slope in AR 3010?
17. What is the straight-line distance between Paretetaitonga (AR 3011) and Girdlestone Peak (AR 3108)?
18. What is the length of the longest ski lift at Iwikau Village?
19. What is the area of the Summit Plateau?
20. What is the area of Crater Lake?
21. What is the density of buildings in AR 2918?
22. What is the height of Pyramid Peak (AR 3110)?
23. What is the difference in elevation of Tahurangi (AR 3109) and Girdlestone Peak (AR 3108)?
24. Estimate the local relief experienced on a traverse from the summit of Paretetaitonga (AR 3011) to the summit of the Dome (AR 3111).
25. Construct the cross-section from GR 260150 to the summit of Paretetaitonga at GR 308111. Use a vertical scale of 1 cm = 200 m.
26. Calculate the vertical exaggeration of the cross-section that you constructed in Activity 25.
27. What is the gradient of the slope in the cross-section that you constructed in Activity 25?
28. Construct the cross-section from GR 311040 to Tahurangi (GR 311097). Use a vertical scale of 1 cm = 100 m.
29. Calculate the vertical exaggeration of the cross-section you constructed in Activity 28.
30. What is the gradient of the slope in the cross-section you constructed in Activity 28?

Figure 5.2d Mt Ruapehu viewed from Ohakune.

Figure 5.2e Crater of Mt Ruapehu.

SCALE 1:50 000

1 0 1 2 3 4

kilometres

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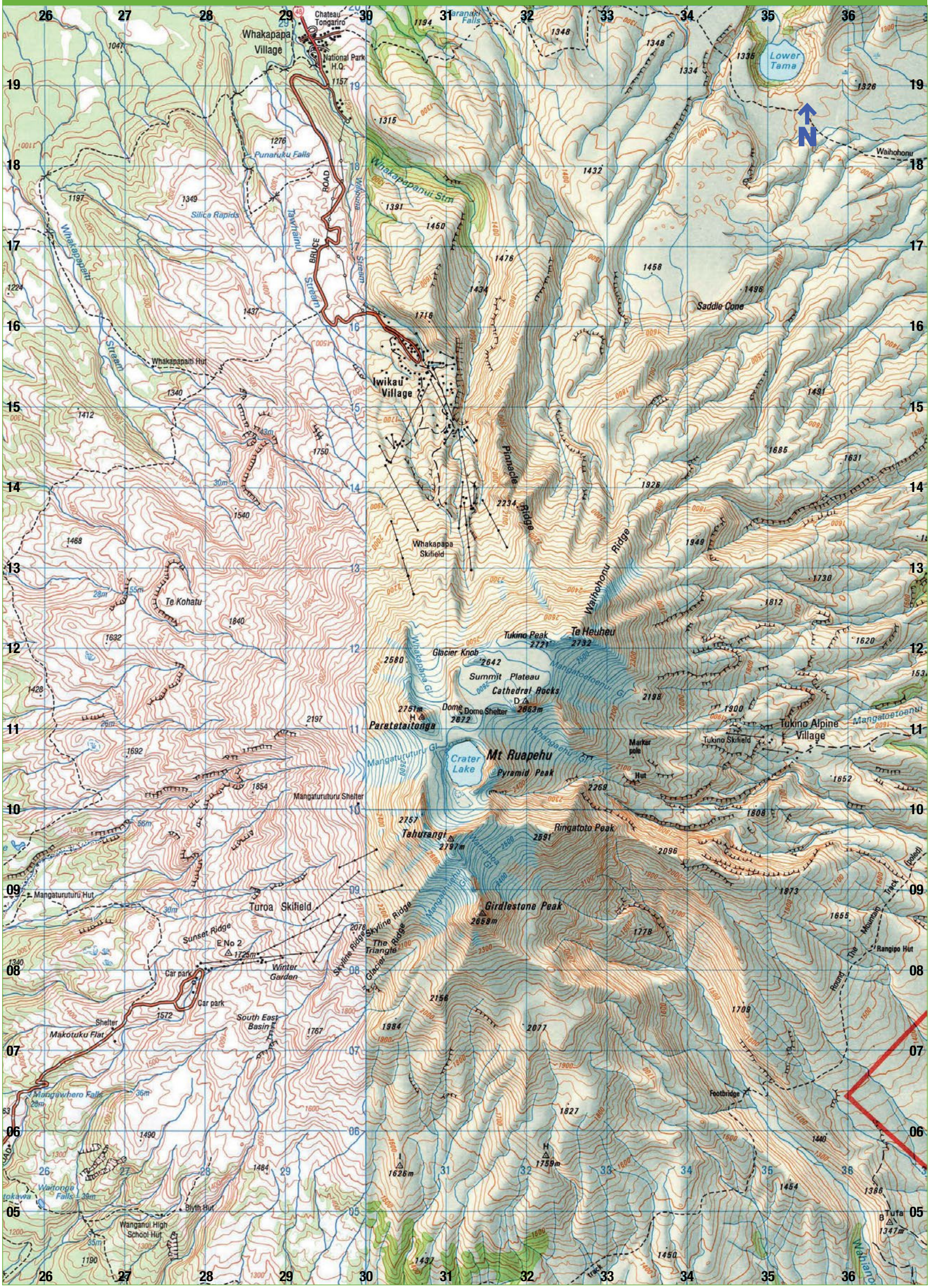
Mt Ruapehu topographic map extract (Mt Ruapehu: latitude 39°17′S, longitude 175°34′E)



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5.3 Lake Coleridge topographical map extract

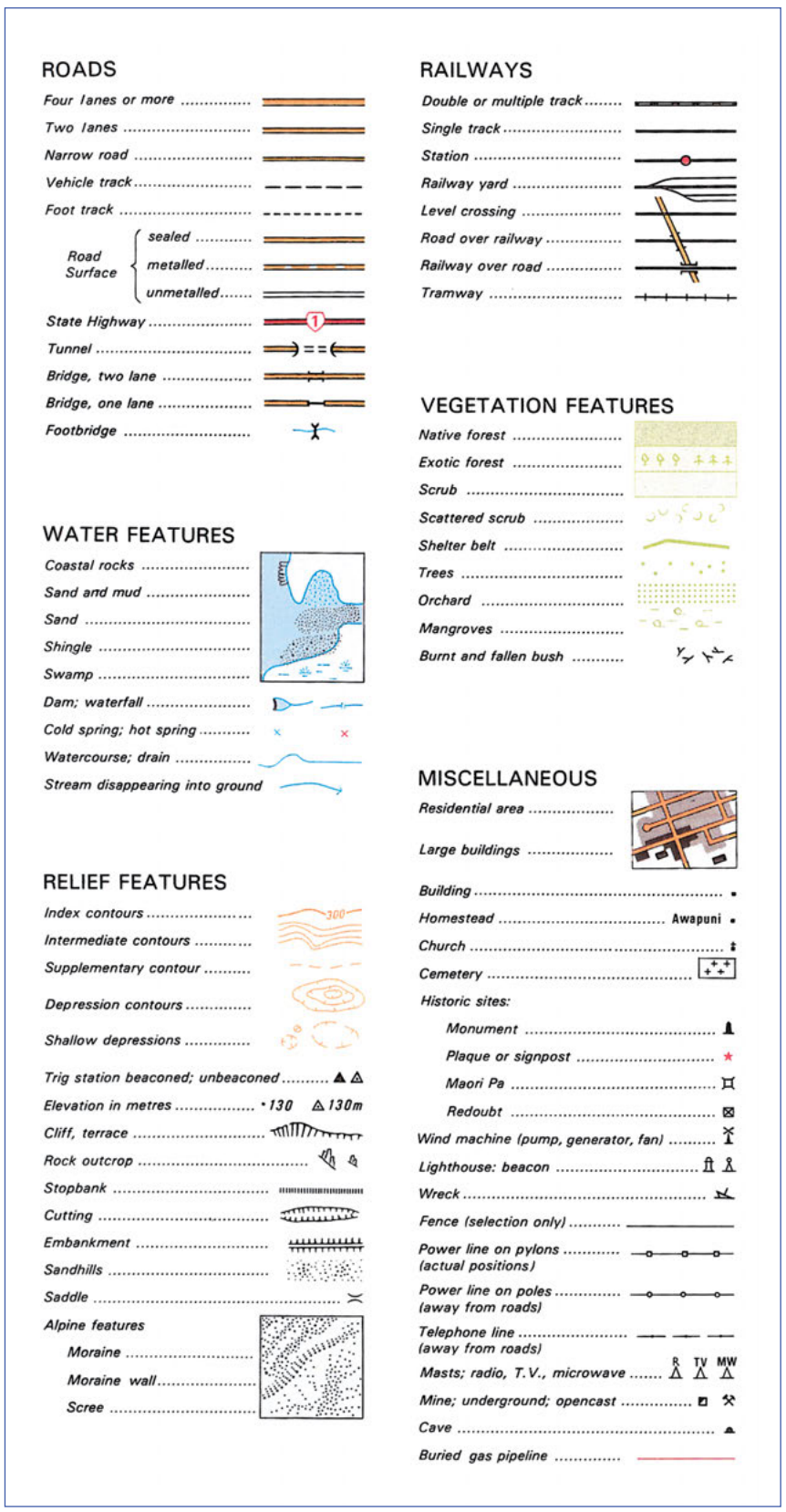
Lake Coleridge is located on New Zealand's South Island. The lake and its surrounding landscape were formed over millions of years. Massive glaciers have gouged out the land, and wind, rain, frost and even earthquakes and volcanoes have all had a role in shaping the landscape as we see it today.

The lake is the site of one of New Zealand's earliest hydro-electric schemes, completed in 1914. The project makes use of the difference in altitude between the lake and Rakaia River. (The lake is some 150 metres higher.) The lake is also a valued recreational resource.

Figure 5.3a Oblique aerial photograph of Lake Coleridge, looking towards the north-west.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Study Figure 5.3a. Locate and name the features labelled a–d.
4. Identify the feature of the biophysical environment located at:
   - **a** GR 928689
   - **b** GR 951611
   - **c** GR 925655
   - **d** GR 935672.
5. Identify the feature of the constructed environment located at:
   - **a** GR 923617
   - **b** GR 873629
   - **c** GR 908666
   - **d** GR 917675.
6. What is the grid reference of Lake Coleridge power station?
7. Name the type of vegetation found at GR 927655.
8. Name the two land use activities in AR 9059.
9. What river flows into Lake Coleridge at GR 903678?
10. What is the direction of Round Hill (AR 9268) from Peak Hill (AR 8764)?
11. In what direction is the Ryton River flowing in AR 9168?
12. What is the bearing of:
    - **a** Round Hill (AR 9268) from Laings Hill (AR 9468)
    - **b** Mt Barker (GR 970609) from the summit of Mt Georgina (GR 960644)?
13. What is the aspect of the slope in:
    - **a** AR 9768
    - **b** AR 8765?
14. Estimate the straight-line distance between the summit of Peak Hill (AR 8764) and the summit of Mt Barker (GR 970609).
15. What is the length of the Lake Coleridge power station hydro-electricity tunnels and pipelines?
16. Estimate the area of Lake Coleridge shown on the map extract.
17. What is the density of buildings in:
    - **a** AR 8365
    - **b** AR 9561?
18. What is the elevation of Lake Coleridge?
19. Estimate the height of the following landform features:
    - **a** GR 928644
    - **b** GR 962631.
20. What is the difference in elevation of Peak Hill (AR 8764) and Mt Barker (AR GR 970609)?
21. Estimate the local relief experienced on a traverse from the summit of Carriage Drive (AR 9069) to the summit of Round Hill (AR 9268)?
22. Construct the cross-section from point A to point B using a vertical scale of 1 cm = 200 m.
23. Construct the cross-section from point C to point D using a vertical scale of 1 cm = 200 m.
24. Construct the cross-section from point E to point F using a vertical scale of 1 cm = 400 m.
25. Calculate the vertical exaggeration used for the cross-sections drawn in Activities 22, 23 and 24.
26. What is the gradient of the slope between GR 877645 and the water's edge at GR 888650?
27. What is the gradient of the slope from the spot height at GR 982696 to the spot height at GR 967671?
28. Construct a photo sketch of Figure 5.3a. Label the prominent features of the physical environment.



Lake Coleridge topographic map extract (Lake Coleridge: latitude 43°22′S, longitude 171°32′E)

5.4 Fiordland and Milford Sound topographic map extract

FIORDLAND NATIONAL PARK

New Zealand's Fiordland National Park occupies the south-west corner of New Zealand's South Island. It is the largest of the nation's 14 national parks, with an area of 12 500 km². It forms part of the Te Wahipounamu World Heritage site.

When the world was colder, vast glaciers carved many deep fiords in New Zealand. The most famous (and most frequently visited) of these fiords is Milford Sound, which is located within Fiordland National Park.

Figure 5.4a Milford Sound.

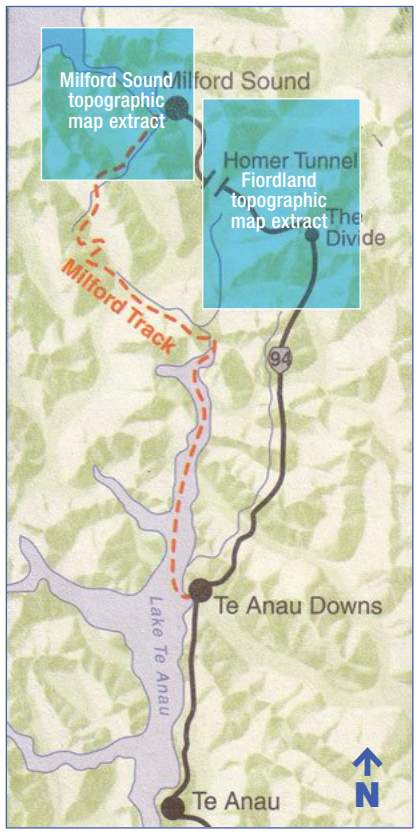


Figure 5.4b Map showing the location of the topographic map extracts in Unit 5.4.

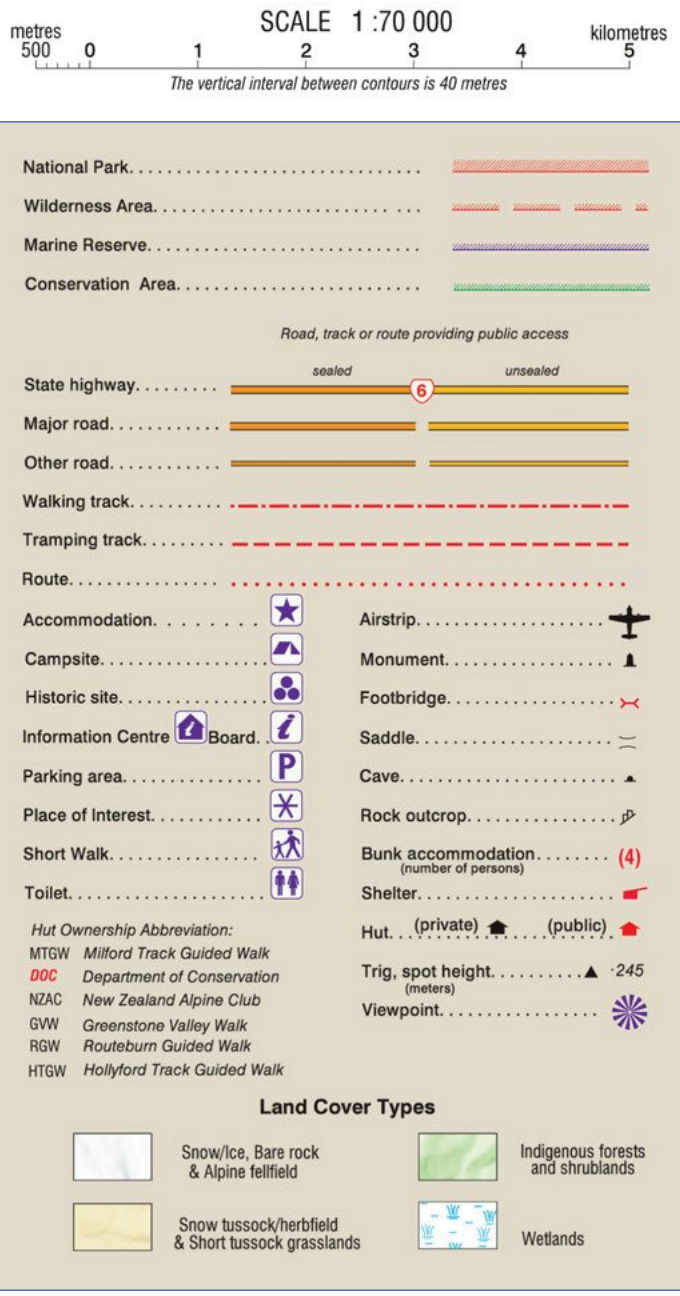
ACTIVITIES

The legend provided opposite is for both topographic map extracts in this unit.

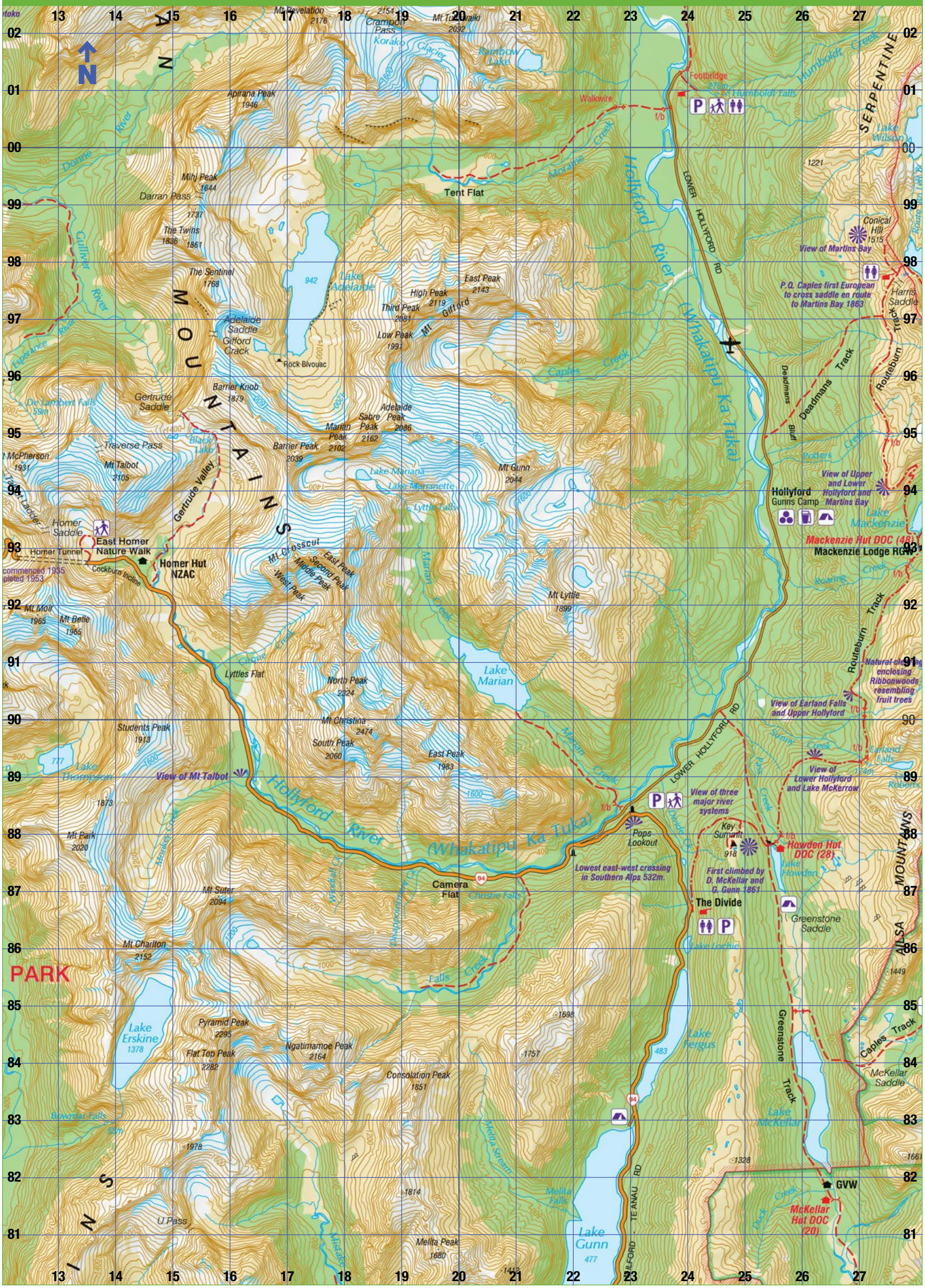
1. Construct a photo sketch of Figure 5.4a.
2. Undertake research. Investigate the geographical processes responsible for the landscape of New Zealand's Fiordland.

Study the Fiordland topographic map extract and then complete the following tasks.

3. What is the scale of the map extract?
4. What is the contour interval used on the map extract?
5. Identify the feature of the biophysical environment located at:
   - **a** GR 171929
   - **b** GR 136948
   - **c** GR 278003
   - **d** GR 191937
   - **e** GR 169963.
6. Identify the feature of the constructed environment located at:
   - **a** GR 248966
   - **b** GR 144928
   - **c** GR 258868
   - **d** GR 231884.
7. What is the grid reference of the Key Summit viewpoint?
8. What is the name of the biophysical feature found in AR 1801?
9. What creek flows into Lake Marian at GR 198914?
10. What tributary joins the Hollyford River at GR 233022?
11. What type of lake is found at GR 163861?
12. What is the direction of Mt Lyttle (AR 2191) from Barrier Peak (AR 1794)?
13. In what direction is Falls Creek flowing in AR 2085?
14. What is the bearing of Students Peak (AR 1489) from Mt Gunn (GR 210942)?
15. What is the aspect of the slope in:
    - **a** AR 2191
    - **b** AR 2485?
16. What is the length of the Homer Tunnel in ARs 1292 and 1392?
17. Estimate the area of Lake Marian.
18. What is the elevation of:
    - **a** Lake Adelaide (AR 1797)
    - **b** Lake Marian?
19. What is the elevation of the cirque lake in AR 2292?
20. What is the difference in elevation of Mt Talbot (GR 140943) and Mt Belle (AR 1391)?
21. Construct the cross-section from the spot height at GR 217848 to the spot height at GR 248821 using a vertical scale of 1 cm = 500 m.
22. Calculate the vertical exaggeration of the cross-section you constructed in Activity 21.
23. What is the average gradient of the slope between the summit of Mt Lyttle (GR 218920) and the Hollyford River at GR 254918?

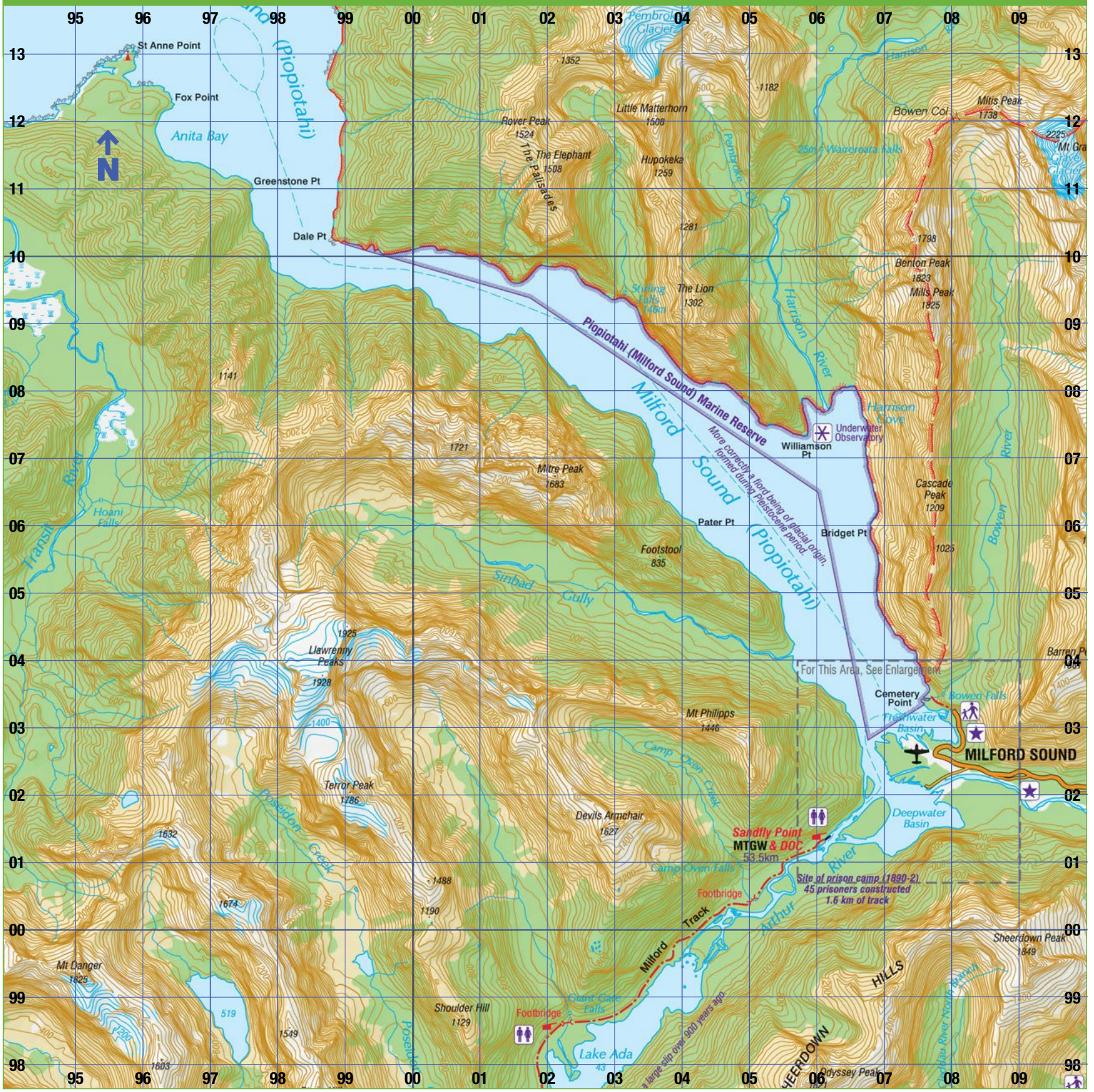


Fiordland topographic map extract (Milford Sound: latitude 44°41′S, longitude 167°47′E)



ISBN 978-1-139-77461-1

Milford Sound topographic map extract (Milford Sound: latitude 44°41′S, longitude 167°47′E)



ACTIVITIES

Study the Milford Sound topographic map extract and then complete the following tasks.

24 Identify the feature of the biophysical environment located at:
- **a** GR 988102
- **b** GR 045031
- **c** GR 031095
- **d** GR 076098
- **e** GR 081120.

25 Identify the feature of the constructed environment located at:
- **a** GR 075027
- **b** GR 019986
- **c** GR 051005
- **d** GR 061074.

26 What is the grid reference of St Anne Point lighthouse?

27 What type of biophysical feature is found in:
- **a** AR 0313
- **b** AR 0701?

28 What type of vegetation is found in AR 0509?

29 What river flows into Milford Sound at GR 062077?

30 What is the direction of Mitre Peak (GR 021068) from Benton Peak (AR 0709)?

31 In what direction is Bowen River flowing in AR 0806?

32 What is the bearing of Mt Phillips (AR 0403) from Terror Peak (GR 990020)?

33 What is the aspect of the slope in AR 0706?

34 What is the difference in elevation of Cascade Peak (AR 0706) and Benton Peak (AR 0709)?

35 What is the local relief in AR 0706?

36 Construct the cross-section from Dale Point (GR 988103) to Rover Peak (GR 016119) using a vertical scale of 1 cm = 200 m.

37 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 36.

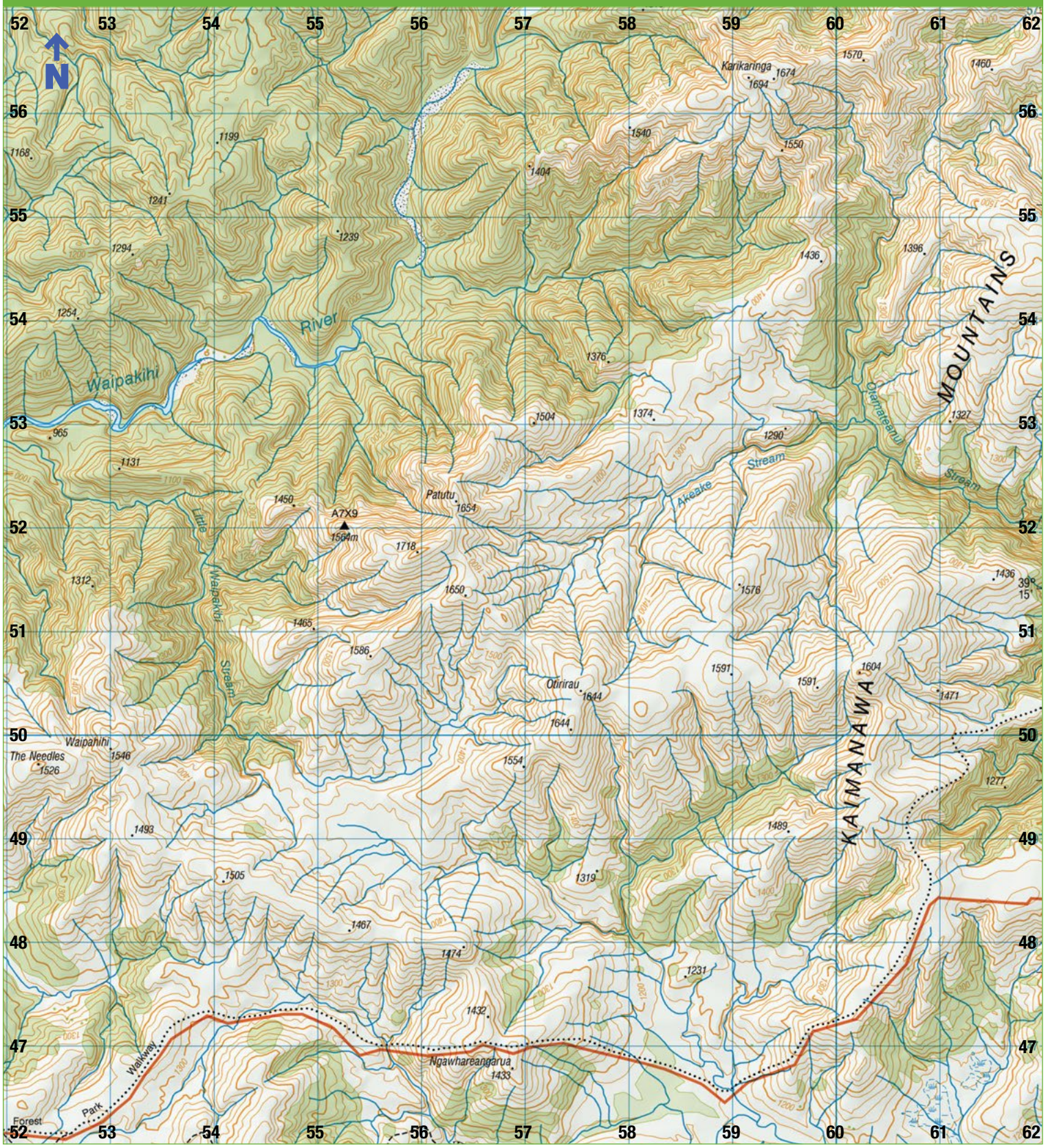
38 What is the average gradient of the slope between Dale Point (GR 988103) and Rover Peak (GR 026119)?

39 Construct the cross-section between Mitre Peak (AR 0206) and The Lion (AR 0409) using a vertical scale of 1 cm = 400 m.

40 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 39.

5.5 Kaimanawa Mountains topographic map extract

Kaimanawa Mountains topographic map extract (Kaimanawa Mountains: latitude 39°15′S, longitude 175°56′E)



SCALE 1:50 000

ACTIVITIES

1. What is the contour interval used on the Kaimanawa Mountains topographic map extract?
2. What techniques are used to show relief on the Kaimanawa Mountains topographic map extract?
3. What is the direction of The Needles (AR 5249) from Karikaringa (AR 5956)?
4. What is the direction of Otirirau in AR 5750 from Karikaringa?
5. In what direction is Otamateanui Stream flowing in AR 6052?
6. In what direction is Akeake Stream flowing in AR 5852?
7. What is the bearing of Karikaringa (GR 592180) from the peak at GR 560518?
8. What is the aspect of the slope in:
   a. AR 6051
   b. AR 5253?
9. What is the difference in elevation between Karikaringa (GR 592564) and the spot height at GR 555508?
10. Construct the cross-section between the spot height at GR 590506 and the spot height at GR 595491 using a vertical scale of 1cm = 100m.

ISBN 978-1-139-77461-1

5.6 Lake Tekapo topographic map extract

Figure 5.6a Lake Tekapo.

ACTIVITIES

Study the Lake Tekapo topographic map extract and complete the following tasks:

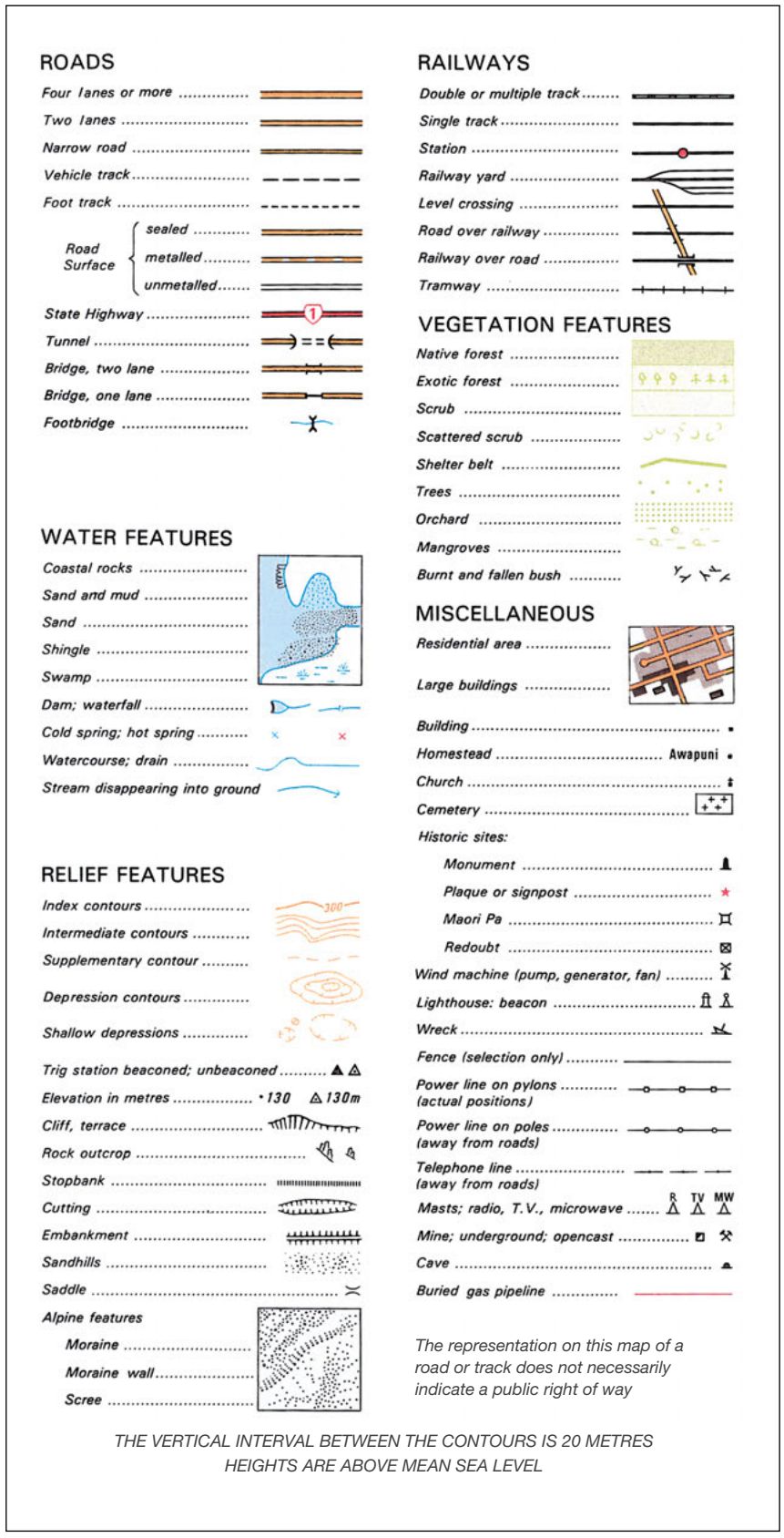
1. What is the scale of the Lake Tekapo map extract?
2. What is the contour interval used on the Lake Tekapo map extract?
3. Identify the feature of the biophysical environment located at the following grid references:
   - **a** 146925
   - **b** 067973
   - **c** 116930
   - **d** 064890.
4. Identify the feature of the constructed environment located at the following grid references:
   - **a** 064873
   - **b** 063863
   - **c** 066868
   - **d** 065849
   - **e** 066882.
5. Identify the productive activity taking place in AR 0685.
6. What is the area of the following features?
   - **a** Lake McGregor
   - **b** Lake Alexandrina
   - **c** Motuariki Island
7. What is the density of buildings in AR 0693?
8. What is the depth of Lake Tekapo at GR 110950?
9. What is the distance by road from the bridge in Lake Tekapo township (GR 080860) to the gravel pit located at GR 144981?
10. Calculate the time it would take for a truck to travel from the bridge in Lake Tekapo township to the gravel pit located at GR 144981 at an average speed of 60 km/h.
11. Estimate the water surface height, or elevation, of Lake Alexandrina.
12. What is the local relief experienced in a traverse from the summit located at GR 130854 to the spot height at GR 148843?
13. What is the aspect of the slope in AR 0688?
14. What is the bearing of Mt John (AR 0688) from Mt Hay (AR 1492)?
15. Identify the landform feature located at a distance of 4 km and with a bearing of 202° from Mt Hay.
16. Construct a cross-section from Mt Hay (GR 145925) to the spot height at GR 090924. Include indicators of water depth.
17. Calculate the vertical exaggeration of the cross-section.
18. Describe how the water cycle has been modified by people in the south-west quadrant of the map extract.

Study Figure 5.6a and the Lake Tekapo topographic map extract and complete the following tasks:

19. Locate the following features on the photograph:
    - **a** Lake Tekapo
    - **b** Motuariki Island.
20. Construct a line drawing of the photograph and label the features of the physical environment listed in activity 19.
21. In what direction was the camera pointing when the photograph was taken?

Study Table 5.6a and complete the following tasks:

22. Construct a climate graph for Lake Tekapo.
23. Study the climate graph you have drawn and complete the following tasks:
    - **a** Calculate the annual range of average monthly temperatures.
    - **b** Name the wettest month of the year.
    - **c** Name the driest month of the year.
    - **d** Describe the seasonal distribution of rainfall.



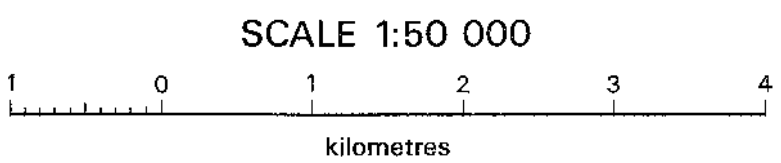


Table 5.6a Climate data for Lake Tekapo, elevation 767 metres

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Temperature (°C)	15.2	15.1	12.7	9.6	5.8	2.5	1.7	3.6	6.6	9.1	11.3	13.4	8.9
Rainfall (mm)	41	36	53	53	51	60	53	63	51	58	41	44	604

Lake Tekapo topographic map extract (Lake Tekapo: latitude 44°01'S, longitude 170°29'E)

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5.7 Queenstown topographic map extract

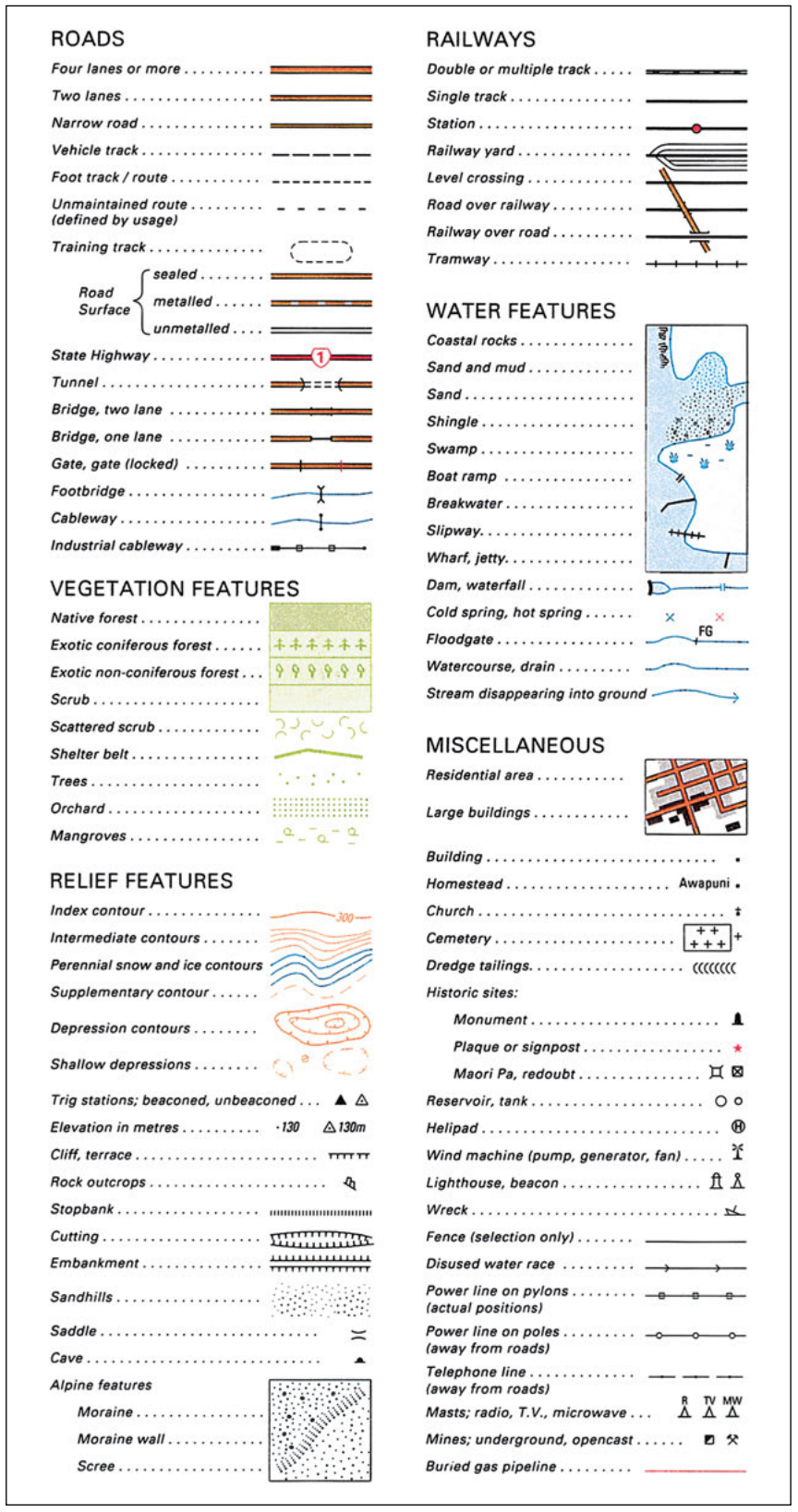
Figure 5.7a Queenstown.

Figure 5.7b Coronet Peak.

SCALE 1:50 000

1 0 1 2 3 4

kilometres



ACTIVITIES

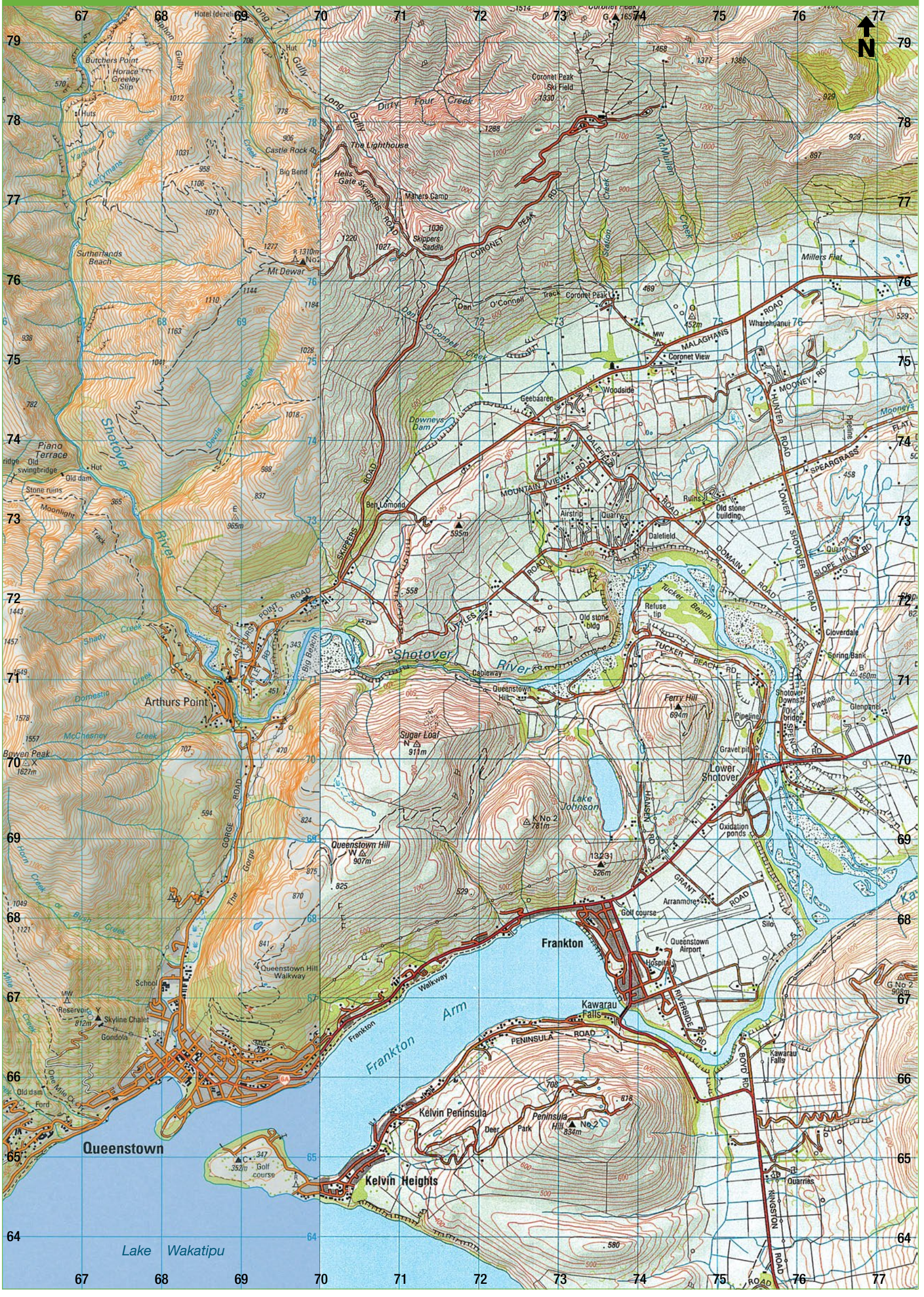
Study the Queenstown topographic map extract and complete the following tasks:

1. What is the scale of the Queenstown topographic map extract?
2. What is the contour interval used on the Queenstown topographic map extract?
3. Identify the feature of the biophysical environment located at the following grid references:
   - **a** 737695
   - **b** 745707
   - **c** 699713
   - **d** 760710.
4. Identify the feature of the constructed environment located at the following grid references:
   - **a** 672668
   - **b** 715743
   - **c** 755692
   - **d** 667736.
5. What type of vegetation is found in AR 6767?
6. Name the type of land use in AR 7378.
7. What creek flows into the Shotover River at GR 677731?
8. What is the direction of Coronet Peak (AR 7379) from Queenstown?
9. In what direction is the Shotover River flowing in AR 6773?
10. What is the aspect of the slope in AR 7465?
11. What is the bearing of Bowen Peak (GR 663699) from Queenstown Hill (AR 7068)?
12. What is the bearing of Queenstown Hill (AR 7068) from Peninsula Hill (AR 7365)?
13. What is the straight-line distance between the summit of Queenstown Hill (AR 7068) and Peninsula Hill (AR 7365)?
14. What is the length of the Coronet Peak ski lift?
15. Estimate the area of Lake Johnson (AR 7369).
16. What is the elevation of Lake Wakatipu?
17. Construct the cross-section from the summit of Queenstown Hill (GR 705688) to the summit of Peninsula Hill (AR 7365).
18. Calculate the vertical exaggeration of the cross-section from Queenstown Hill (GR 705688) to the summit of Peninsula Hill (AR 7365).
19. What is the gradient of the slope between the summit of Queenstown Hill (AR 7068) and the shoreline of Lake Wakatipu at GR 716674?
20. What is the gradient of the slope between the summit of Peninsula Hill and the bridge at GR 737667?
21. Is Arthurs Point (GR 690710) visible from the summit of Peninsula Hill (AR 7364)? Justify your answer.

Study Figures 5.7a and 5.7b and complete the following tasks:

22. In what direction was the camera facing when Figure 5.7b was taken?
23. Construct a photo sketch of either Figure 5.7a or 5.7b. Label the prominent features of the physical and human environments.

Queenstown topographic map extract (Queenstown: latitude 45°02'S, longitude 168°40'E)



5.8 Franz Josef Glacier topographic map extract

ACTIVITIES

Study the Franz Josef Glacier topographic map extract and complete the following tasks. Refer to the legend on page 122.

1. Identify the feature of the biophysical environment located at the following grid references:
   - **a** 816446
   - **b** 810467
   - **c** 822539
   - **d** 806541
   - **e** 808480.
2. Identify the features of the constructed environment located at the following grid references:
   - **a** 816505
   - **b** 841557.
3. In what general direction is the Franz Josef Glacier moving?
4. In what direction does the Waiho River flow in AR 8155?
5. What is the bearing of Mt Gunn (AR 8350) from Mt Roon (AR 8145)?
6. What is the bearing of Tower Saddle (AR 7948) from the footbridge in AR 8152?
7. Construct a cross-section of the Franz Josef Glacier from GR 813492 to GR 835459. Use a vertical scale of 1 cm = 200 m.
8. What is the vertical exaggeration of the cross-section you have constructed?
9. Calculate the gradient of the Franz Josef Glacier from GR 813492 to GR 835459.
10. Study Figures 5.8a to 5.8c. Account for the changes evident in the series of photographs.

Figure 5.8a Franz Josef Glacier, 1951.

Figure 5.8b Franz Josef Glacier, 1957.

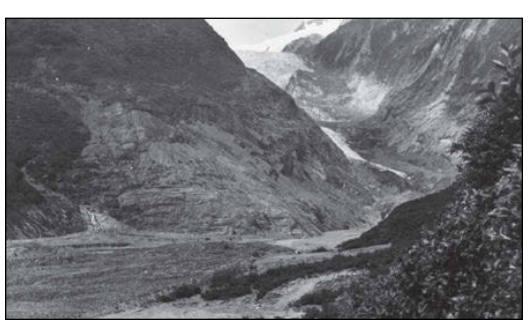
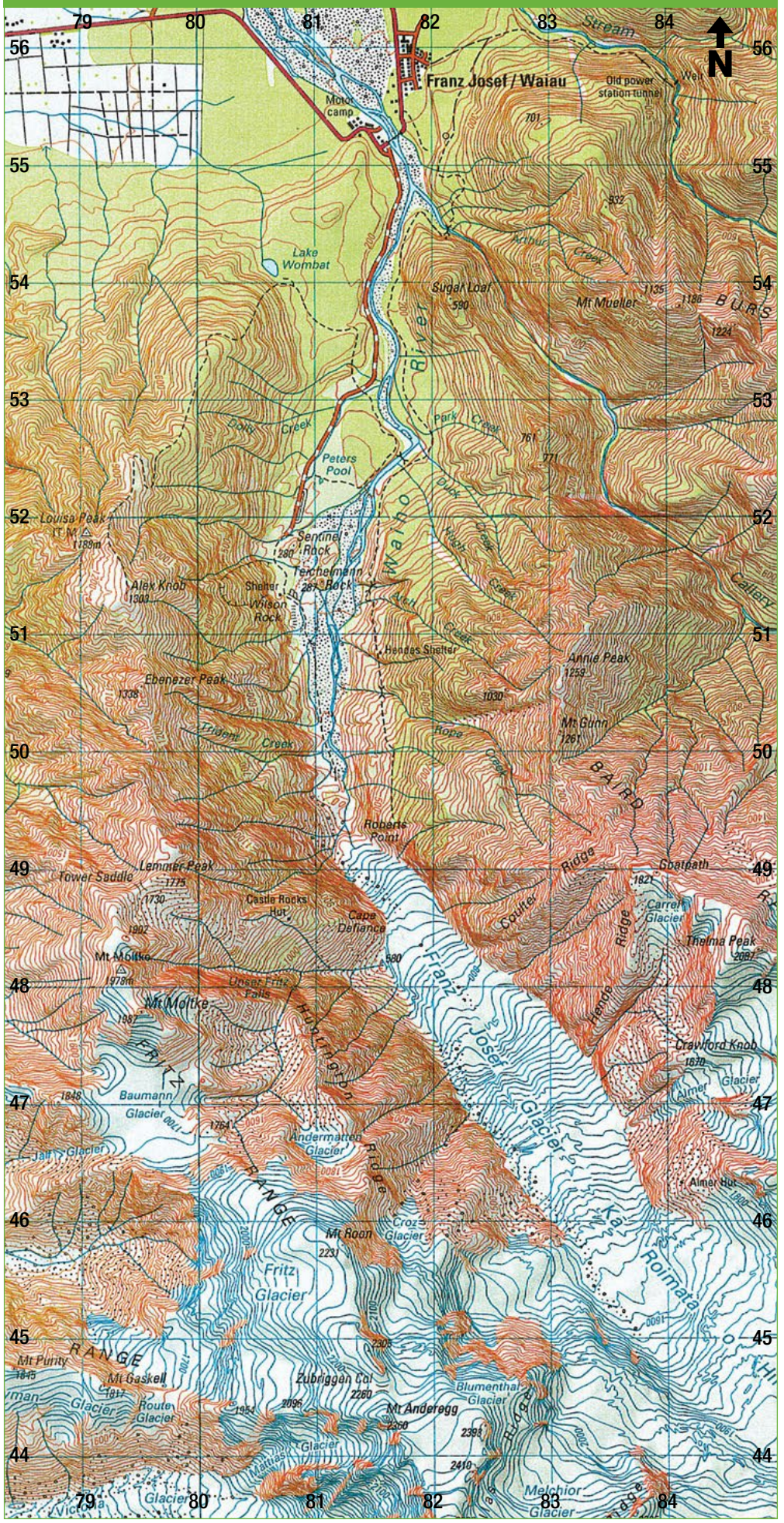


Figure 5.8c Franz Josef Glacier, 1964.

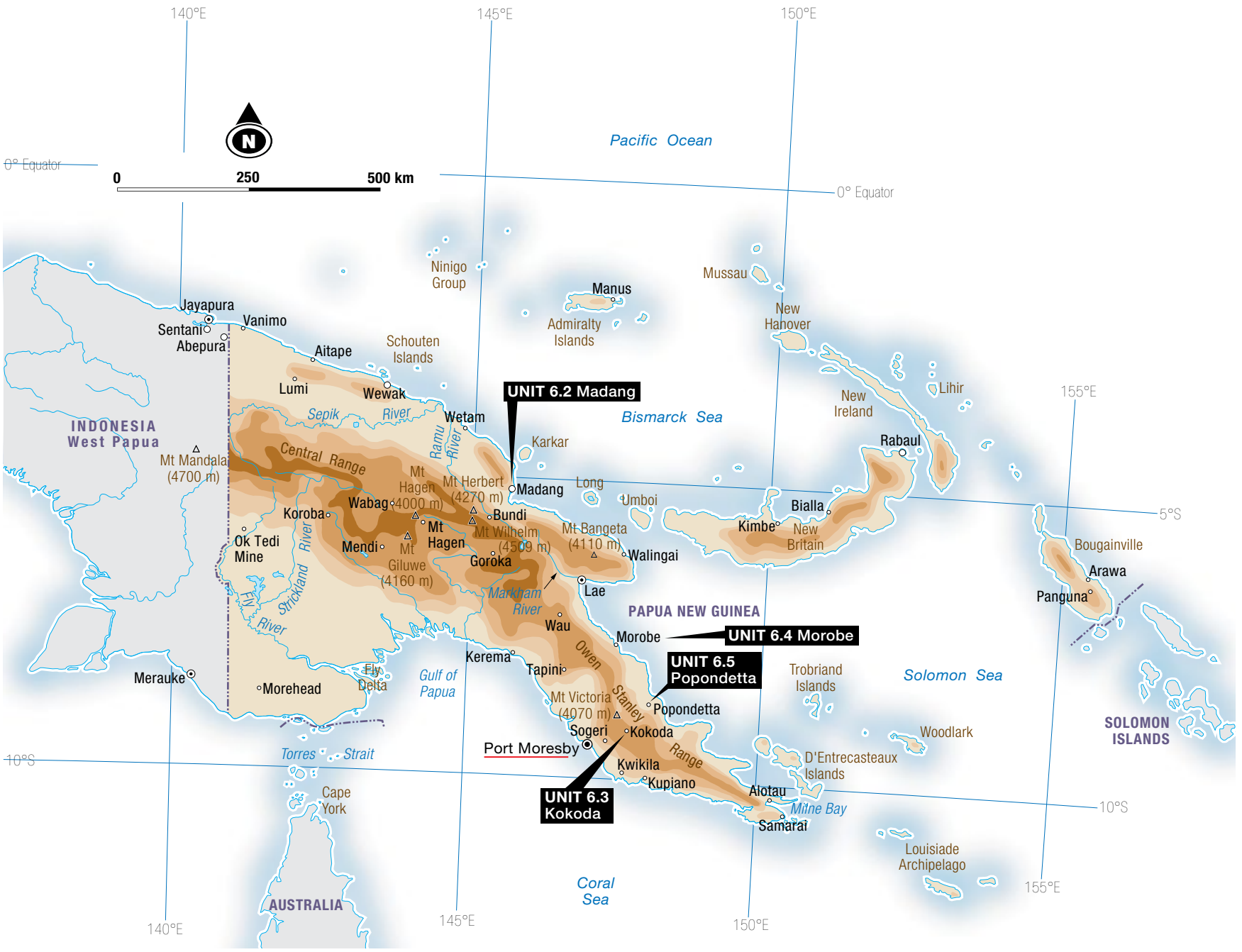
Franz Josef Glacier topographic map extract

(Franz Josef Glacier: latitude 43°28'S, longitude 170°10'E)



PAPUA NEW GUINEA

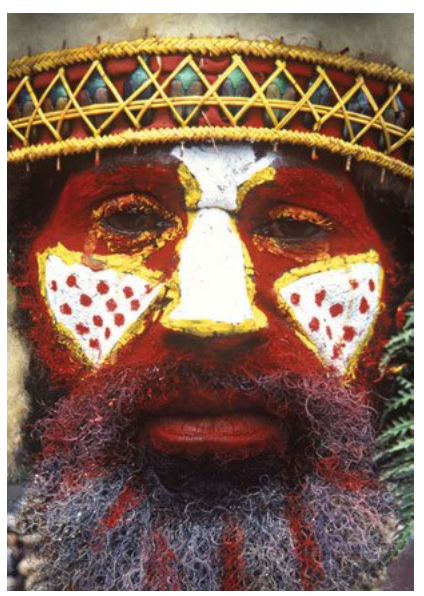
6.1 Papua New Guinea



LAND HEIGHT IN METRES
4000
2000
1000
500
200
Mean sea level
Land below sea level

River
Freshwater lake
Mt Hagen (4000 m)
Mountain with height in metres
International border
Port Moresby
National capital

Population
- 100 000 and over
- 50 000 to 100 000
- 25 000 to 50 000
- Less than 25 000



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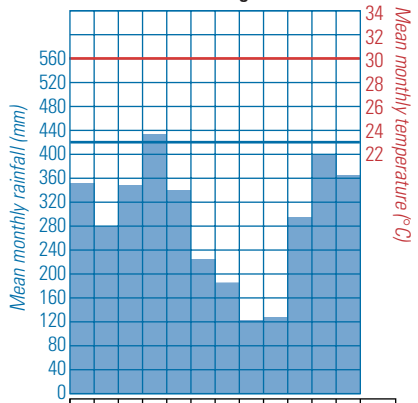
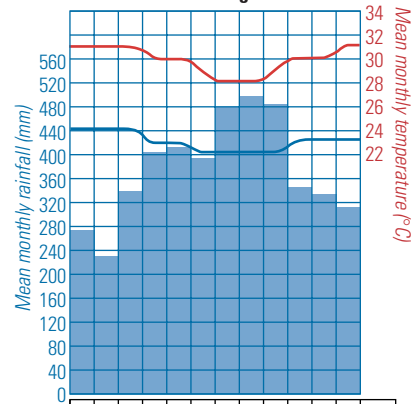
Station: Madang
Latitude: 5°12′S **Longitude:** 145°25′E



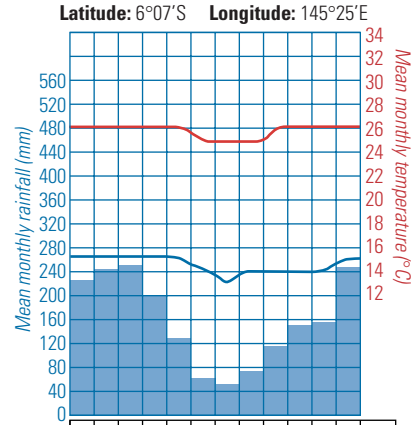
	J	F	M	A	M	J	J	A	S	O	N	D	Year
Max. temp. (°C)	30	30	30	30	30	30	30	30	30	30	30	30	30 av.
Min. temp. (°C)	23	23	23	23	23	23	23	23	23	23	23	23	23 av.
Rainfall (mm)	356	282	349	435	339	221	182	125	130	289	400	364	3482 total

Station: Lae
Latitude: 6°40′S **Longitude:** 147°02′E



	J	F	M	A	M	J	J	A	S	O	N	D	Year
Max. temp. (°C)	31	31	31	30	30	29	28	28	29	30	30	31	30 av.
Min. temp. (°C)	24	24	24	23	23	22	22	22	22	23	23	23	23 av.
Rainfall (mm)	275	232	339	408	412	393	481	498	483	345	324	312	4502 total

Station: Goroka
Latitude: 6°07′S **Longitude:** 145°25′E



	J	F	M	A	M	J	J	A	S	O	N	D	Year
Max. temp. (°C)	26	26	26	26	26	25	25	25	26	26	26	26	26 av.
Min. temp. (°C)	15	15	15	15	15	14	13	14	14	14	14	15	14 av.
Rainfall (mm)	225	246	251	201	215	60	50	75	118	149	158	249	1907 total

Figure 6.1a Climate graphs.

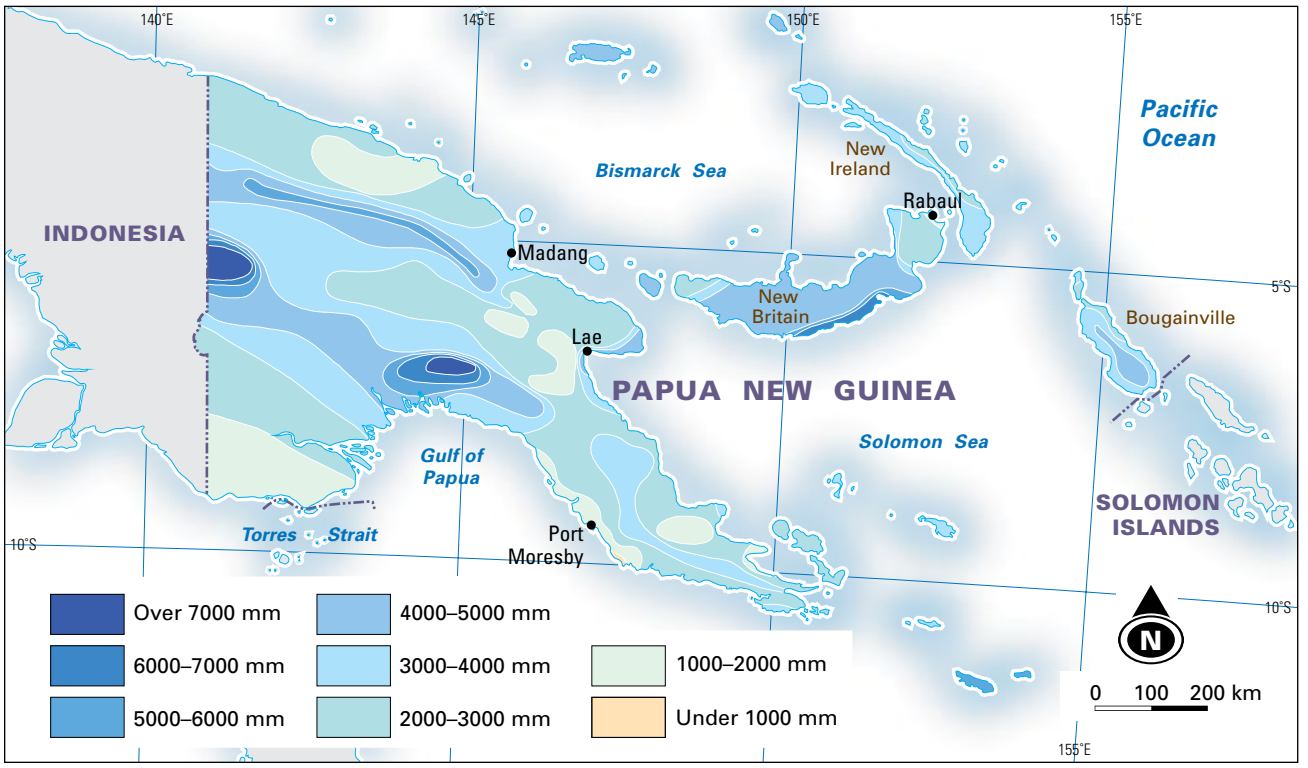


Figure 6.1b Rainfall.

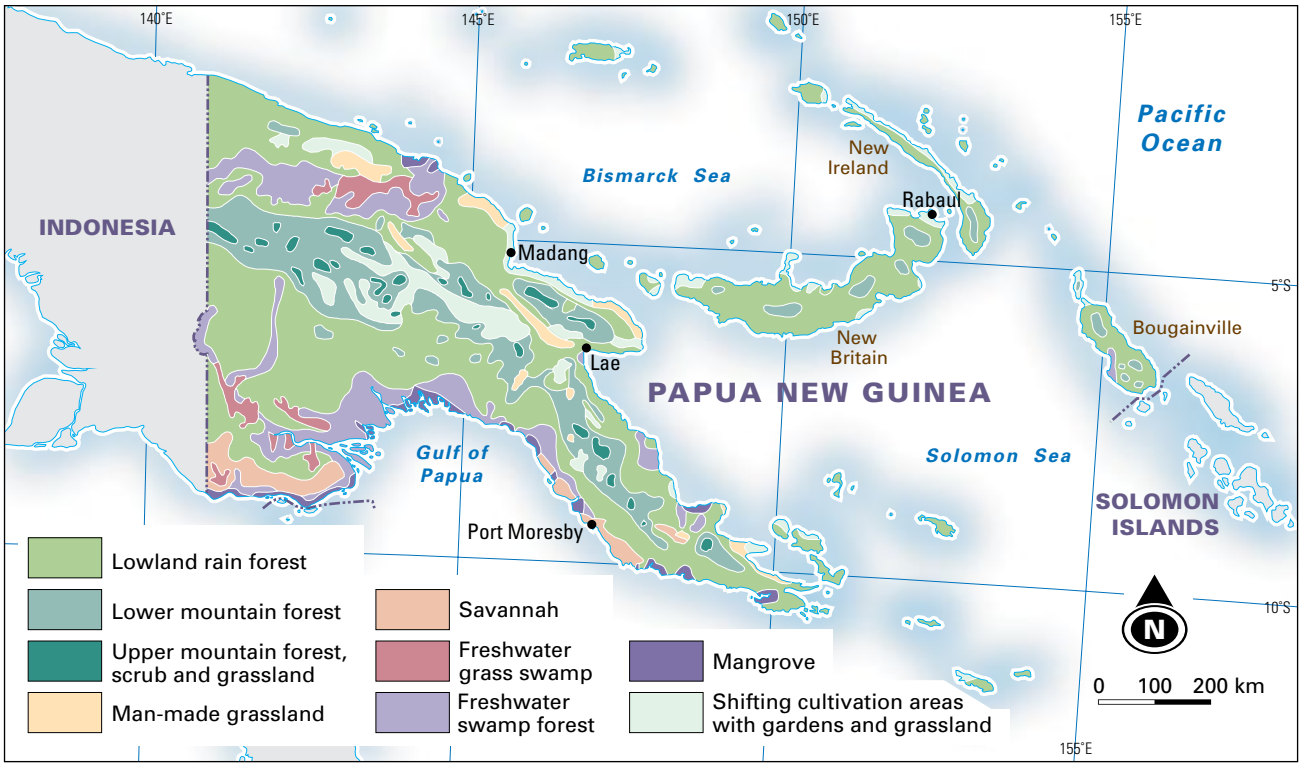


Figure 6.1c Vegetation.

Table 6.1a Climate data for Port Moresby, elevation 28 metres

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Max. temp. (°C)	32	32	32	31	31	30	30	30	31	32	32	32	31
Min. temp. (°C)	23	23	23	23	23	22	22	22	22	23	23	23	23
Rainfall (mm)	169	214	172	172	53	42	20	35	39	38	68	155	1177

Figure 6.1d Erap River Valley in Lae Province.

Figure 6.1e Hill-top village in the Central Highlands.

Figure 6.1f Highlanders in traditional dress.

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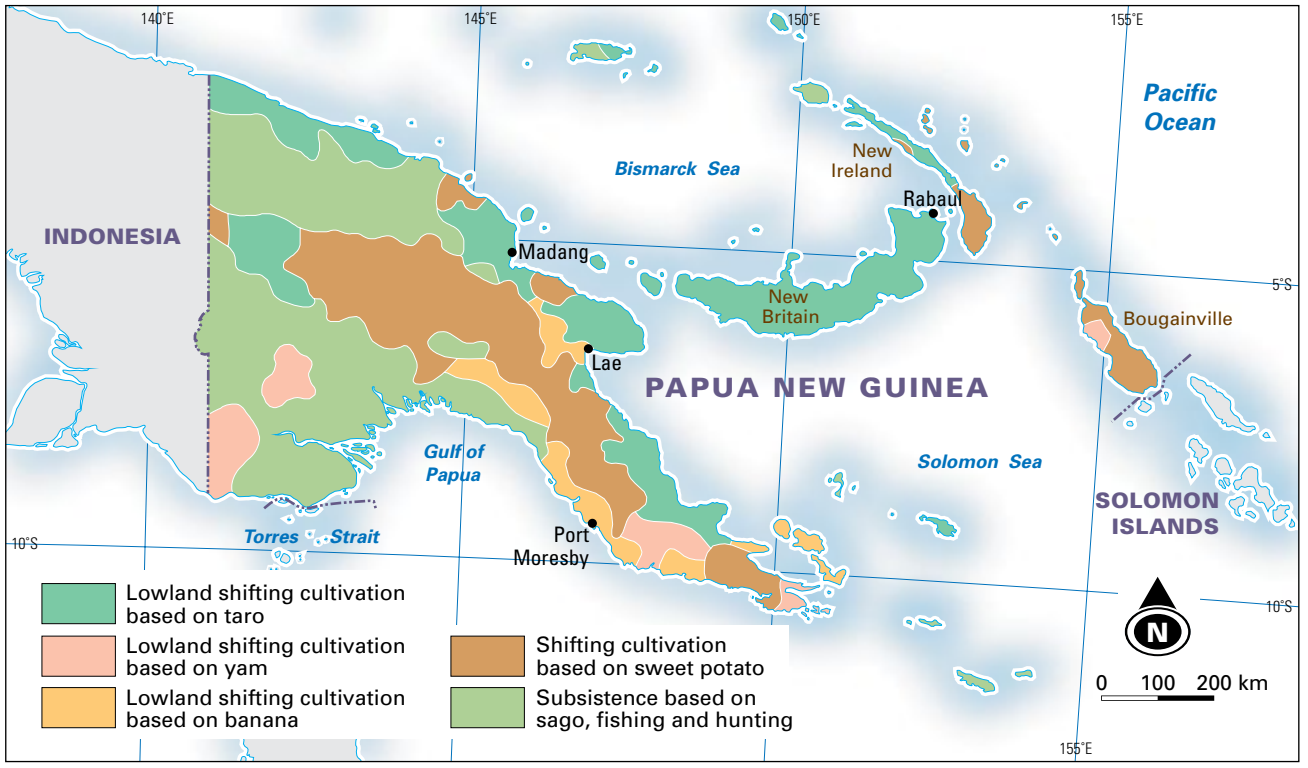

Figure 6.1g Traditional land use.

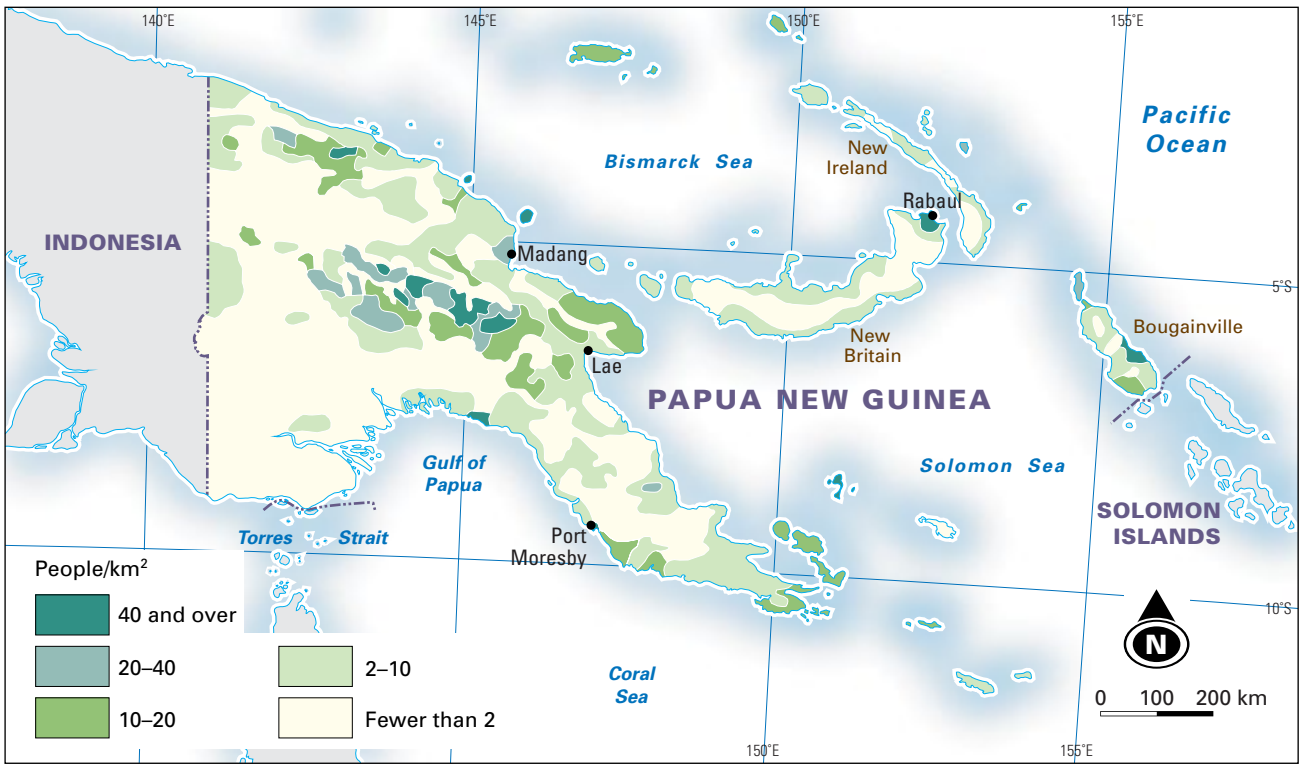

Figure 6.1h Population density.

Figure 6.1i Asaro mudman.

Figure 6.1j Villager collecting yams in the Central Highlands.

ACTIVITIES

1. Using the data in Table 6.1a construct a climate graph for Port Moresby.

Study the climate graphs (Figure 6.1a) and the climate graph you have constructed for Port Moresby and complete the following tasks:

2. State which station or stations have:
   - **a** the highest annual rainfall
   - **b** the lowest annual rainfall
   - **c** the highest average maximum temperature
   - **d** the lowest average minimum temperature
   - **e** the largest annual range of temperature
   - **f** the lowest annual range of temperature
   - **g** a 'winter' rainfall maximum.
3. Describe the seasonal pattern of rainfall experienced in Madang.
4. After locating Goroka on the map on page 125, account for the greater range of temperatures and lower rainfall experienced by the Goroka station.

Study the map on page 125 and Figures 6.1b, 6.1c, 6.1g and 6.1h and complete the following tasks:

5. Describe the pattern of rainfall received by mainland Papua New Guinea and the island of New Britain.
6. Estimate the average annual rainfall received by Port Moresby.
7. Estimate the average annual rainfall received by Madang.
8. Estimate the average annual rainfall received in the Ok Tedi area.
9. Name the dominant vegetation type in the coastal areas of the Gulf of Papua.
10. Describe the relationship between:
    - **a** topography and rainfall
    - **b** population density and landform
    - **c** population density and rainfall distribution.
11. Explain why population densities are low in the Sepik River and Fly River lowlands.
12. State the dominant type of traditional land use in:
    - **a** the Sepik River and Fly River lowlands
    - **b** Papua New Guinea's mountainous interior
    - **c** the island of New Britain.
13. Library research activity:
    - **a** Explain why there are a number of German place names in Papua New Guinea.
    - **b** Outline the nature of Australia's relationship with Papua New Guinea since 1918.
    - **c** Describe the difficulties encountered by Australian military forces fighting in Papua New Guinea during World War II.

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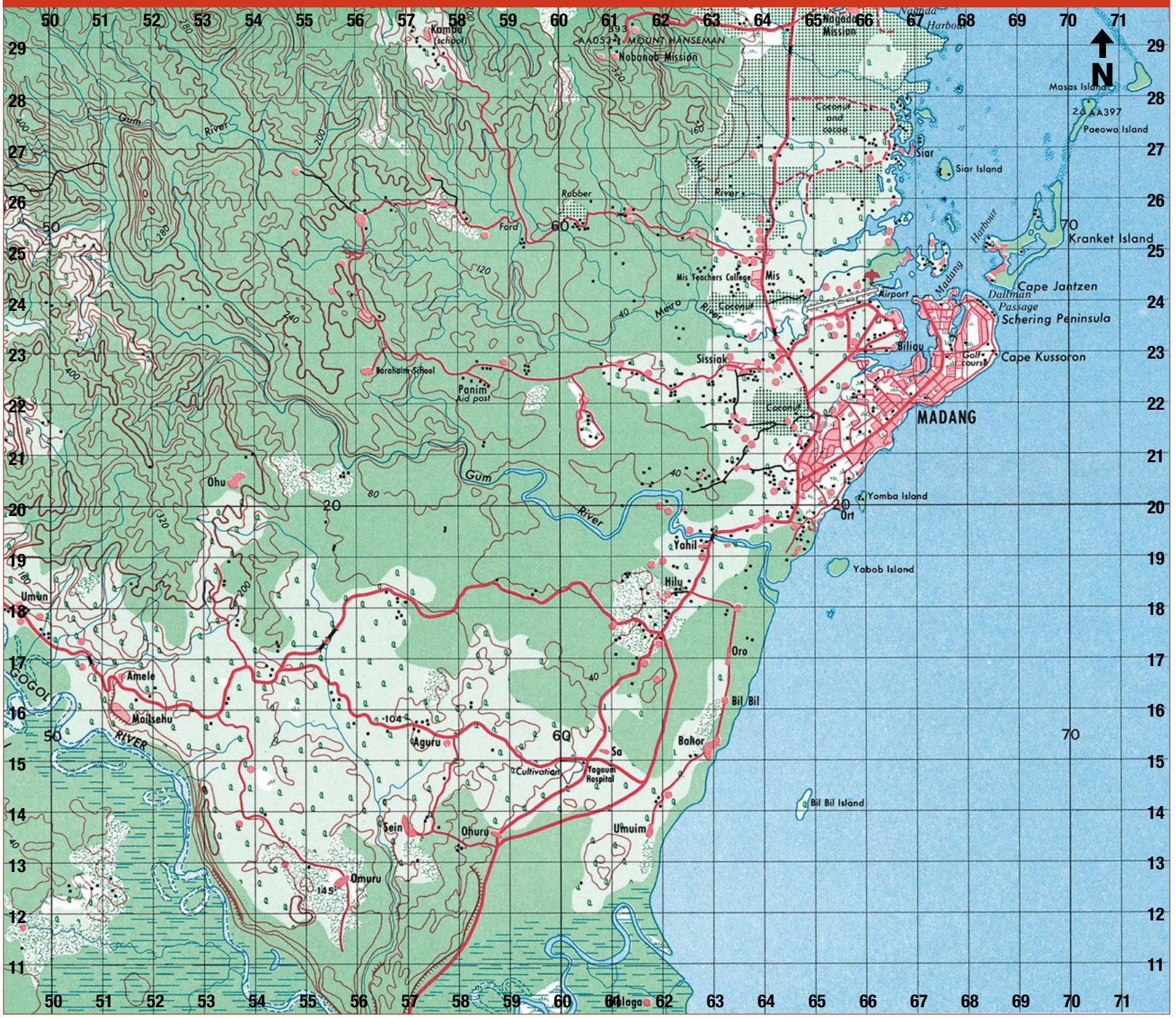
6.2 Madang topographic map extract

Madang topographic map extract (Madang: latitude 5°14'S, longitude 145°45'E)



ACTIVITIES

Study the Madang topographic map extract and complete the following tasks. Refer to the legend on page 122.

1. What is the scale of the Madang topographic map extract?
2. What is the contour interval of the Madang topographic map extract?
3. Identify the feature of the biophysical environment located at the following grid references:
   - **a** 675266
   - **b** 648140
   - **c** 689242
   - **d** 685240.
4. Identify the feature of the constructed environment located at the following grid references:
   - **a** 586224
   - **b** 555175
   - **c** 536205
   - **d** 611288
5. What is the area reference of the Madang Golf Course?
6. What type of biophysical feature is found in AR 5212?
7. Identify the type of vegetation found in each of the following area references:
   - **a** 5619
   - **b** 5911
   - **c** 5415.
8. Name the type of land use found in AR 6527.
9. What river flows into the sea in AR 6418?
10. What is the direction of Mount Hanseman (AR 6129) from Madang?
11. In what direction is the Gum River flowing in AR 6019?
12. What is the aspect of the slope in AR 5126?
13. Estimate the distance by road from the intersection at GR 605150 to the intersection at GR 646229.
14. Estimate the time it would to take to travel by road between the intersection at GR 605150 to the intersection at GR 646229 at an average speed of 30 km/h.
15. What is the length of the runway at Madang Airport?
16. What is the density of buildings in AR 5922?
17. What is the height of the landform feature located at the following grid references?
    - **a** 507227
    - **b** 627277
    - **c** 518267.

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6.3 Kokoda topographic map extract

THE KOKODA TRAIL

Papua New Guinea's Kokoda Trail holds a special place in Australia's military history. Between July 1942 and January 1943 a series of fierce battles was fought between Japanese and Australian forces. More than 600 Australians were killed and some 1680 were wounded during perhaps the most significant of all battles waged by Australian troops in World War II.

The Australian objective was to repel a Japanese invasion force, which had landed at Gona on the north coast of Papua on 21 July 1942. The Japanese aim had been to capture Port Moresby, the main Australian base in New Guinea. This involved an overland strike across the Owen Stanley Range. The most direct route across these rugged mountains was by a jungle pathway known as the Kokoda Trail.

The Japanese reached Ioribaiwa, just 50 km from Port Moresby, before the Australian forces drove them back in fierce hand-to-hand combat.

In addition to the battle-hardened Japanese troops, the Australian forces had to cope with appalling conditions: hot, humid days with intensely cold nights, torrential rainfall, knee-deep mud and tropical diseases, such as malaria.

The trail crosses some of the most rugged and isolated terrain in the world. It starts at Owers Corner, 50 km to the east of Port Moresby, and runs 96 km overland (60 km as the crow flies) over the Owen Stanley Range. The trail ends at the village of Kokoda. The narrow trail reaches a height of 2190 m at Mount Bellamy and is only passable on foot. Today, a growing number of Australians seek to walk in the footsteps of heroes by trekking the Kokoda Trail.

Figure 6.3b Map of the Kokoda Trail.

Figure 6.3a A wounded Australian soldier being tended. [AWM/013606]

Figure 6.3c 25-pounder guns being pulled through dense jungle near Uberi on the Kokoda Trail. [AWM/026850]

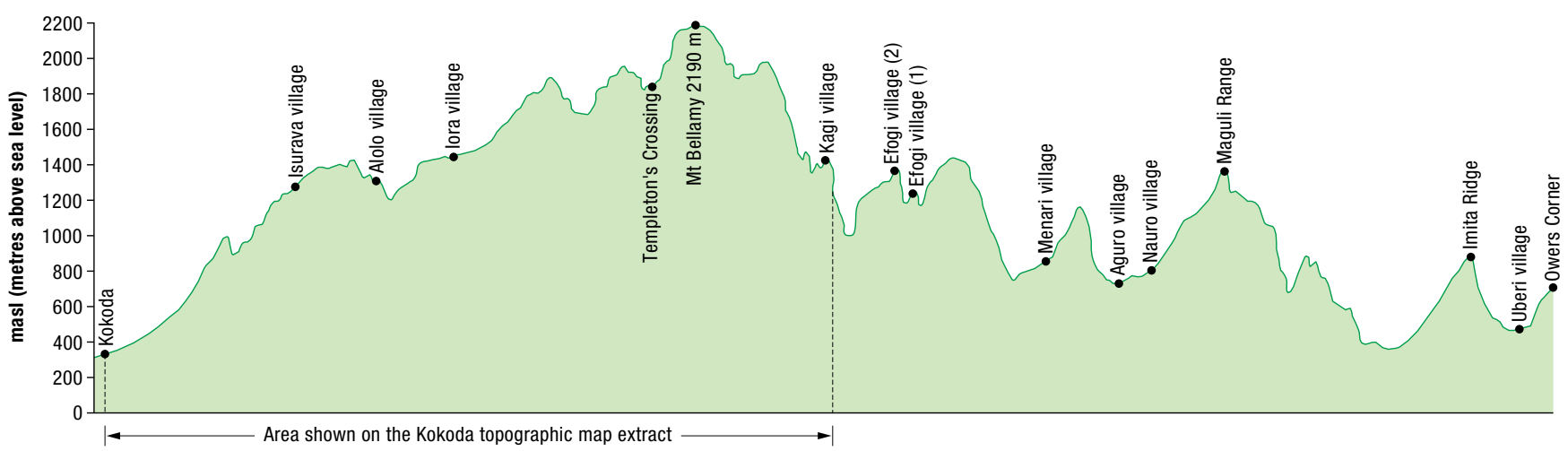

Figure 6.3d Cross-section of the Kokoda Trail (not to scale).

ISBN 978-1-139-77461-1

Figure 6.3e Japan's advance along the Kokoda Trail, 21 July 1942 to 17 September 1942.

Figure 6.3f Australia's advance along the Kokoda Trail, 27 September 1942 to 21 January 1943.

ACTIVITIES

1. What is the scale of the map extract Figure 6.3b?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 782904
   - **b** GR 783951.
4. Identify the feature of the constructed environment located at:
   - **a** GR 815183
   - **b** GR 791192
   - **c** GR 869127
   - **d** GR 889111.
5. What is the grid reference of Alolo Village on the Kokoda Trail?
6. Name the type of vegetation found in AR 7718.
7. Through what type of forest does the Kokoda Trail pass?
8. Name the type of land use found in AR 7719.
9. Name the tributary that joins the Mambare River at GR 831190.
10. Name the type of drainage pattern evident in the southwest quadrant of the map.
11. What is the direction of Kokoda (AR 8118) from Sengi (AR 8811)?
12. In what direction is the Mamba River flowing in AR 8417?
13. What is the bearing of Mt Bellamy (AR 7895) from Alolo Village (AR 8004)?
14. What is the aspect of the slope in AR 7117?
15. Estimate the straight-line distance between The Gap (AR 7890) and Kokoda (AR 8118).
16. Estimate the distance from The Gap (AR 7890) to Kovelo No 1 (GR 803148) via the Kokoda Trail.
17. What is the length of the Kokoda Airfield runway?
18. What is the density of buildings in AR 7819?
19. Estimate the height of the landform features located at:
    - **a** GR 845058
    - **b** GR 886058.
20. What is the elevation of the bridge at GR 838141?
21. What is the difference in elevation of Mt Bellamy (AR 7895) and the mountain summit at GR 898009?
22. Study Figure 6.3c (page 129). Write a paragraph describing the environmental conditions experienced by Australian troops fighting the Japanese on the Kokoda Trail.
23. Study Figures 6.3e and 6.3f. Write a report outlining the Kokoda campaign: the Japanese advance and the Australian fightback.
24. Access the Australian War Memorial website (refer to www.cambridge.edu.au/skillsgeo1weblinks) and undertake further research into the importance of the Kokoda campaign in Australian history.

SCALE 1:100 000

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 kilometres

CONTOUR INTERVAL 40 METRES

Built-up area; Landing ground or airfield
Village, large; small
Road all weather hard or loose surface
Road fair or dry weather loose or light surface
Vehicle track; Vehicle track approximate
Bridge; Embankment; Cutting
Foot track; Foot track approximate; Footbridge
Power transmission line (across country)
Telephone line
Building; Church

Postal facilities; Hospital; Cultivation — P H Cultivation
Mine; Quarry
Fence; Levee bank
Trig station; Bench mark; Spot elevation — BM·198 ·132
Contour with value; Auxiliary contour — 200
Depression contour; with sinkhole
Cliff; High cliff or gorge
Rain forest; Medium forest
Secondary growth; Plantation
Savannah; Grassland

Flood plain forest; Nipa
Tree swamp; Mangrove
Swampland; Rice
Subject to inundation; Tank or small dam
Stream; Lake
Stream indefinite with flood banks
Lighthouse; Wreck exposed
Sand; Foreshore flat; Rock bare or awash
Breakwater; Pier; Wharf; Prominent submerged reef
Coastline indefinite; Rock ledge or reef awash

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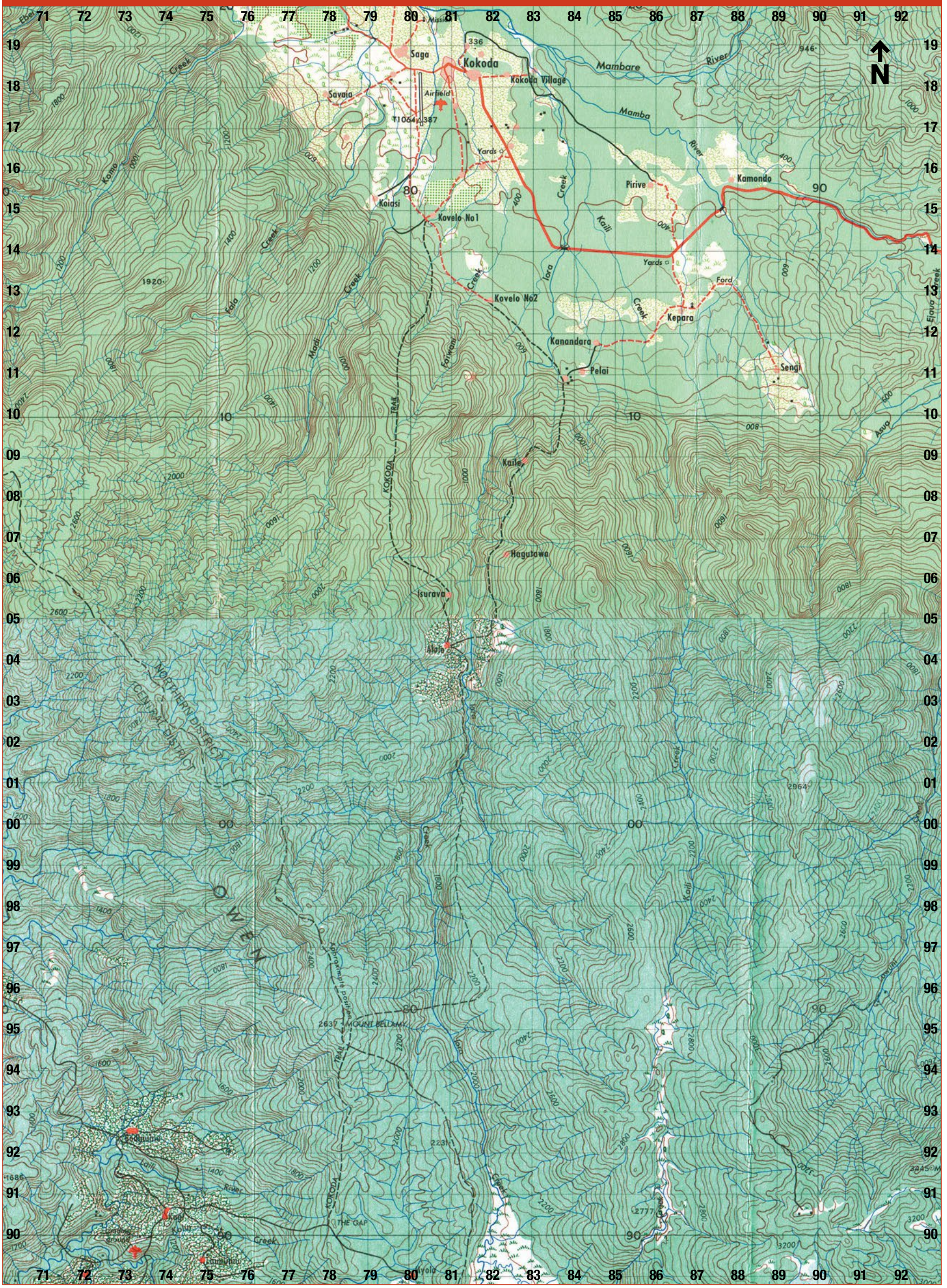
Kokoda topographic map extract (Kokoda: latitude 8°52′S, longitude 147°45′E)



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Cambridge University Press

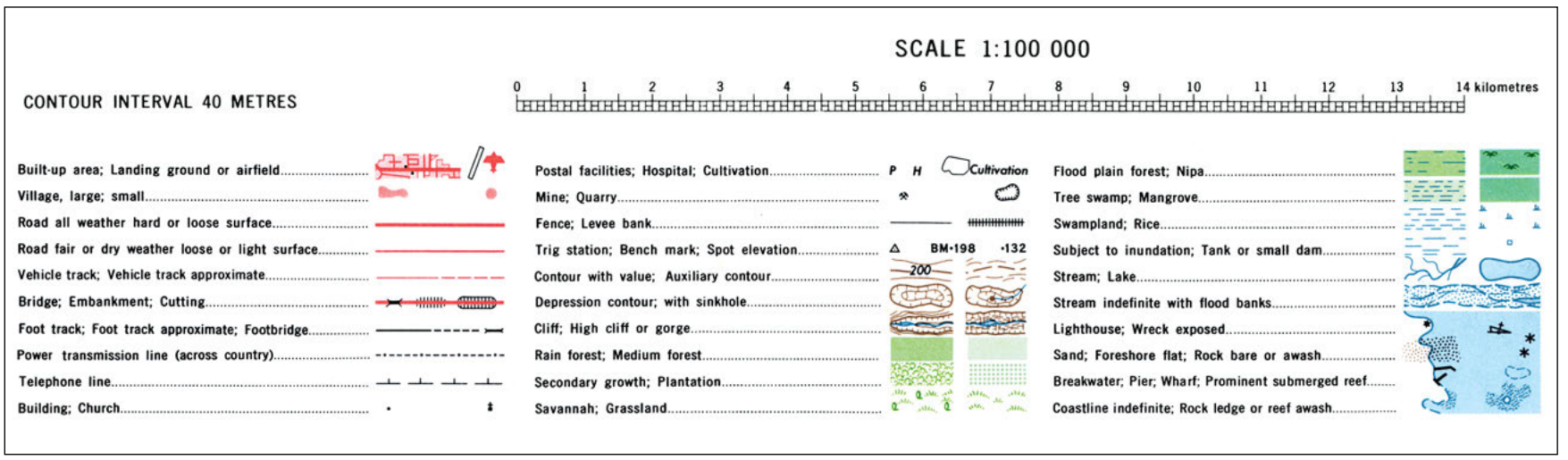
6.4 Morobe topographic map extract

Figure 6.4a Coastal village near Morobe.

ACTIVITIES

Study the Morobe topographic map extract and complete the following tasks:

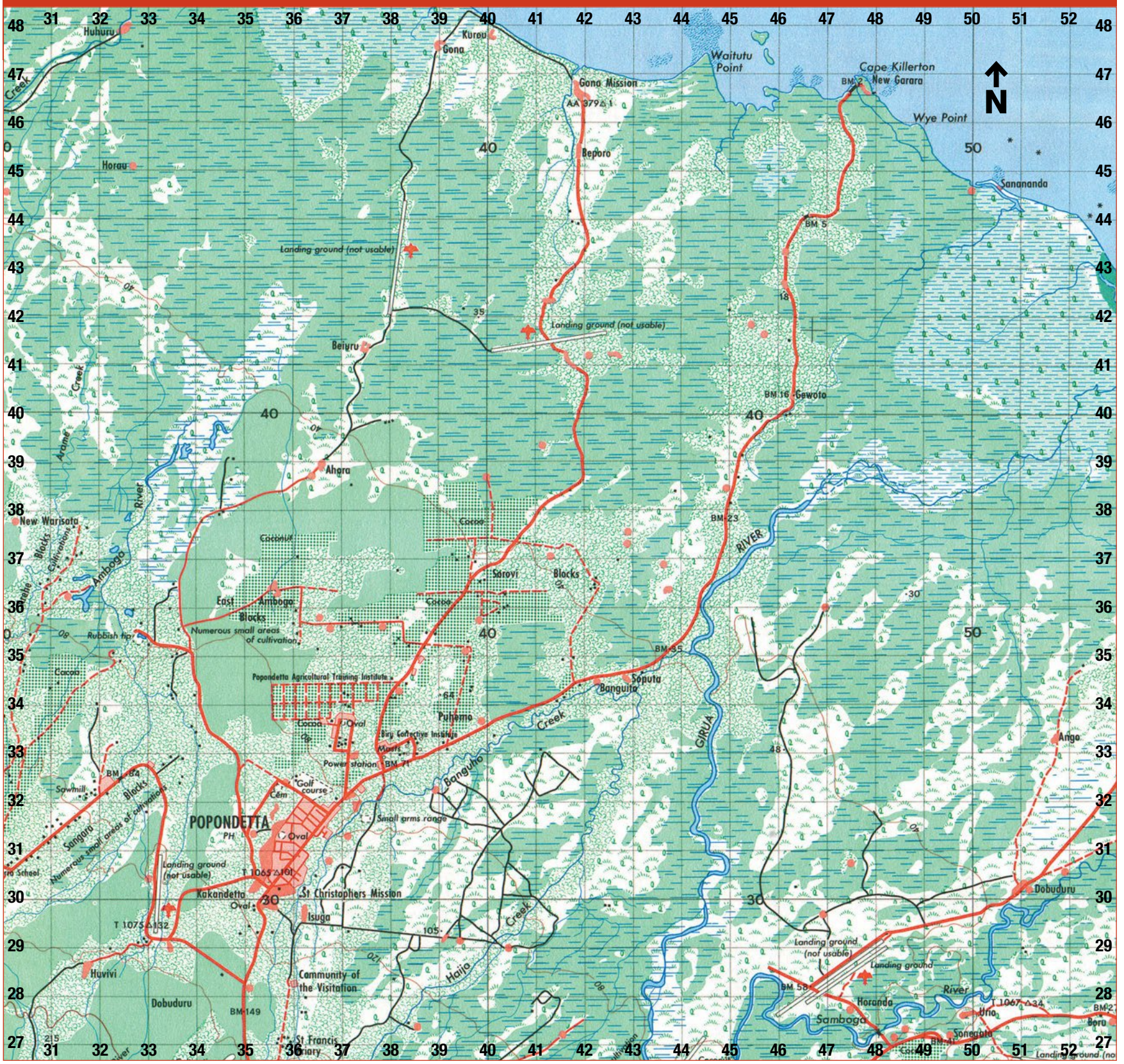
1. What is the scale of the Morobe topographic map extract?
2. What is the contour interval of the Morobe map extract?
3. Identify the feature of the biophysical environment located at the following grid references:
   - **a** GR 797241
   - **b** GR 791199
   - **c** GR 732386
   - **d** GR 769294.
4. Identify the feature of the constructed environment located at the following grid references:
   - **a** GR 647442
   - **b** GR 727353
   - **c** GR 638419
   - **d** GR 703305.
5. What is the dominant vegetation type found in the following area references?
   - **a** AR 7621
   - **b** AR 6044
   - **c** AR 7034
   - **d** AR 7334
   - **e** AR 6729.
6. What is the direction of Tumo Point (AR 7338) from Cormoran Point (AR 6940)?
7. What is the direction of Babaguto Island (AR 6944) from Station Point (AR 6542)?
8. What is the bearing of Tauwara Island (GR 796241) from Mount Bernie (GR 791199)?
9. What is the bearing of Tumo Point (GR 732386) from Babaguto Island (AR 6944)?
10. Estimate the height of the landform feature located at the following grid references:
    - **a** GR 688351
    - **b** GR 600392
    - **c** GR 665297
    - **d** GR 626387.
11. What is the density of buildings in AR 6825?
12. Estimate the area of the following:
    - **a** Lake Inlet
    - **b** Eware Inlet.
13. Explain why navigation could be hazardous in the area surrounding the islands in the north-west quadrant of the Morobe map extract.
14. What evidence is there that the course of the Waria River has changed over time?
15. Estimate the distance by road from Kobo (GR 754347) to Auno (GR 770234).
16. Estimate the time it would take for a car travelling at a constant speed of 60 km/h to cover the distance from Kobo to Auno.
17. What difficulties would need to be overcome during the construction of the proposed road from Zaka Mission (AR 7235) to the end of the existing road (GR 717385)?
18. Estimate the length of the proposed road.
19. Construct a vegetation transect from Gorie (GR 600477) to Posei (GR 602359).
20. Name one commercial land-use activity found on the Morobe map extract.
21. Describe the nature of the physical environment in the area covered by the Morobe map extract.
22. Describe the pattern of settlement and land use found on the Morobe map extract.
23. Account for the areas covered by secondary growth forest.
24. Identify the locational characteristic that most of the area's plantations have in common.
25. Undertake library research. What is nipa? Under what conditions does it grow?
26. Hypothetical: describe the possible environmental effects the development of a large open-cut mine in the headwaters of the Waria River would have on both the river system and the adjacent marine ecosystem.



Morobe topographic map extract (Morobe: latitude 7°45'S, longitude 147°35'E)

6.5 Popondetta topographic map extract

Popondetta topographic map extract (Popondetta: latitude 8°7′S, longitude 148°25′E)



Popondetta is the capital of Oro (Northern) Province in Papua New Guinea. It is a small town of a few thousand people. During World War II, Popondetta was the site of a major United States airbase. This accounts for the number of now unusable runways in the area.

ACTIVITIES

Refer to the legend on page 132.

1. Identify the feature of the biophysical environment located at:
   - **a** GR 446474 **b** GR 318362
   - **c** GR 456478 **d** GR 476470.
2. Identify the feature of the constructed environment located at:
   - **a** GR 358271 **b** GR 390476
   - **c** GR 363323 **d** GR 375317.
3. Name the type of land use found in AR 3937.
4. Name the type of vegetation found in:
   - **a** AR 5041 **b** AR 4443
   - **c** AR 3440 **d** AR 3333.
5. Name the tributary that joins the Girua River at GR 442350.
6. What is the direction of Cape Killerton (AR 4746) from Popondetta?
7. In what direction is Banguho Creek flowing in AR 4033?
8. What is the bearing of Cape Killerton (AR 4746) from Popondetta oval (AR 3531)?
9. Estimate the straight-line distance between the intersection at GR 367318 and the bridge at GR 475468.
10. Estimate the distance by road from the intersection at GR 367318 to the bridge at GR 475468.
11. What is the density of buildings in AR 3131?
12. What is the elevation of the village at GR 330304?

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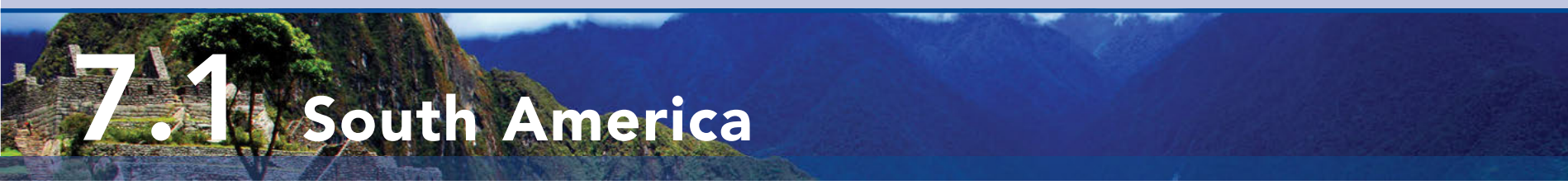
SOUTH AMERICA



7.1 South America

UNIT 7.4 Cordillera Huayhuash
UNIT 7.3 Machu Picchu
UNIT 7.2 Cuzco
UNIT 7.5 Rio de Janeiro

Caribbean Sea
Nether. Antilles
Barbados
Grenada
Trinidad & Tobago
Santa Marta
Barranquilla
Cartagena
Maracaibo
Valencia
Caracas
Cumaná
Barquisimeto
Maracay
Barcelona
Sincelejo
Montería
Mérida
Pico Bolívar (5007 m)
Cúcuta
Ciudad Guayana
Ciudad Bolívar
Orinoco
Panamá
Cauca
Magdalena
Bucaramanga
Venezuela
Guyana
Georgetown
Paramaribo
Cayenne
French Guiana
Suriname
Roraima (2810 m)
Medellín
Tunja
Manizales
Bogotá
Pereira
Ibagué
Villavicencio
Pacific Ocean
Cali
Neiva
Colombia
Popayán
Huila (5750 m)
Florencia
Esmeraldas
Pasto
Neblina (3014 m)
Caquetá
Quito
Cotopaxi (5897 m)
Ambato
Ecuador
Chimborazo (6272 m)
Japurá
Rio Negro
Amazon
Manaus
Santarém
Macapá
Marajó Island
Belém
Guayaquil
Cuenca
Iquitos
São Luis
Parnaíba
Sobral
Fortaleza
Machala
Caxias
Teresina
Mossoró
Juruá
Purus
Madeira
Tapajós
Xingu
Piura
Brazil
Natal
Chiclayo
Trujillo
Pucallpa
Porto Velho
Araguaia
João Pessoa
Caruarú
Recife
Chimbote
Huascarán (6768 m)
Tocantins
Maceió
Peru
Callao
Huancayo
Juruena
Feira de Santana
Aracaju
Lima
Machu Picchu
Beni
Guaporé
Ayacucho
Cuzco
Mato Grosso Plateau
Morro Alto (1292 m)
Salvador
Lake Titicaca
Bolivia
Mato Grosso
Vitória da Conquista
Coropuna (6613 m)
Illimani (6439 m)
Cuiabá
Brasília
São Francisco
Ilhéus
Arequipa
La Paz
Cochabamba
Goiânia
Anápolis
Montes Claros
Tacna
Oruro
Santa Cruz
Pico de Itambé (2033 m)
Teófilo Otoni
Arica
Sucre
Corumbá
Uberlândia
Governador Valadares
Lake Poopó
Potosí
Camiri
Uberaba
Belo Horizonte
Iquique
Campo Grande
Ribeirão Prêto
Vitória
Pico da Bandeira (2890 m)
Calama
Marília
Bauru
Nova Iguaçu
Campos
Petrópolis
Antofagasta
Jujuy
Salta
Asunción
Ciudad del Este
Campinas
São Paulo
Niterói
Rio de Janeiro
Tucumán
Formosa
Ponta Grossa
Santos
Iguaçu Falls
Curitiba
Copiapo
Resistencia
Encarnación
Joinville
Blumenau
Ojos del Salado (6880 m)
Corrientes
Passo Fundo
Florianópolis
Santiago del Estero
Caxias do Sul
La Serena
Coquimbo
Santa Maria
Canôas
San Juan
Córdoba
Santa Fé
Concordia
Porto Alegre
Chile
Aconcagua (6959 m)
Pelotas
Viña del Mar
Valparaíso
Río Cuarto
Rosario
Rio Grande
Mendoza
San Nicolás
San Antonio
Santiago
Buenos Aires
Montevideo
Rancagua
La Plata
Río de la Plata
Talca
Argentina
Talcahuano
Chillán
Concepción
Los Angeles
Bahía Blanca
Mar del Plata
Temuco
Neuquén
Valdivia
Lanín (3776 m)
Osorno
Gulf of San Matias
Puerto Montt
Valdés Peninsula
Chiloé Island
Chonos Archipelago
Comodoro Rivadavia
Taitao Peninsula
Gulf of San Jorge
Gulf of Peñas
Cape Tres Puntas
San Valentín (4058 m)
Wellington Island
Paine (2360 m)
Falkland Islands (Islas Malvinas) (UK)
Magellan's Strait
Punta Arenas
Cape San Diego
South Georgia (UK)
Cape Horn
Tropic of Capricorn
0° Equator
80°W
70°W
60°W
50°W
40°W
10°N
20°S
30°S
40°S
50°S
0 300 600 km
N

River
Freshwater lake
Paine (2360 m) Mountain with height in metres
Ice cap or glacier
Lima National capital

Population
over 5 000 000
1 000 000 to 5 000 000
500 000 to 1 000 000
100 000 to 500 000

LAND HEIGHT IN METRES
over 5000
2000–5000
1000–2000
500–1000
200–500
0–200
Mean sea level
Land below sea level

Figure 7.1a South America: physical features.

ACTIVITIES

Study an atlas map of South America and then complete the following tasks.

1. Name the capital city of the following countries:
   - **a** Peru
   - **b** Argentina
   - **c** Brazil
   - **d** Colombia.
2. Name the country that has the following city as its capital:
   - **a** Santiago
   - **b** Caracas
   - **c** Montevideo
   - **d** La Paz.
3. Name the major river system draining the northern half of South America.
4. Name the mountain range running the length of South America's west coast.
5. What is the straight-line distance between:
   - **a** Lima and Buenos Aires
   - **b** Santiago and Caracas?
6. What is the direction of:
   - **a** Buenos Aires from Lima
   - **b** Brasilia from Santiago?
7. Name the feature of the physical environment located at the following latitudes and longitudes:
   - **a** 32°40′S, 70°10′W
   - **b** 9°08′S, 77°36′W.
8. Name the urban centres located at the following latitudes and longitudes:
   - **a** 23°33′S, 46°39′W
   - **b** 34°55′S, 56°10′W
   - **c** 16°30′S, 68°10′W
   - **d** 22°55′S, 43°17′W.

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7.2 Cuzco, Peru, topographic map extract

Figure 7.2a Cuzco, Peru: once the capital of the Inca Empire.

CUZCO: CITY OF THE INCAS

Cuzco (see Figure 7.2a), in southern Peru, was once the capital of the Inca Empire (1197–1572). The city sits in a valley (see Figure 7.2b), with the snow-capped Andes Mountains to its north. The river running across the top of Figure 7.2b passes through the region known to the Inca people as the Sacred Valley. As in the time of the Inca, the valley is fertile agricultural land. This is in stark contrast to the more arid slopes of the high mountains, which are only thinly covered in vegetation.

Many Inca ruins, including ceremonial pyramids and fortresses, can be found in the region. These help us to understand Inca culture and society.

The Inca Trail (see Figure 7.2c) is a popular walking route that passes through the mountains above the Urubamba River. It follows (at least in part) the path of an old Inca roadway leading to the city of Machu Picchu. There are many well-preserved Inca ruins along the trail, and hundreds of thousands of tourists from around the world make the three or four-day trek each year, accompanied by guides.

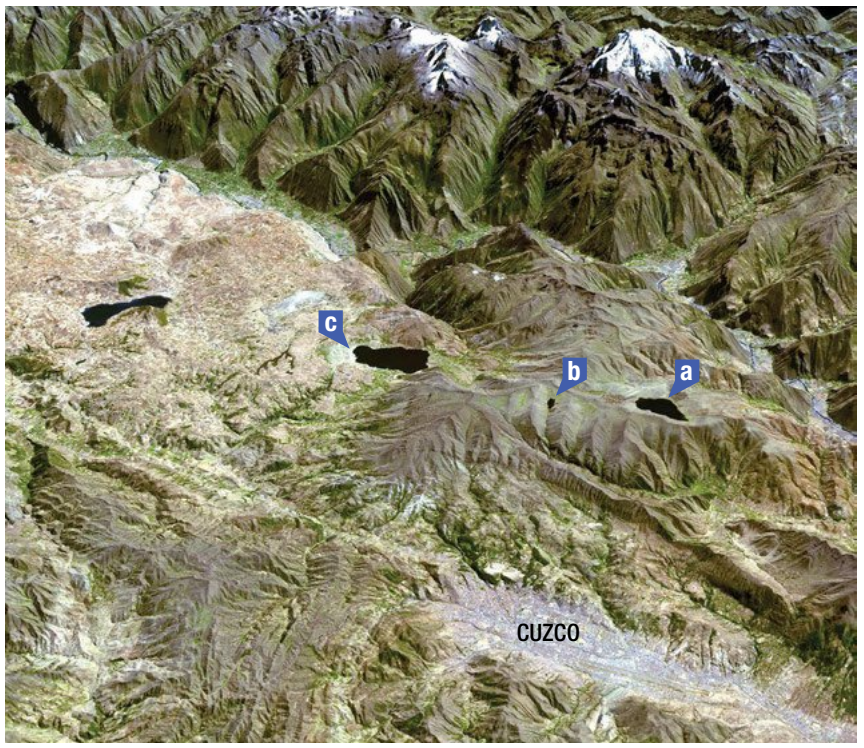


Figure 7.2b Topographic image of Cuzco, produced by a NASA satellite in July 2006.

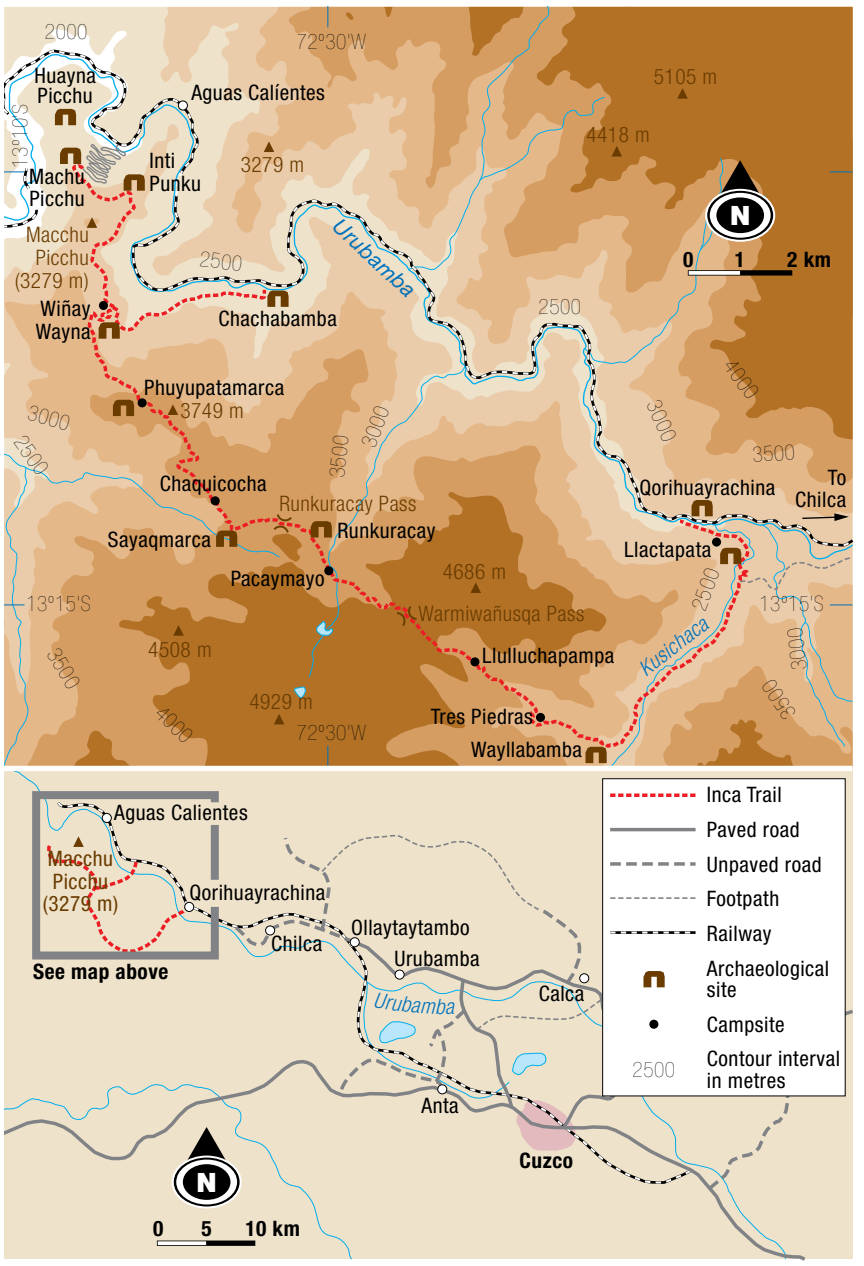
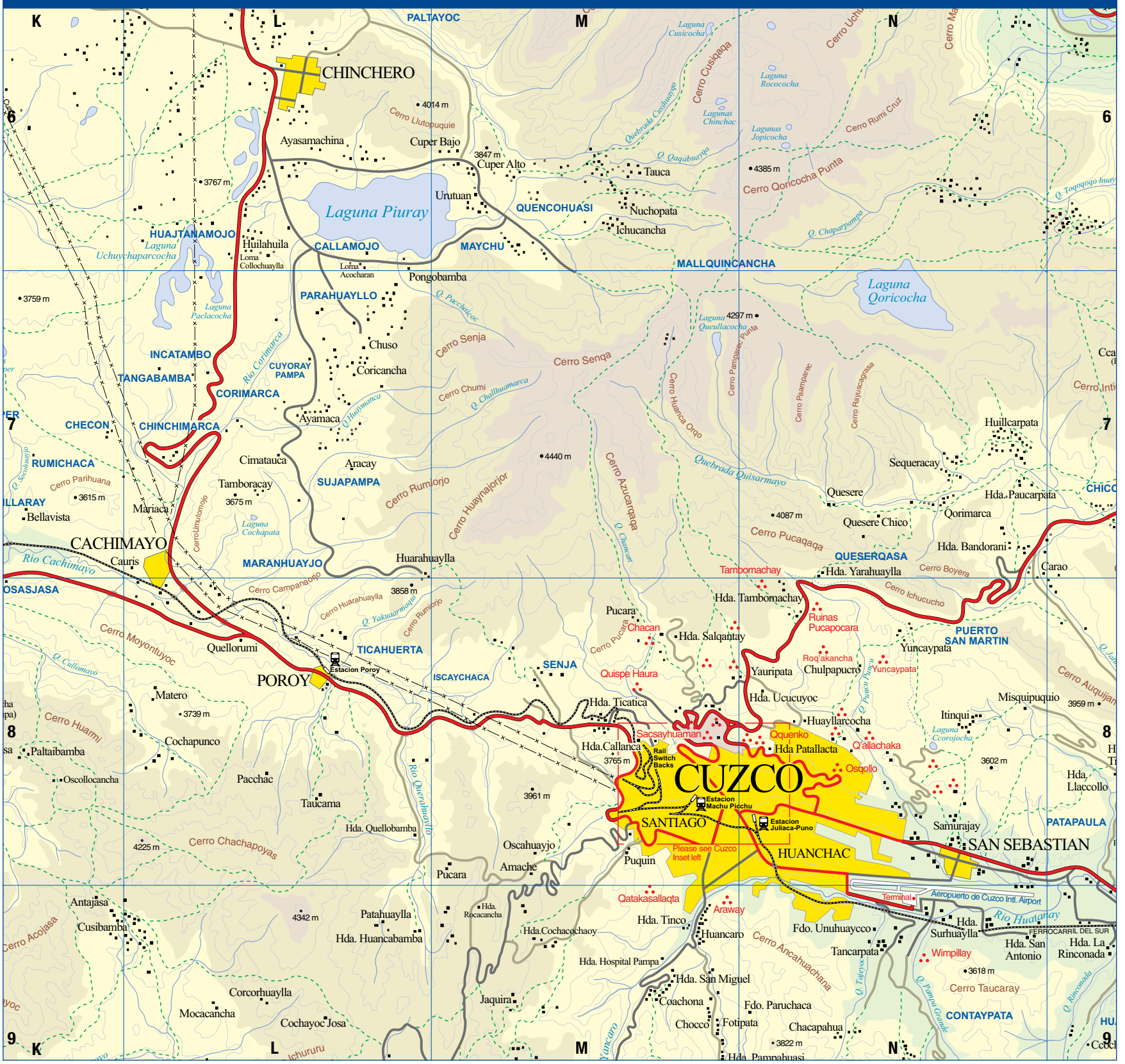


Figure 7.2c The Inca Trail.

Cuzco topographic map extract (Cuzco: latitude 13°32′S, longitude 71°57′W)



Legend / Leyenda

Please see Cuzco Inset for Symbols appearing on that map

- Railway w/ Station (Poroy)
- Inca Trail / Camino Inca
- Paved Major Highway
- Main Road (hard surface)
- Dirt Road
- Dirt Track (not reliable) & Hiking
- Settlements / Villages (Iquique)
- Towns / Cities (POROY, CUZCO)
- Area Names (TORONTOY)
- Accommodation / Camping
- Ruins / Bus Stop (Intipata)
- Rivers / Aqueducts (Urubamba)
- Power Corridor
- Glaciated Peak (Nevado)

Scale / Escala 1:110, 000

Contour lines show every 100 m

4600 m +
4200 m
3800 m
3400 m
3000 m
0 m

Please note some abbreviations:
Hda.....Hacienda (village)
Q.....Quebrada (creek)
Lag.....Laguna (lake)
Co.....Cerro(mountain)
Nev.....Nevado(glaciated peak)

0 1km 2km 3km
0 1 Mile 2 Miles

ACTIVITIES

1. Study Figures 7.2a and 7.2b. Describe the physical setting (the site) of Cuzco.
2. Study Figure 7.2a. Describe the urban landscape of Cuzco. Comment on the nature of the buildings shown in the photograph; for example, their height and the building materials used.
3. Identify the type of photographic image shown in Figure 7.2b.
4. Study Figure 7.2b and the topographic map extract. Identify the features of the biophysical environment labelled a–c.
5. Study the topographic map extract and then complete the following tasks:
   - a What is the scale of the map extract?
   - b What technique is used to show elevation on the map extract?
   - c What is the direction of Laguna (Lake) Piuray from Cuzco?
   - d In what general direction is Quebrada Quisarmayo flowing in M7?
   - e What two rivers meet just to the north-east of Chinchimarca (L7)?
   - f What is the bearing of Estacion Machu Picchu (M8) from Estacion Poroy (L8)?
   - g What is the length of the runway at the Aeropuerto de Cuzco International Airport in the south-eastern map quadrant?
   - h What is the elevation of Cuzco's International Airport?
   - i What type of landform feature is Cerro Pamparec Punta and Cerro Paamparec in N7?
   - j What is the area of Laguna Piuray?

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7.3 Machu Picchu, Peru, topographic map extract

Machu Picchu is sometimes called the 'Lost City of the Incas'. It is a World Heritage–listed Inca ruin located 70 km northwest of Cuzco, Peru. The site is located 2430 m above sea level on a narrow mountain ridge 600 m above the Urubamba River. The distinctive landform feature Huayna Picchu (at 2720 m above sea level) towers over the site.

According to archaeologists, the site was divided into three great sectors: the Sacred District; the Popular District; and the District of the Priests and the Nobility (royal sector). All the construction at the site used the classic Inca architectural style of polished dry-stone walls of regular shape. The Incas were masters of this technique, called ashlar. The blocks of stone were cut to fit together tightly without the use of mortar. Many joints are so perfect that not even a knife fits between the stones.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 671323
   - **b** GR 675302
   - **c** GR 789326
   - **d** GR 708246.
4. Identify the feature of the constructed environment located at:
   - **a** GR 773267
   - **b** GR 681318
   - **c** GR 709290
   - **d** GR 720235.
5. What is the area reference of Machu Picchu?
6. Name the settlement found in AR 6932.
7. Identify the landform features centred on GR 720300 and GR 765275.
8. How many camping sites are there on the Inca Trail between GR 728230 and Machu Picchu?
9. What river joins the Rio Urubamba at GR 747274?
10. In what is direction is the Rio Urubamba flowing in AR 7329?
11. What is the bearing of the hotel at Machu Picchu (AR 6731) from the village of Chachabamba (AR 7028)?
12. What is the aspect of the slope in AR 7823?
13. Estimate the straight-line distance between the railway station in AR 7527 and the railway station at GR 681317.
14. Estimate the distance by rail from the railway station in AR 7527 to the railway station at GR 681317.
15. Estimate the area of the Machu Picchu site.
16. What is the elevation of Machu Picchu?
17. Estimate the elevation of the following landform features:
    - **a** mountain (GR 705307)
    - **b** Huayna Picchu.
18. Estimate the elevation of the railway station at GR 681317.
19. Estimate the elevation of the ruins in AR 6929.
20. What is the difference in elevation between the railway station at GR 681317 and Machu Picchu (AR 6731)?
21. What is the difference in elevation between Cerro Machu Picchu (AR 6730) and the landform feature at GR 789326?
22. What is the density of ruins in AR 6830?
23. Construct the cross-section from point A to point B using a vertical scale of 1 cm = 200 m.
24. Calculate the vertical exaggeration of the cross-section that you constructed in Activity 23.
25. Construct the cross-section from point C to point D using a vertical scale of 1 cm = 400 m.
26. Calculate the vertical exaggeration of the cross-section that you constructed in Activity 25.
27. Construct the cross-section from point E to point F using a vertical scale of 1 cm = 500 m.
28. Calculate the vertical exaggeration of the cross-section that you constructed in Activity 27.
29. What is the gradient of the slope between point E (GR 750240) and point F (GR 750269)?
30. In what direction was the camera facing when the photograph in Figure 7.3a was taken?
31. Construct a photo sketch of Figure 7.3a.
32. Access the UNESCO World Heritage website (whc.unesco.org) and outline the criteria used to list Machu Picchu.
33. Access the Destination: Peru website (www.destination360.com/peru.htm) and undertake a virtual tour of the Machu Picchu World Heritage site.

Figure 7.3a Machu Picchu.

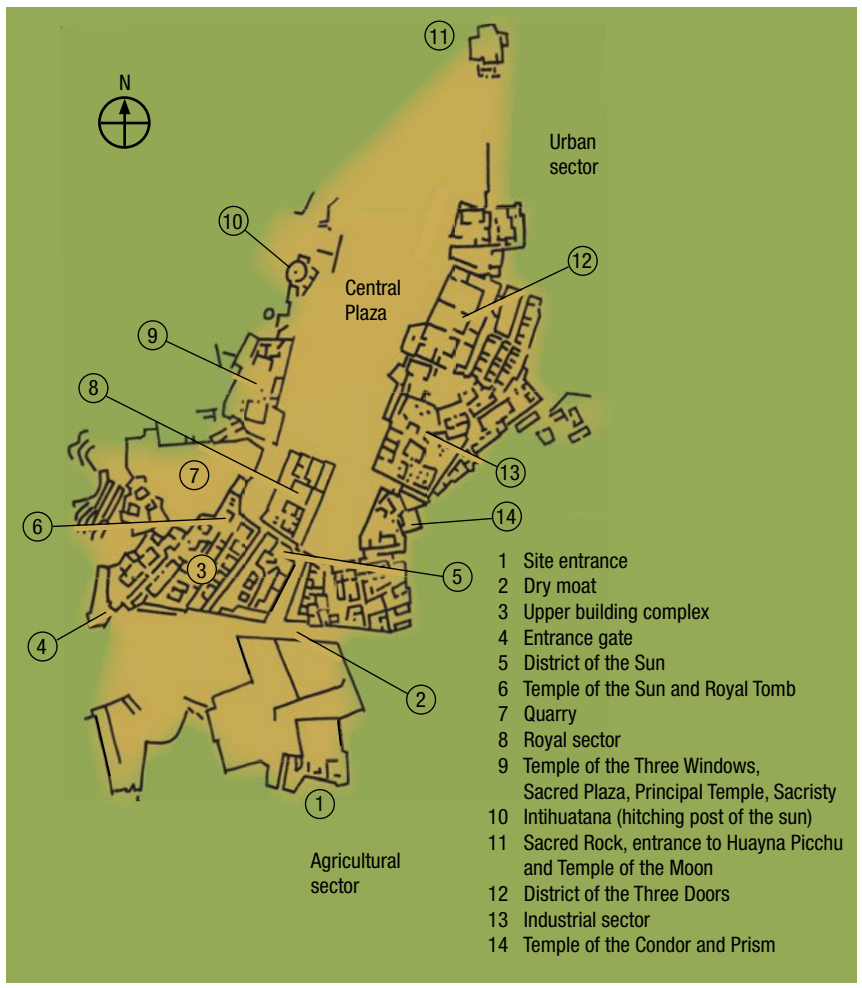
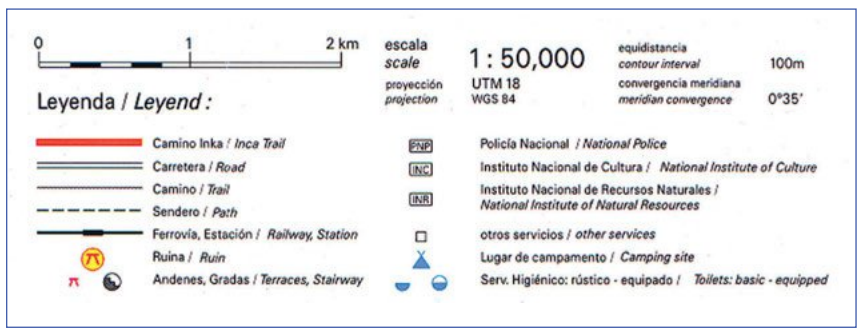


Figure 7.3b Map of Machu Picchu.



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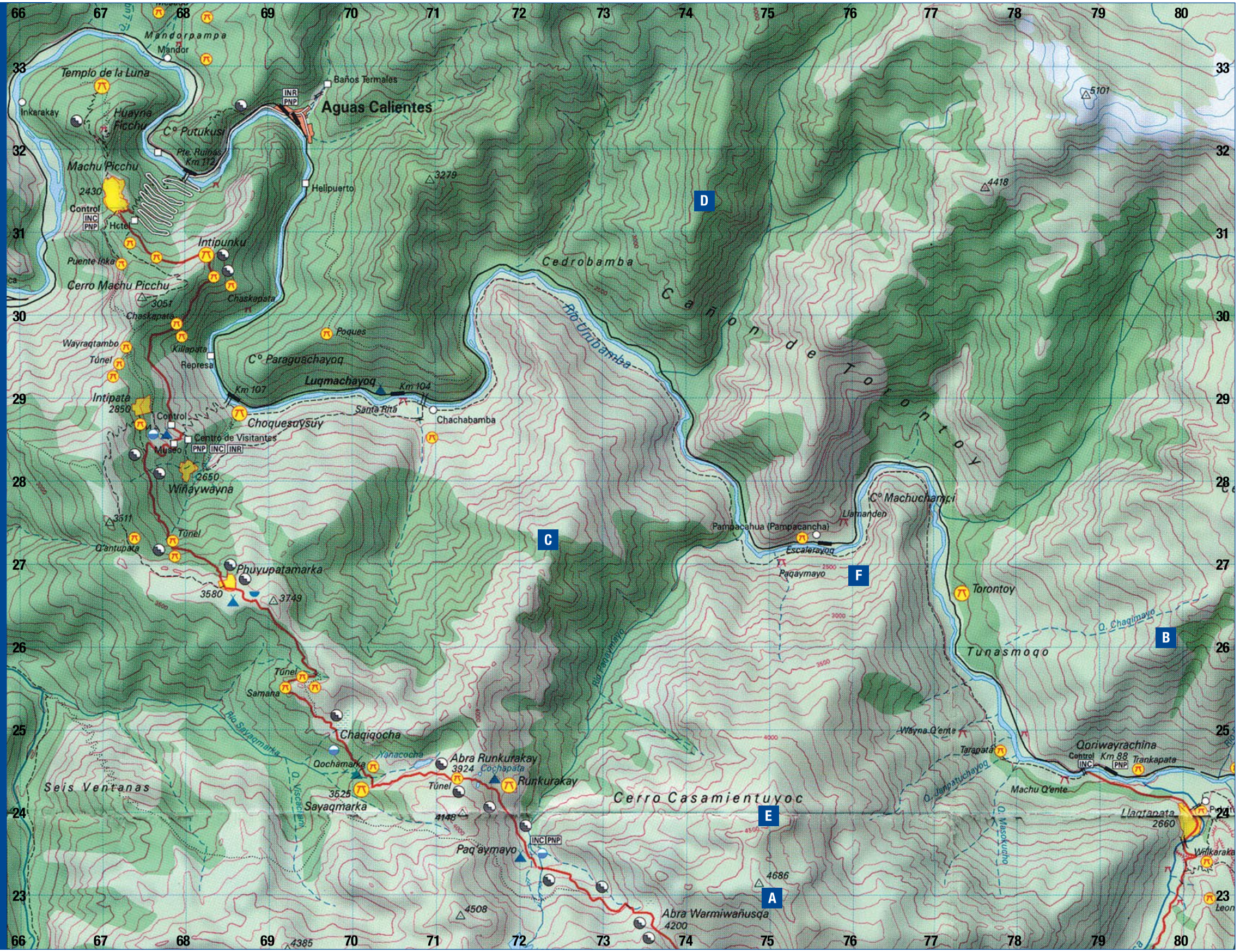
Machu Picchu topographic map extract (Machu Picchu: latitude 13°09'S, longitude 72°32'W)



7.4 Cordillera Huayhuash, Peru, topographic map extract

The Cordillera Huayhuash is a mountain range in the Andes of Peru. Aligned north to south, the main range stretches for approximately 25 km and includes 20 major peaks. Six of these peaks exceed 6000 m. These include Yerupajá (6617 m), the second highest mountain in Peru (the highest is Huascarán at 6768 m), and Siula Grande (6344 m).

The range has become a popular destination for those who enjoy trekking. The trek around the range is called the Huayhuash Circuit. It takes between 10 and 14 days, depending on the route taken. The Huayhuash Circuit is considered more demanding than the famous Inca Trail.

Figure 7.4a Cordillera Huayhuash.

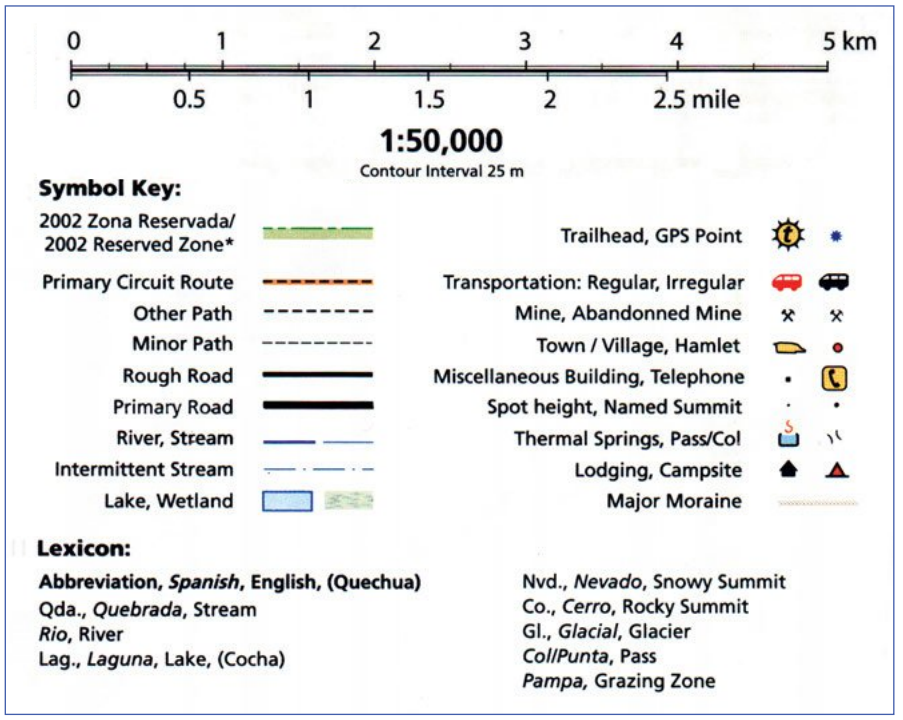


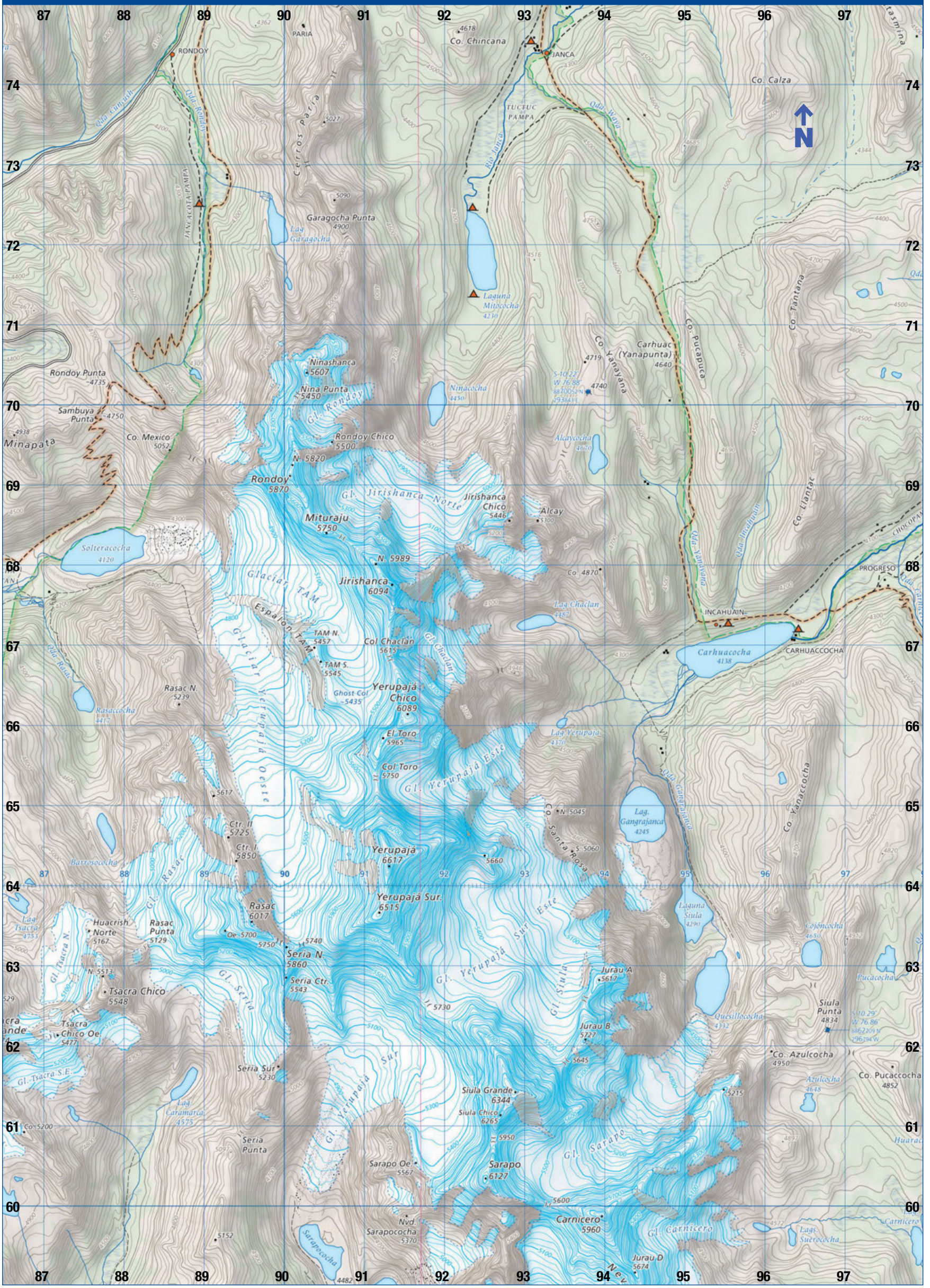
Figure 7.4b Lake Carhuacocha.

Figure 7.4c Trekkers camp at Lake Carhuacocha.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 914677
   - **b** GR 915662
   - **c** GR 907722
   - **d** GR 965613
   - **e** GR 934660.
4. Identify the feature of the constructed environment located at:
   - **a** GR 932744
   - **b** GR 924714
   - **c** GR 948669
   - **d** GR 938702.
5. What is the grid reference of the summit of Mituraju?
6. Name the type of biophysical feature found in AR 8966.
7. Name the type of vegetation found in AR 9273.
8. What is the name of the stream flowing from Laguna Siula (GR 952637) to Carhuacocha at GR 951667?
9. What are the names of the glaciers that supply the lake called Solteracocha (GR 878683) with its meltwater?
10. What is the direction of Lag. Gangrajanca (GR 945648) from the summit of Jirishanca (AR 9167)?
11. In what direction is Glaciar Yerupajá Oeste flowing in AR 8965 and AR 8966?
12. What is the aspect of the slope in:
    - **a** AR 8870
    - **b** AR 9162?
13. What is the bearing of:
    - **a** Yerupajá Chico (AR 9166) from the summit of Jirishanca (AR 9167)
    - **b** the GPS Point AR 9370 from the GPS Point in AR 9662?
14. Estimate the straight-line distance between the summit of Mituraju (AR 9068) and the summit of Yerupajá Chico (AR 9166).
15. Estimate the distance from Incahuain Hamlet (AR 9567) to Janca Hamlet (AR 9374) via the walking trail.
16. Estimate the height of the following landform features:
    - **a** Lag. Chaclan (AR 9367)
    - **b** the peak at GR 898731
    - **c** the lake at GR 963653
    - **d** the campsite at AR 8872
    - **e** Carhuacocha.
17. What is the elevation of the mountain pass at GR 907721?
18. What is the difference in elevation of Jirishanca (AR 9167) and Yerupajá Chico (AR 9166)?
19. Estimate the area of Lag. Gangrajanca (GR 945648).
20. Identify the major erosional process responsible for the landscape shown on the map extract.
21. Construct a photo sketch of Figure 7.4b. Label the principal features of the physical landscape.
22. In which direction was the camera facing when Figures 7.4b and 7.4c were taken?

Cordillera Huayhuash topographic map extract (Cordillera Huayhuash: latitude 10°16′S, longitude 76°54′W)



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7.5 Rio de Janeiro Summer Olympic Games 2016

Rio de Janeiro in Brazil will host the 2016 Summer Olympic Games. The events will be held within four zones in the city: Barra de Tijuca, Copacabana Beach, Maracana and Deodoro. The Barra de Tijuca area in south-western Rio will host the most sporting events. The Olympic village will also be located in this zone. Copacabana, with its famous 4 km beach, will host water-based sports. The Deodoro zone will be used for six Olympic competitions – modern pentathlon, shooting, equestrian, cycling, canoeing and fencing. The Maracana district houses the Maracana Stadium, the site of the opening and closing ceremonies and some football matches.

Figure 7.5a Satellite image of Rio de Janeiro, Brazil.

Figure 7.5b Rio's spectacular landscape.

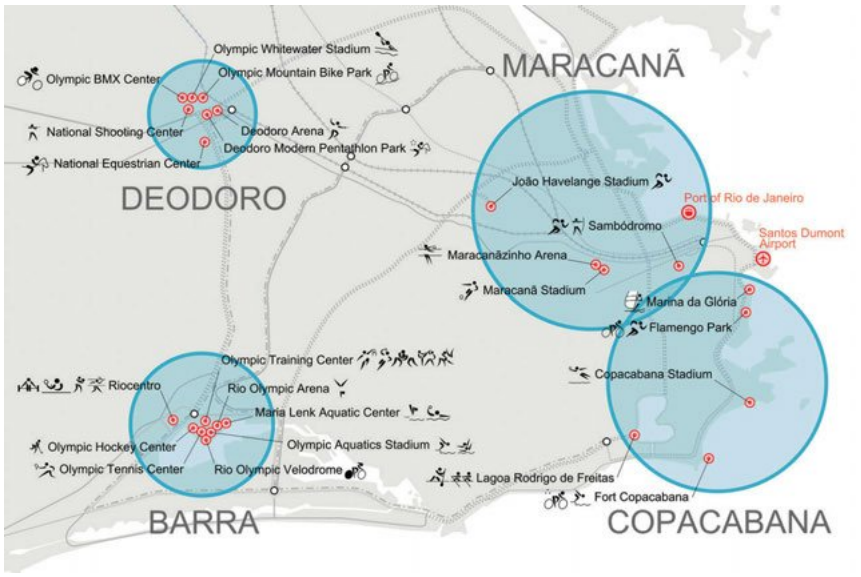


Figure 7.5c Rio's Olympic Games venues.

Figure 7.5d Rio's Olympic Park. The 300-acre waterfront venue, built on the old Brazil Grand Prix track, will host 15 sports, including swimming and hockey, and 11 Paralympics competitions.

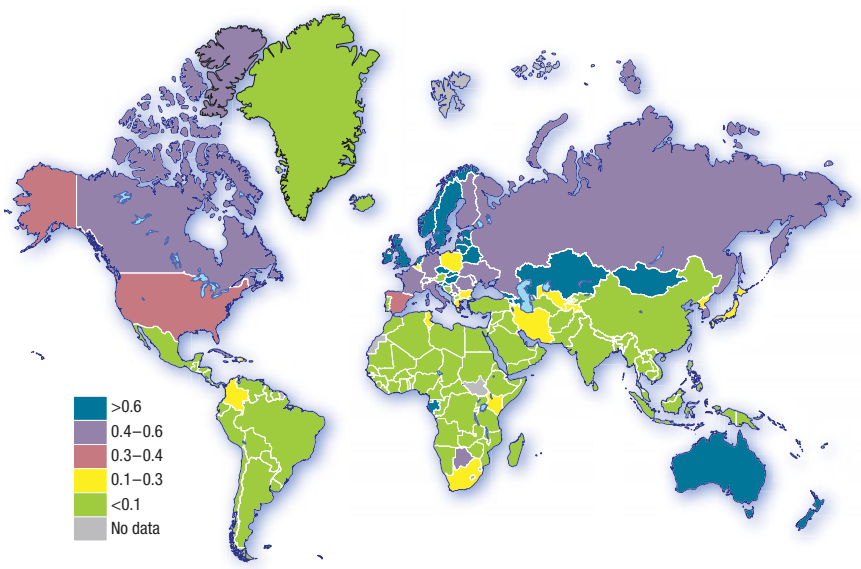


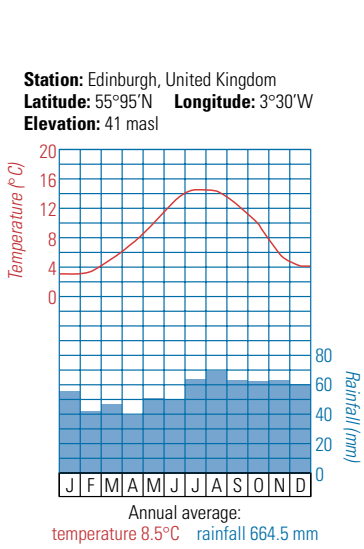
Figure 7.5e Average number of medals won per million population, London Olympics, 2012.

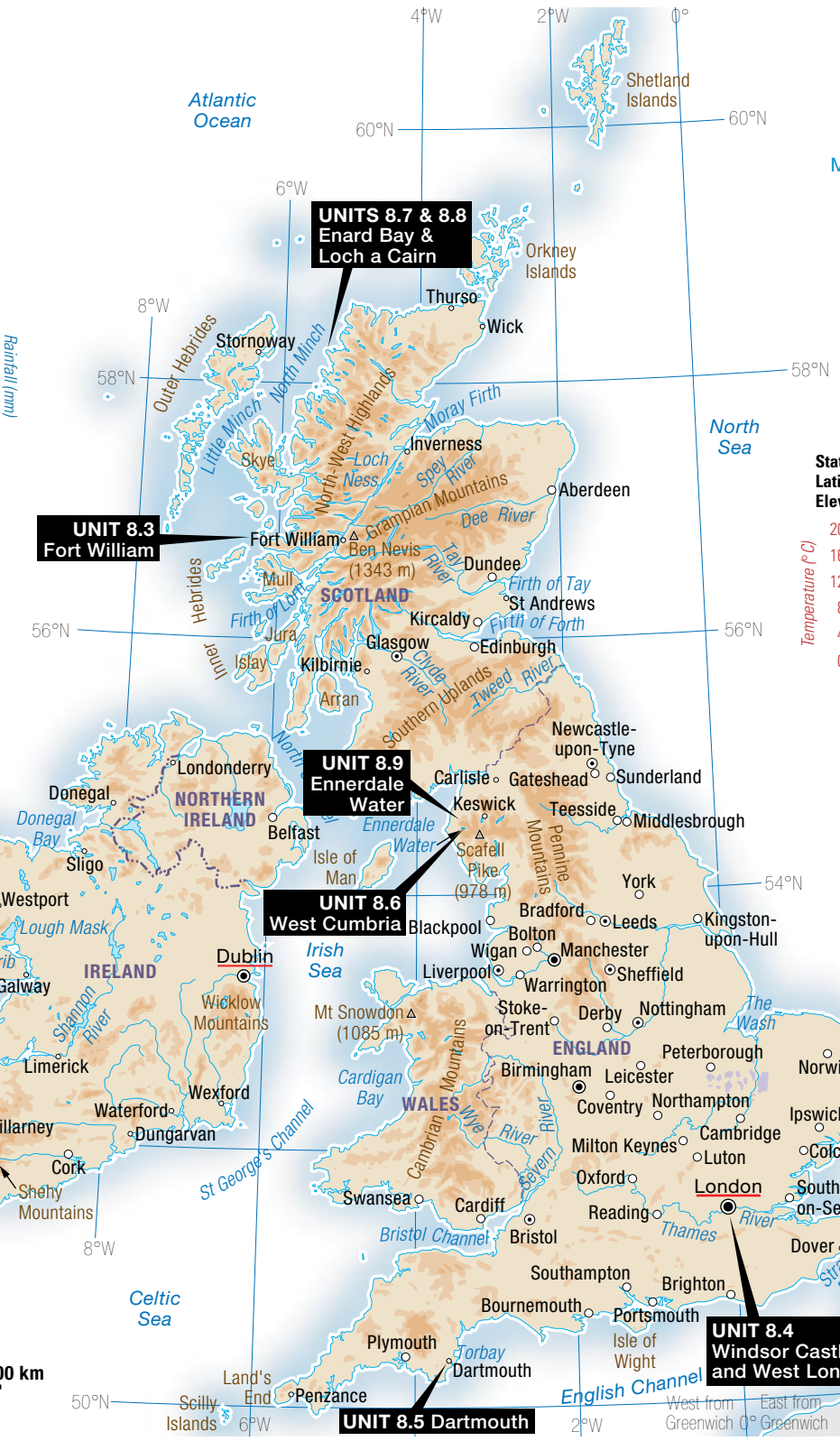
ACTIVITIES

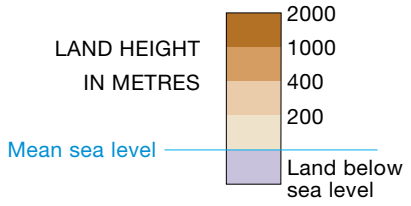
1. Study Figure 7.5a. Construct a précis sketch map of the area covered by the satellite image. Show the relationship between topography and settlement. Use the internet to find a map of Rio de Janeiro. Use this map to annotate your sketch map with place names.
2. Study Figure 7.5b. Construct an annotated photosketch. Use the information gathered in Activity 1 to annotate your sketch.
3. Study Figures 7.5c and 7.5d. Undertake internet research to update the preparations for the Games. Collect images from the internet to build a wall display of the various Games precincts.
4. Study Figure 7.5e. With the aid of an atlas map, identify the countries with the highest medal count per one million people. Compare this map with Figure 4.4a (page 91). What is the relationship between high per capita gross national income and success at the Olympics? Are there any anomalies? If so undertake research to explain why.

UNITED KINGDOM

8.1 United Kingdom

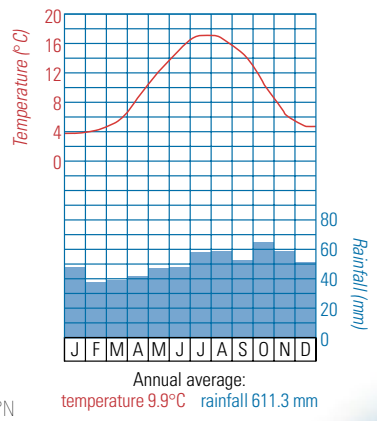






Population

- 5 000 000 and over
- 1 000 000 to 5 000 000
- 500 000 to 1 000 000
- 100 000 to 500 000
- Less than 100 000



- River
- Freshwater lake
- Ben Nevis (1343 m) — Mountain with height in metres
- International border
- State or territory border
- London — National capital

Figure 8.1 United Kingdom and the Republic of Ireland: physical features.

ACTIVITIES

1. What is the latitude and longitude of the following physical features:
   - a Lough Mask (Republic of Ireland)
   - b Mt Carrauntoohill (Republic of Ireland)
   - c Isle of Wight (England)
   - d Scafell Pike (England)
   - e Ben Nevis (Scotland)?
2. What cities are located at the following latitudes and longitudes:
   - a 55°57′N, 3°01′W
   - b 50°48′N, 1°05′W
   - c 51°30′N, 0°10′W
   - d 52°30′N, 1°50′W?
3. What is the name of the waterway separating the United Kingdom from Ireland?
4. What is the name of the waterway separating the United Kingdom from Northern France?
5. What is the capital city of the Republic of Ireland?
6. What is the direction of the Strait of Dover from London?
7. What is the direction of Dublin from London?
8. What is the straight-line distance between:
   - a Dublin and London
   - b Edinburgh and London?
9. Name the mountain range located in the west of England.
10. Name the mountain range to the north-west of Edinburgh.
11. Name the mountains in central United Kingdom.
12. Name the highest mountain in the United Kingdom.
13. Name three cities with a population of more than 1 million in the United Kingdom.
14. Name the river on which London is located.
15. Study the climate graphs of London and Edinburgh and then complete the following tasks:
    - a What is the range of average monthly temperatures experienced by London and Edinburgh?
    - b Which months receive the most rainfall in both London and Edinburgh?
    - c Describe the seasonal distribution of rainfall in both London and Edinburgh.

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8.2 Liveability: Perceptions of crime in England and Wales

Some British cities, towns or neighbourhoods are seen as being better places in which to live than others. However, such perceptions vary from person to person depending on what each individual considers to be important. Factors such as the person's age, gender, sexuality, income or wealth, ethnicity and/or family type influence the way people see and interact with the world around them.

FACTORS AFFECTING PEOPLE'S PERCEPTIONS OF LIVEABILITY

The liveability of a city, town or neighbourhood depends on the environmental and social amenity of an area as perceived by residents, workers, customers and visitors. The factors people take into account include safety and health-related issues (personal security, public health, traffic safety), local environmental conditions (cleanliness, noise, dust, air and water quality), the quality of social interactions (community identity and pride, neighbourliness), opportunities for recreation and entertainment, aesthetics, and existence of unique cultural and environmental resources (historic structures, mature trees, traditional architectural styles, streetscapes).

THE PUBLIC REALM

The relative liveability of places is largely affected by perceptions people hold about the condition of the 'public realm'. The public realm is those places where people interact with each other and the broader community. These spaces include streets, parks, sporting facilities, shopping centres, public transport interchanges and other public facilities. As a consequence, the liveability of a place is influenced by the quality of public policy and the planning decisions of authorities such as local councils.

PERCEPTIONS OF PERSONAL SAFETY

The perceptions people hold regarding their safety in particular neighbourhoods are especially important. Over time, people develop a view about the relative safety of different neighbourhoods. In addition to crimes of violence, there are crimes against property (graffiti and vandalism). These 'victimless' crimes are sometimes referred to as 'quality of life crimes' and they help shape people's thinking about neighbourhoods. Anti-social behavior such as littering, spitting and public urination also have an effect, as does the number of homeless people seen in the streets.

One of the more interesting figures is that of the perception of crime. The UK Crime Survey asked people whether they thought crime was getting worse where they lived and nationally. Findings: people thought crime was getting worse – but not where they lived. This is the gap between what we know is going on and what we think is going on.

In the wake of the 2011 London riots, both London and Manchester slumped on the index of the world's most liveable cities drawn up by the Economist Intelligence. Manchester fell nine places to 51, while London dipped two places to 55.

LIVEABILITY AND PROPERTY VALUES

Areas seen as being 'nice' places in which to live and work (that is, have high liveability) tend to have have higher property values and levels of business activity as people compete to locate there. Neighbourhoods perceived to have low levels of liveability have cheaper housing because people are less likely to choose it as a place in which to live.

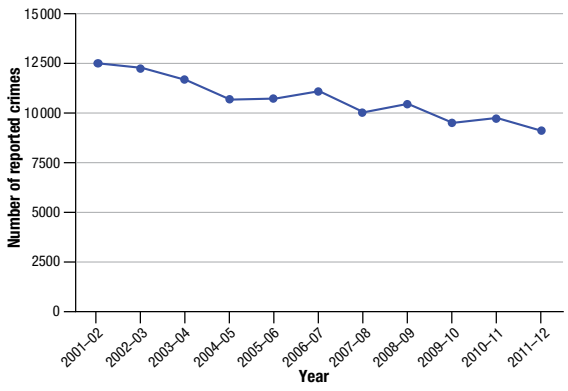


Figure 8.2a All reported crimes, England and Wales, 2001–02 to 2011–12.

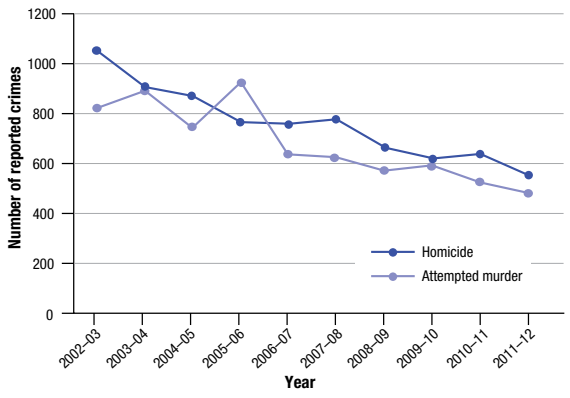


Figure 8.2b Reported homicides and attempted murders, England and Wales, 2002–03 to 2011–12.

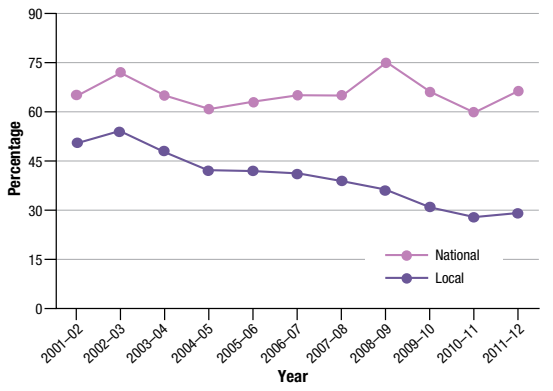


Figure 8.2c Percentage of those in England and Wales who thought there was 'a little more' or 'a lot more' crime than two years earlier.

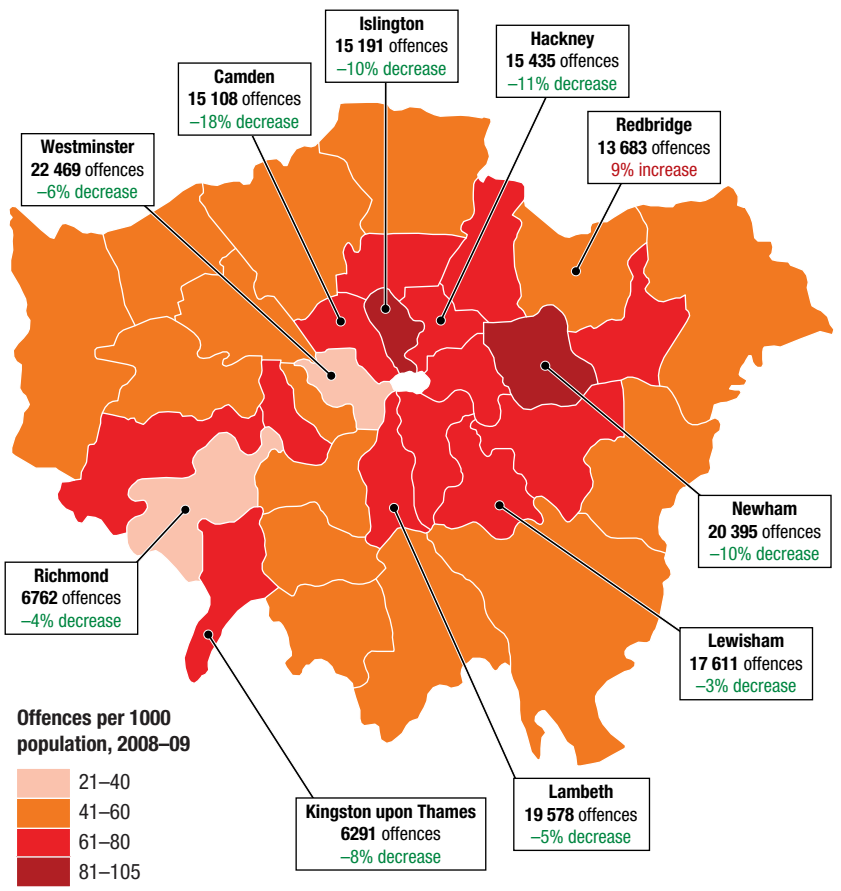


Figure 8.2d Map of London crime statistics, 2008–09.

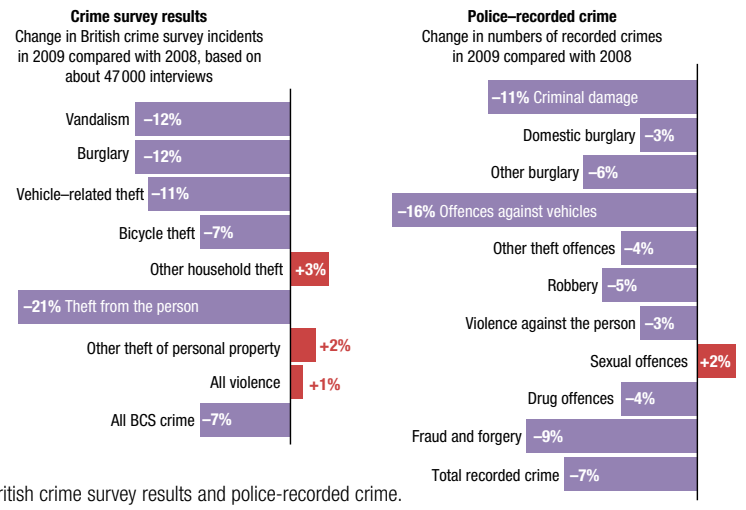


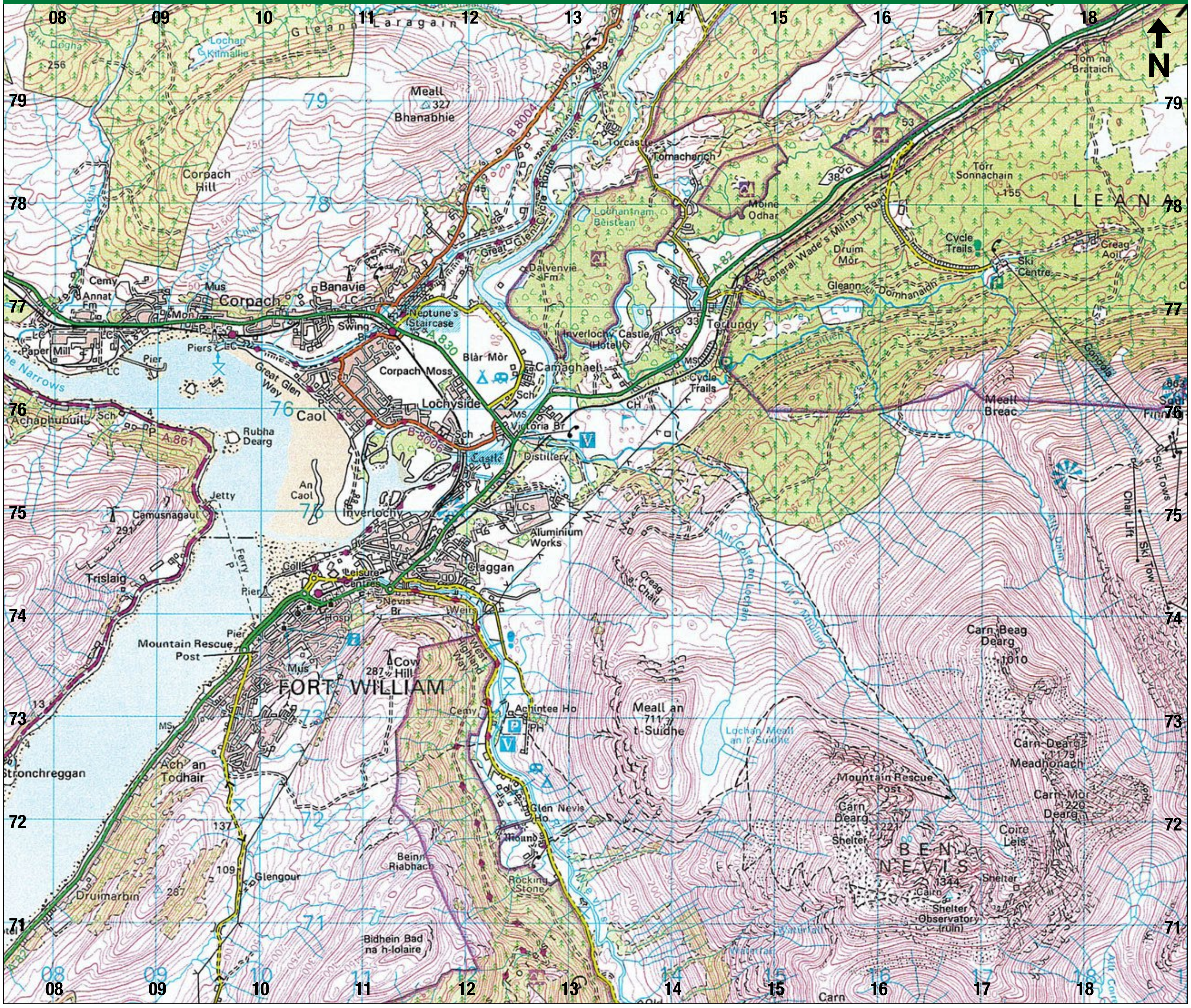
Figure 8.2e British crime survey results and police-recorded crime.

ACTIVITIES

1. Study Figure 8.2a. Using data from the graph, describe the general trend in reported crimes. In what year did the number of reported crimes increase?
2. Study Figure 8.2b. Using data from the graph, describe the general trend in reported homicides and attempted murders in England and Wales from 2002–03 to 2011–2012. In what years did the number of homicides and attempted murders increase?
3. Study Figure 8.2c. What has been the general trend in the percentage of the population saying that crime is getting worse at: a) the national level; and b) the local level?
4. Study Figure 8.2d. Identify those parts of London where the number of criminal offences exceeded 81 per 1000 population.
5. Study Figure 8.2e. Compare the crime survey results of police-recorded crime in 2009 with 2008. What are the principal differences?

8.3 Fort William topographic map extract

Fort William topographic map extract (Fort William: latitude 56°49'N, longitude 4°48'W)



ACTIVITIES

Study the Fort William topographic map extract and complete the following tasks. Refer to the legend on page 146.

1. Identify the feature of the biophysical environment at the following grid references:
   a 116789 **b** 144727.
2. Identify the feature of the constructed environment at the following grid references:
   a 122755 **b** 126719
   c 100743 **d** 167723.
3. Identify the productive activity occurring at the following grid references:
   a 083767 **b** 126749.
4. What are the biophysical features found in AR 1572?
5. What type of vegetation is found in AR 1575?
6. What is the direction of Ben Nevis (AR 1671) from Fort William?
7. What is the aspect of the slope in AR 1674?
8. In what direction is Allt Daim flowing in AR 1775?
9. What is the bearing of Meall Bhanabhie (AR 1178) from Ben Nevis (AR 1671)?
10. What is the height of Ben Nevis (AR 1671)?
11. What is the difference in elevation between Ben Nevis (AR 1671) and Meall an t-Suidhe (GR 139729)?
12. Estimate the elevation of Lochan Meall an t-Suidhe (AR 1472).
13. Calculate the gradient of the slope from GR 170740 to GR 160750.

Figure 8.3a The view from the summit of Ben Nevis.

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8.4 Windsor Castle and West London topographic map extract

Windsor Castle is the oldest and largest occupied castle in the world.

It has been occupied continuously for nearly a thousand years. Over that time it has been added to and remodelled by successive British monarchs.

William the Conqueror chose the site, high above the River Thames, because it was a day's march from the Tower of London. It also provided an ideal position from which to guard western approaches to the capital.

Today, the Queen uses the castle as a private home and as a royal residence, where she undertakes a range of formal duties.

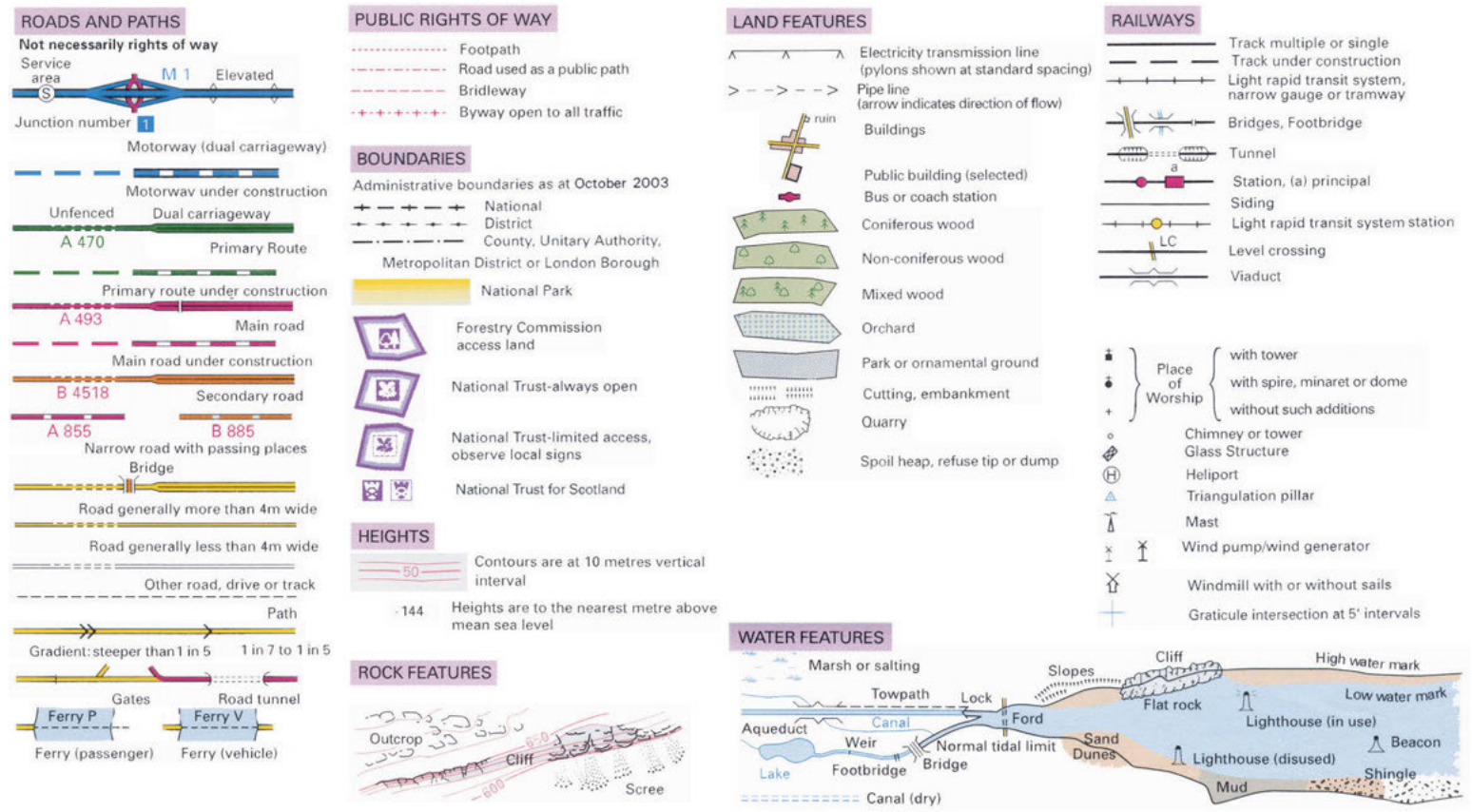
Ten British monarchs lie buried in the chapel: Edward IV, Henry VI, Henry VIII, Charles I, George III, George IV, William IV, Edward VII, George V and George VI.

To the south of the castle are Home Park and Windsor Great Park – a 2020 ha parkland. The parks, which stretch from Windsor Castle to the north and Ascot to the south, attract more than 2 million visitors a year. Historical sites within the parks include Frogmore House and its mausoleum (Queen Victoria's burial place); Fort Belvedere (preferred home of Edward VIII); and the Royal Lodge. The Royal Lodge is the former Windsor home of Queen Elizabeth and the Queen Mother.

Figure 8.4a Windsor Castle.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the feature of the biophysical environment located at:
   - **a** GR 975689
   - **b** GR 000729
   - **c** GR 997757
   - **d** GR 026677.
4. Identify the feature of the constructed environment located at:
   - **a** GR 969720
   - **b** GR 967774
   - **c** GR 977761
   - **d** GR 975759
   - **e** GR 966682
   - **f** GR 967769.
5. Identify the historical feature located at:
   - **a** GR 973739
   - **b** GR 992746
   - **c** GR 004727
   - **d** GR 968778.
6. What is the grid reference of Windsor Castle?
7. Name the type of vegetation found in AR 9569.
8. Name the type of land use found in AR 0478.
9. What waterway flows into the Thames River at GR 019720?
10. What two rivers merge at GR 977778?
11. What two motorways intersect in AR 0478?
12. What primary route joins the M25 in AR 0272?
13. What is the direction of Windsor Castle (GR 970770) from Magna Carta Island (AR 9973)?
14. What is the direction of the King George VI Reservoir from The Queen Mother Reservoir?
15. What is the bearing of the statue (AR 9672) from Windsor Castle (GR 970770)?
16. Estimate the distance by road from the motorway junction at AR 0167 to the motorway junction at AR 0478.
17. Calculate the time it would take to travel by road from the motorway junction at AR 0167 to the motorway junction at AR 0478 at an average speed of 120 km/h.
18. What is the length of The Long Walk from Windsor Castle (GR 9790770) to the intersection at GR 967729?
19. Estimate the area of:
    - **a** Wraysbury Reservoir
    - **b** King George VI Reservoir.
20. Estimate the elevation of the memorial at GR 997728.
21. Estimate the elevation of the statue at GR 967729.
22. Using Google Earth, explore the area surrounding Windsor Castle. Locate Windsor Castle and the features you have identified in the above activities.
23. Investigate the historical importance of Runnymede and the Magna Carta.



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West London topographic map extract (West London: latitude 51°48′N, longitude 0°6′W)

SCALE 1:50 000

1 0 1 2 3 4 KILOMETRES

ISBN 978-1-139-77461-1

8.5 Dartmouth topographic map extract

ACTIVITIES

Study the Dartmouth topographic map extract and complete the following tasks. Refer to the legend on page 146.

1. What is the scale of the Dartmouth map extract?
2. What is the contour interval used on the Dartmouth map extract?
3. Identify the feature of the biophysical environment located at the following grid references:
   - **a** 919497
   - **b** 888496
   - **c** 858556
   - **d** 919507.
4. Identify the feature of the constructed environment located at the following grid references:
   - **a** 946567
   - **b** 897563
   - **c** 876521.
5. Identify the historical feature located at the following grid references:
   - **a** 801606
   - **b** 888537
   - **c** 892504.
6. Identify the recreational activity available in the following area references:
   - **a** 9056
   - **b** 8759.
7. Estimate the height of the landform feature located at the following grid references:
   - **a** 839536
   - **b** 828559
   - **c** 869538.
8. Calculate the gradient of the slope from the spot height at GR 798559 to the road intersection at GR 808563.
9. What is the aspect of this slope?
10. What is the aspect of the slope in AR 8753?
11. Name three tributaries of the River Dart.
12. State the number of vehicle ferries that cross the River Dart.
13. What type of road connects Kingswear (AR 8851) to Higher Brixham (AR 9255)?
14. What type of agricultural land use is found near the village of Aish (GR 843589)?
15. What is the direction of:
    - **a** Paignton from Berry Head
    - **b** Dartmouth from Brixham?
16. What is the direction of flow of the River Wash in AR 8055?
17. Estimate the length of the Breakwater in the north-east quadrant of the map extract.
18. What is the distance by road from the bus station (GR 923561) to the Totnes roundabout (GR 808605)?
19. Calculate how long it would take for a bus to travel from the bus station (GR 923561) to the Totness roundabout (GR 808605) at a constant speed of 30 km/h.
20. Estimate the distance by rail from Kingswear Station (GR 882511) to Churston Station (GR 894563).
21. Estimate the length of the tunnel through which this railway line passes. Select a, b, c or d.
    - **a** 250 m
    - **b** 300 m
    - **c** 450 m
    - **d** 600 m
22. Describe the coastal landform features found in the area extending from Scabbacombe Head (AR 9251) and Duri Head (GR 941557). Explain how these landform features were formed.
23. What evidence is there that tourism is an industry in the area covered by the map extract?
24. What evidence is there that Dartmouth was once an important naval facility?
25. How might the local topography have favoured the location of a naval facility at the mouth of the River Dart?

Compare Figure 8.5a with the Dartmouth topographic map extract and complete the following tasks:

26. Identify the following features on Figure 8.5a:
    - **a** Britannia Royal Naval College
    - **b** One Gun Point
    - **c** Dartmouth Harbour Pontoon
    - **d** Kingswear
    - **e** The Britannia Halt–Dartmouth vehicle ferry.
27. What is the direction in which the camera was pointing when the photograph was taken?
28. Construct a line drawing of the photograph. Label the main features of the physical and human environments.
29. Name the dominant physical processes responsible for the development of the landform system.
30. List the recreational activities available to the people of Dartmouth.

Compare Figure 8.5b with the Dartmouth topographic map extract and complete the following tasks.

31. Identify the following features on the oblique aerial photograph of Dartmouth:
    - **a** Britannia RN College
    - **b** Dartmouth Harbour Pontoon
    - **c** the course of the River Dart
    - **d** Higher Noss Point (GR 880531)
    - **e** Torbay and Dartmouth Railway
    - **f** Britannia Halt vehicle ferry terminal/ramp
    - **g** Old Mill Creek
    - **h** Lower Point (GR 867557).
32. What is the direction in which the camera was facing when the photograph was taken?
33. Describe the rural landscape surrounding Dartmouth.
34. Construct a line drawing of the landscape shown in the photograph. Label the main features of the physical and human environments.

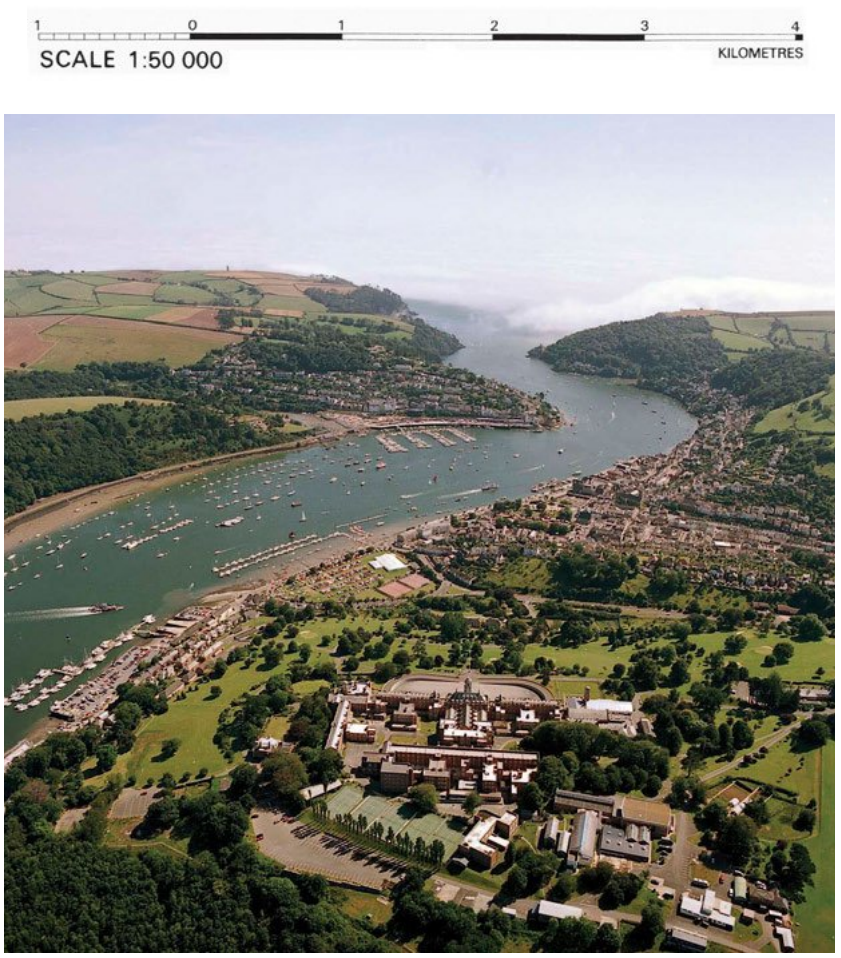

Figure 8.5a Dartmouth and the mouth of the Dart.

Figure 8.5b River Dart, Dartmouth.

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Dartmouth topographic map extract (Dartmouth: latitude 50°21'N, longitude 3°35'W)

ISBN 978-1-139-77461-1

8.6 West Cumbria topographic map extract

ACTIVITIES

Study the West Cumbria topographic map extract and complete the following tasks. Refer to the legend on page 146.

1. What is the scale of the West Cumbia topographic map extract?
2. What is the contour interval used in the West Cumbria map extract?
3. Identify the feature of the biophysical environment at the following grid references:
   a 264213 **b** 248338
   c 278193.
4. Identify the feature of the constructed environment located at the following grid references:
   a 236254 **b** 229316
   c 278225 **d** 265241.
5. Identify the distinctive landform (rock) feature located in the following area references:
   a 2529 **b** 2926.
6. Identify the historical feature located at the following grid references:
   a 291237 **b** 297187.
7. What is the dominant vegetation type found in the following area references?
   a 2427 **b** 2721
8. Identify the change in transport infrastructure evident in AR 2424.
9. Estimate the height of the following landform features:
   a Sale How (GR 277287)
   b Great Calva (GR 291312)
   c Knott (GR 295330).
10. Name the river that joins Derwent Water to Bassenthwaite Lake. State the direction in which it flows.
11. What is the grid reference of the deepest part of Bassenthwaite Lake?
12. Estimate the area of Derwent Water.
13. What is the direction of flow of Wiley Grill (stream) in AR 2931?
14. What is the grid reference of the confluence of Rigg Beck and Newlands Beck in the south-west quadrant of the West Cumbria map extract?
15. What is the bearing of Little Calva (GR 282315) from Great Cockup (GR 274333)?
16. What is the bearing of Kestrel Lodge (GR 244328) from Great Cockup (GR 274333)?
17. Estimate the distance by road from the roundabout at GR 263244 to the road junction at GR 234306.
18. Estimate the time it would take to travel from GR 263244 to GR 234306 at a constant speed of 30 km/h.
19. What is the density of chimneys or towers in AR 2524?
20. What is the gradient of the stream flowing from GR 266299 to GR 275307?
21. What is the gradient of the slope from the summit of Lonscale Fell (GR 285271) to the end of the road at GR 290254?
22. What is the aspect of the slope in AR 2626?
23. Estimate the water level of Bassenthwaite Lake.
24. Construct a cross-section from Sale How (GR 276286) to Great Calva (GR 291312). Use a vertical scale of 1 cm = 100 m.
25. Calculate the vertical exaggeration of the cross-section you have drawn.
26. Name the type of public right-of-way you would travel along to visit Skiddaw (AR 2629) having parked your car in the parking area in AR 2825.
27. List the scenic attractions and recreational activities that would attract tourists to the area covered by the West Cumbria map extract.
28. List the types of infrastructure provided to support tourism.
29. Describe the impact of topography on the pattern of transport shown on the map extract.
30. List the features of Keswick's site that led to the establishment and growth of a settlement at this location.

Study Figure 8.6b and complete the following tasks:

31. Construct a line drawing of Figure 8.6b and then label the following features: St Herbert's Island, Skiddow, Keswick, Lord's Island (AR 2621) and Derwent Isle.

Study Figure 8.6c. Compare it with the West Cumbria topographic map extract and complete the following tasks:

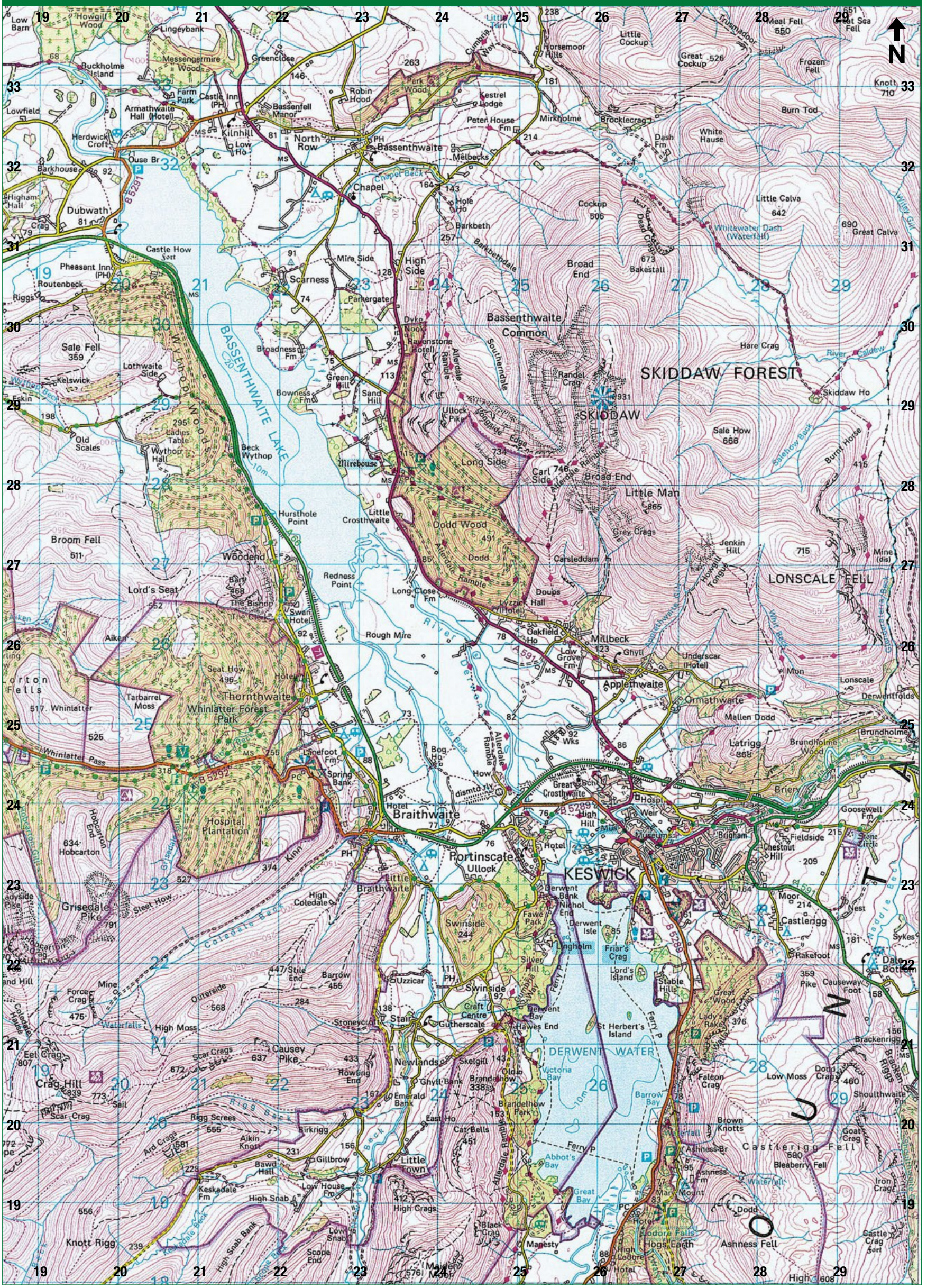
32. Construct a line drawing of the area shown in the photograph.
33. Locate and label the following features:
   a Derwent Water
   b Lord's Island
   c Derwent Isle
   d Swinside (mountain) (AR 2422)
   e Keswick
   f St Herbert's Island
   g Derwent Bay (AR 2521)
   h Cat Bells (AR 2419).
34. What is the direction in which the camera was facing when the photograph was taken?
35. Name the physical processes responsible for the development of this landscape.
36. State whether the area shown is predominantly characteristic of the bio-physical or constructed environment.

Figure 8.6a Keswick, West Cumbria.

Figure 8.6b Derwent Water, West Cumbria.

Figure 8.6c Keswick and Derwent Water, West Cumbria.

West Cumbria topographic map extract (Keswick: latitude 54°35'N, longitude 3°10'W)



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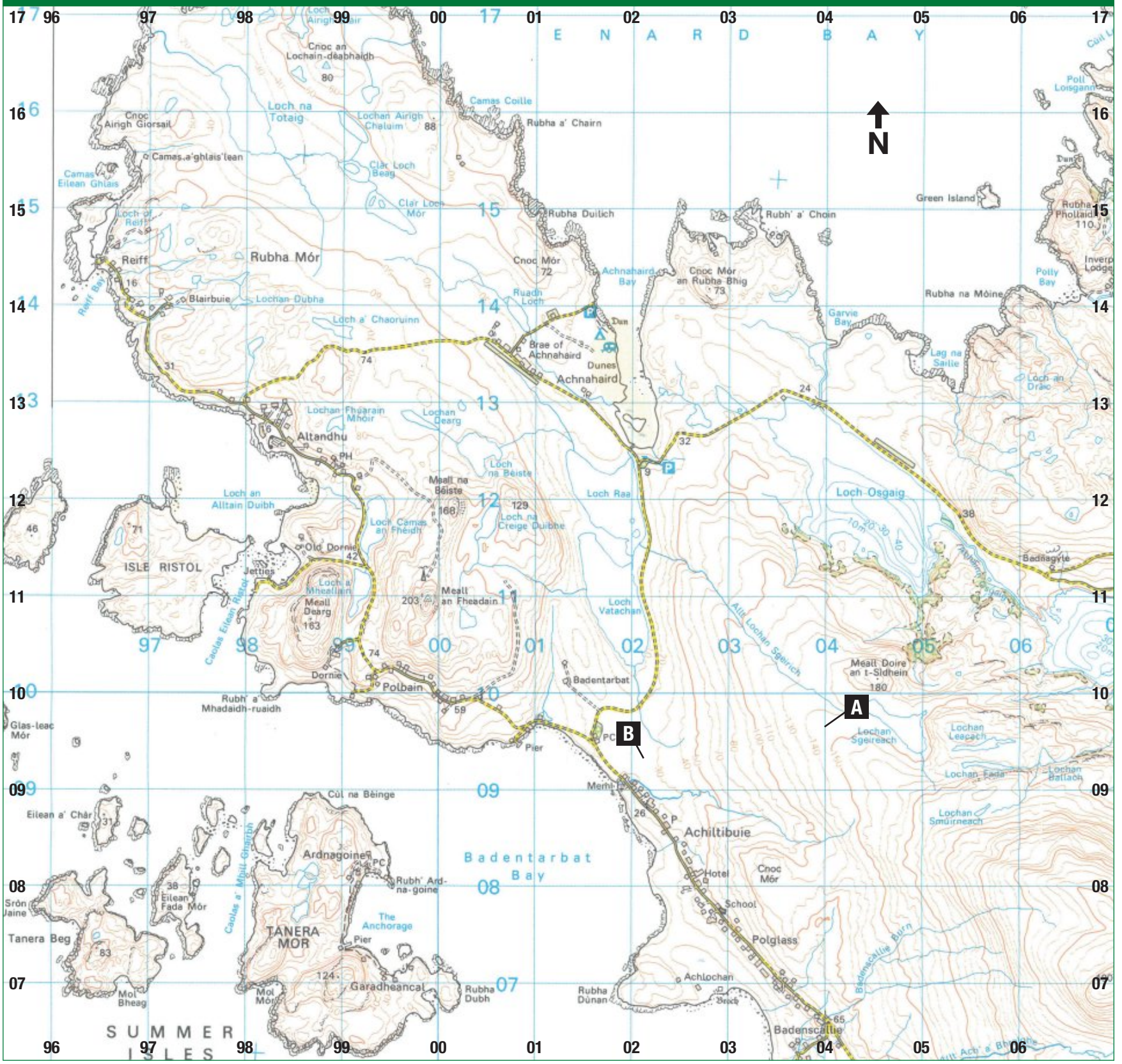
8.7 Enard Bay topographic map extract

Enard Bay topographic map extract (Enard Bay: latitude 58°02′N, longitude 5°22′W)



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SCALE 1:50 000

ACTIVITIES

Study the Enard Bay topographic map extract and complete the following tasks. Refer to the legend on page 146.

1. What is the contour interval used on the map extract?
2. Identify the feature of the biophysical environment located at:
   a GR 986108 **b** GR 057152.
3. Identify the feature of the constructed environment located at:
   a GR 027081 **b** GR 039130
4. What type of depositional landform feature is centred on GR 983113?
5. What settlement pattern is evident in the SE quadrant of the map?
6. What water body flows into the sea at Gavie Bay in AR 0413?
7. What is the direction of flow of Allt Lochan Sgeirich in AR 0310?
8. What is the direction of Cnoc Mor an Uubha Bhig (GR 028142) from Meall an Fheadain (GR 999110)?
9. What is the aspect of the slope in AR 0309?
10. What is the bearing of Cnoc Mor an Uubha Bhig (GR 028142) from Cnoc an Lochain deabhaidh (GR 988165)?
11. What is the straight-line distance between Cnoc Mor an Uubha Bhig (GR 028142) from Cnoc anLochain deabhaidh (GR 988165)?
12. What is the local relief on Tanera More in the SW quadrant of the map?
13. What is the approximate area of Tanera More in the SW quadrant of the map?
14. What is the depth of Loch Osgaig at GR 048115?
15. Calculate the vertical exaggeration of the cross-section you have drawn in Activity 15.
16. Identify the principal geomorphological processes responsible for the landforms of the Enard Bay topographic map extract.

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8.8 Loch a Cairn topographic map extract

Loch a Cairn topographic map extract (Loch a Cairn: latitude 58°15′N, longitude 5°01′W)

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SCALE 1:50 000

ACTIVITIES

Study the Loch a Cairn topographic map extract and complete the following tasks. Refer to the legend on page 146.

1. What feature of the biophysical environment is located at:
   - **a** GR 179364
   - **b** GR 220385?
2. What feature of the constructed environment is located at:
   - **a** GR 224374
   - **b** GR 202345?
3. What type of erosional material is found in AR 2129?
4. What vegetation type found in AR 1936?
5. What tributary joins Bagh Chalbha at GR 172382?
6. What is the direction of flow of Allt nan Ramh in AR 2136?
7. What is the aspect of the slope in AR 2130?
8. What is the elevation of Loch an Leothaid?
9. What is the bearing of the spot height at GR 178329 and the spot height at GR 198305?

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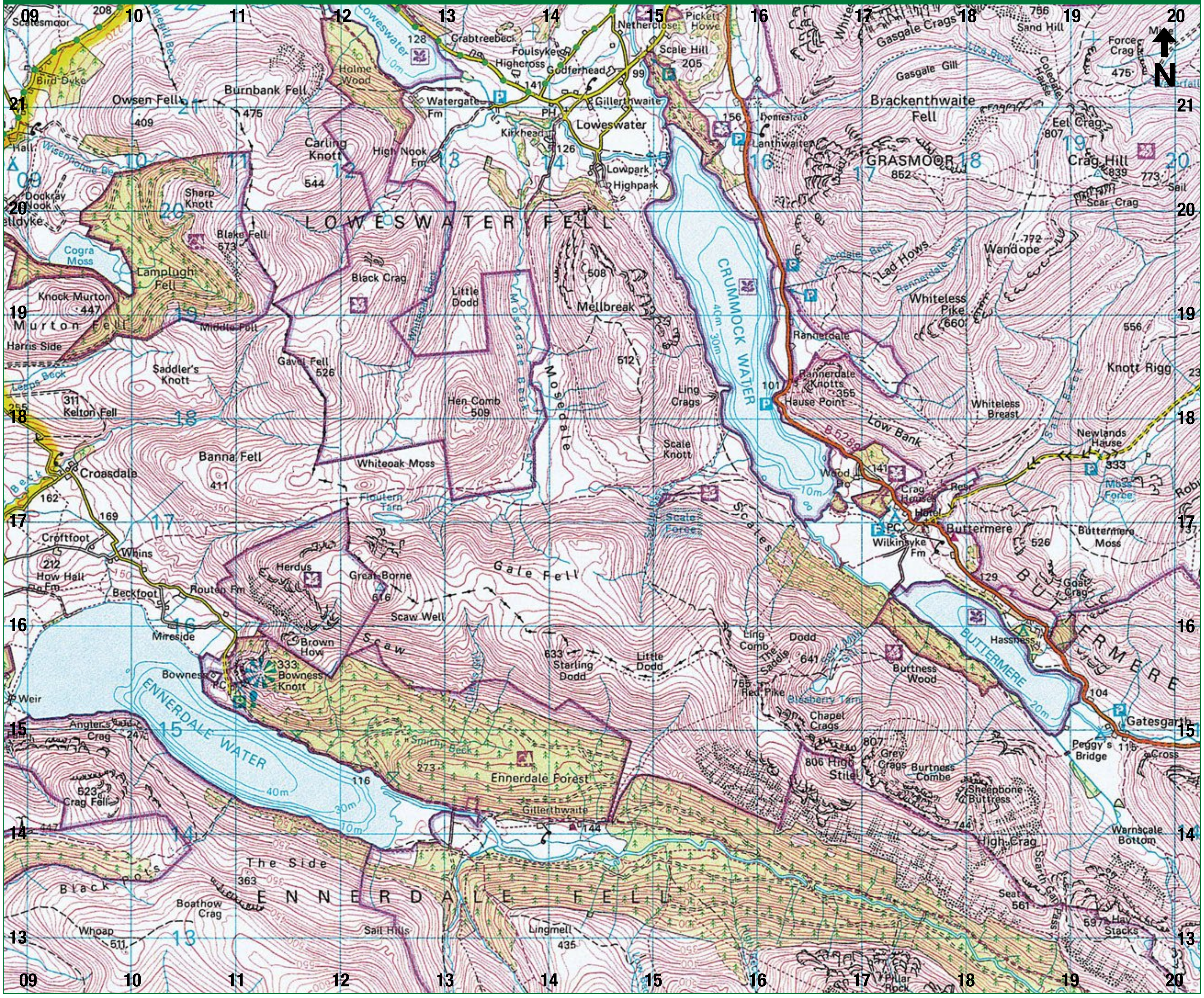
8.9 Ennerdale Water topographic map extract

Ennerdale Water topographic map extract (Ennerdale Water: latitude 54°31'N, longitude 3°22'W)



SCALE 1:50 000 (1 0 1 2 3 4 KILOMETRES)

ACTIVITIES

Study the Ennerdale Water topographic map extract and complete the following tasks. Refer to the legend on page 146.

1. What is the scale of the Ennerdale Water topographic map extract?
2. What is the contour interval of the Ennerdale Water topographic map extract?
3. Identify the feature of the biophysical environment located at the following grid references:
   a 166154   b 132181
   c 096197   d 156183.
4. Identify the feature of the constructed environment located at the following grid references:
   a 194149   b 176170
   c 127211   d 088154.
5. Name the type of biophysical features found in AR 1714.
6. Name the type of vegetation found in AR 1314.
7. What rivers flow into Crummock Water in AR 1619?
8. What is the straight-line distance between Banna Fell (GR 108175) and Hen Comb (GR 132181)?
9. Estimate the area of Buttermere Water.
10. What is the direction of Crummock Water from Ennerdale Water?
11. In what direction is Mosedale Beck flowing in AR 1318?
12. What is the bearing of Hen Comb (GR 132181) from Banna Fell (GR 108175)?

Figure 8.9a The Lakes District

13. What is the aspect of the slope in AR 1317?
14. What is the depth of Ennerdale Water?
15. Estimate the height of the landform features at the following grid references:
    a GR 117174   b GR 121189.

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CANADA AND THE UNITED STATES

9.1 Canada and the United States

Figure 9.1a Canada and the United States: physical features.

ACTIVITIES

1. Name the capital city of Canada and of the United States.
2. What oceans lie to the north, east and west of North America?
3. What is the water body to the immediate south of the mainland of the United States?
4. Name three of the Great Lakes located in the north-east of the United States.
5. What is the width of the United States from west to east along 40° latitude?
6. What major river system drains into the Gulf of Mexico at New Orleans?
7. What mountain range lies parallel to the east coast of the United States?
8. What mountain range is located in California?
9. What mountain range runs the full length of continental North America?
10. What landform feature stretches across central Canada and the northern states of the central United States?
11. Name the capital of the following US states and Canadian provinces:
    - **a** British Columbia
    - **b** Alberta
    - **c** Ontario
    - **d** California
    - **e** Washington
    - **f** Texas
    - **g** Florida
    - **h** Hawaii.
12. Name five cities with a population greater than 5 million.
13. Name three Canadian cities with a population greater than 1 million but less than 5 000 000.
14. What is the direction of:
    - **a** New York from Washington, DC
    - **b** San Francisco from Austin, Texas?
15. In what US state would you find the following tourist attractions:
    - **a** the Grand Canyon
    - **b** Yellowstone National Park
    - **c** Yosemite National Park
    - **d** Niagara Falls
    - **e** Disney World?
16. Identify the feature of the physical environment located at the following latitudes and longitudes:
    - **a** 46°12′N, 122°11′W
    - **b** 63°02′N, 151°01′W.
17. What is the latitude and longitude of the following cities:
    - **a** New York
    - **b** Washington, DC
    - **c** Vancouver
    - **d** Montreal?

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9.2 Population and urban concentrations

By 2060 the population of the United States will be considerably older and more ethnically and racially diverse than it is today. Consider the following:

- The total population is projected to exceed 400 million by 2051 and 420 by 2060.
- Minority groups,* which now account for 37 per cent of the US population, will grow to 57 per cent by 2060. The white population will be in a minority.
- Unlike other racial or ethnic groups, the non-Latino white population is expected to fall by nearly 20.6 million between 2024 and 2060. Meanwhile other groups with higher birth rates will increase.
- The number of Latinos will more than double, from 53 million in 2010 to 129 million in 2060. That is, one in three Americans – up from one in six today.
- The African American population is projected to increase from 41.2 million to 61.8 million by 2060 (up from 13.1 per cent of the population to 14.7 per cent).
- The Asian population is expected to more than double, from 15.9 million to 34.4 million.
- By 2060, one in five people in the United States will be 65 years or older. The share of the population between 18 and 64 years is expected to fall from 62.7 per cent to 56.9 per cent. There will be more people over the age of 65 than under 18 years of age.

* Minorities are defined as all other groups other than single-race, non-Latinos.

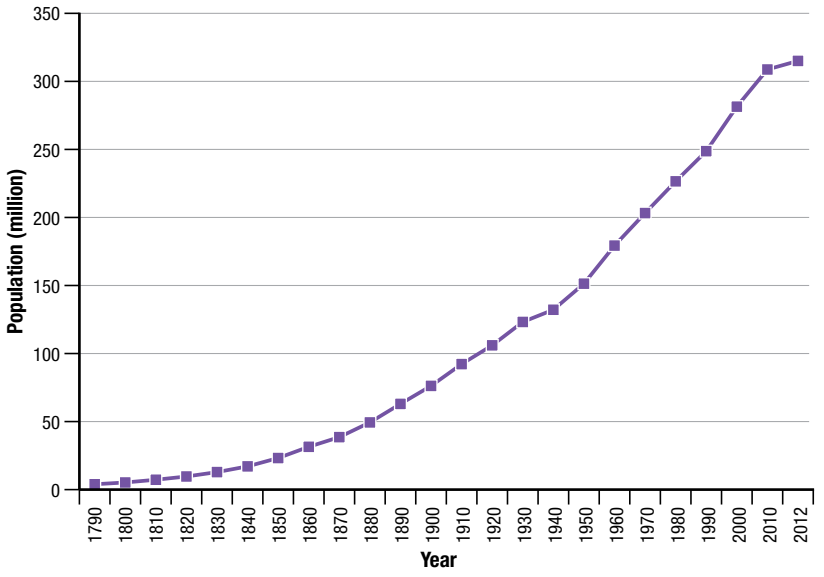

Figure 9.2a Growth of the US population, 1790–2012.

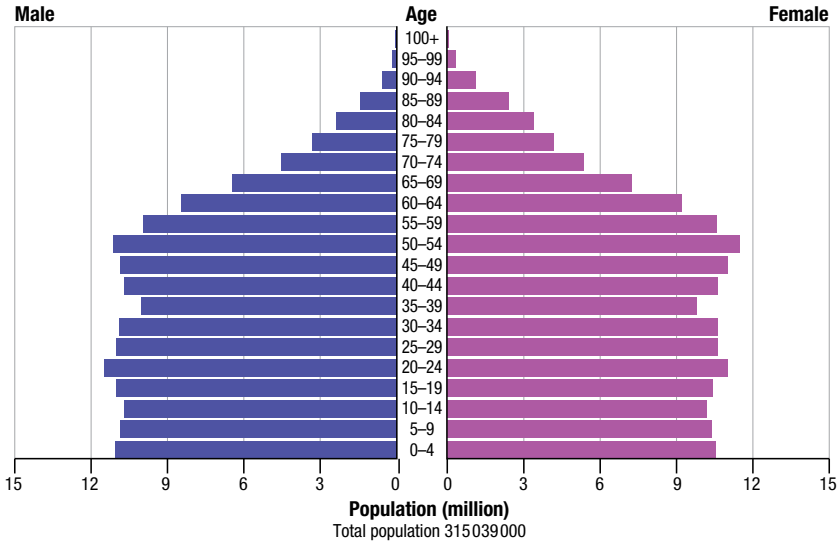

Figure 9.2b The age, sex structure of the US population, 2012.

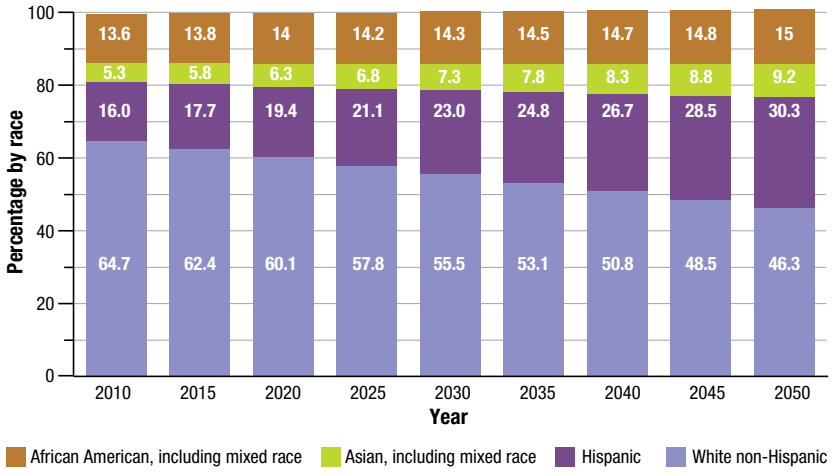

Figure 9.2c Projections of the changing ethnic composition of the US population, 2010–2050.

Figure 9.2d Chinatown, Manhatten, New York

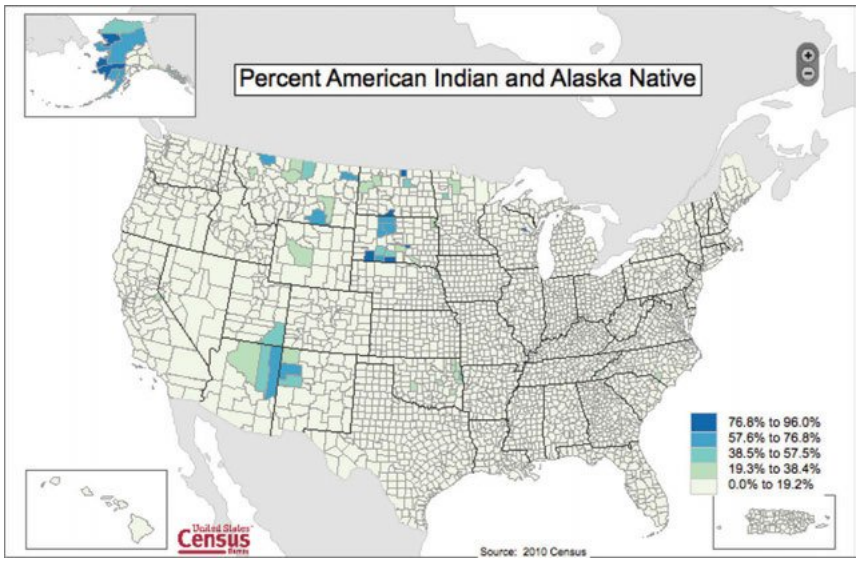

Figure 9.2e Distribution of the United States' indigenous peoples, 2010.

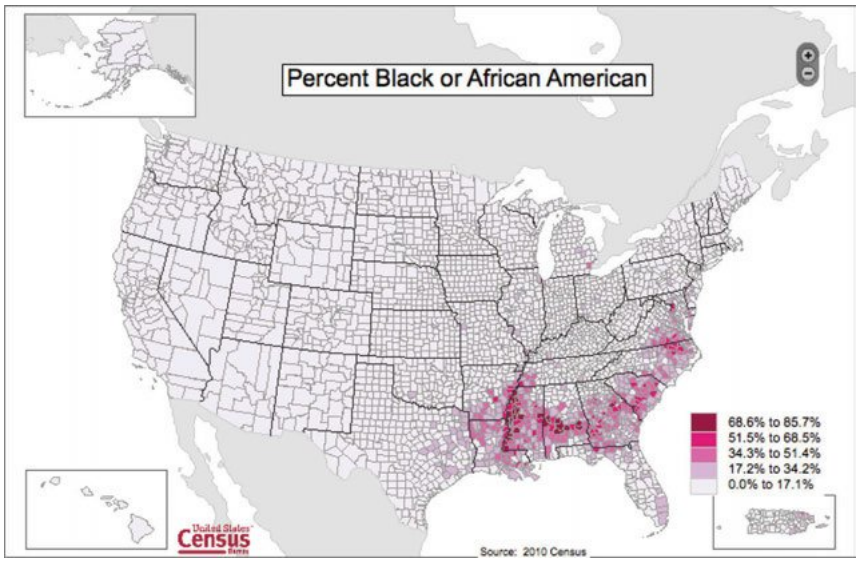

Figure 9.2f Distribution of African Americans, 2010.

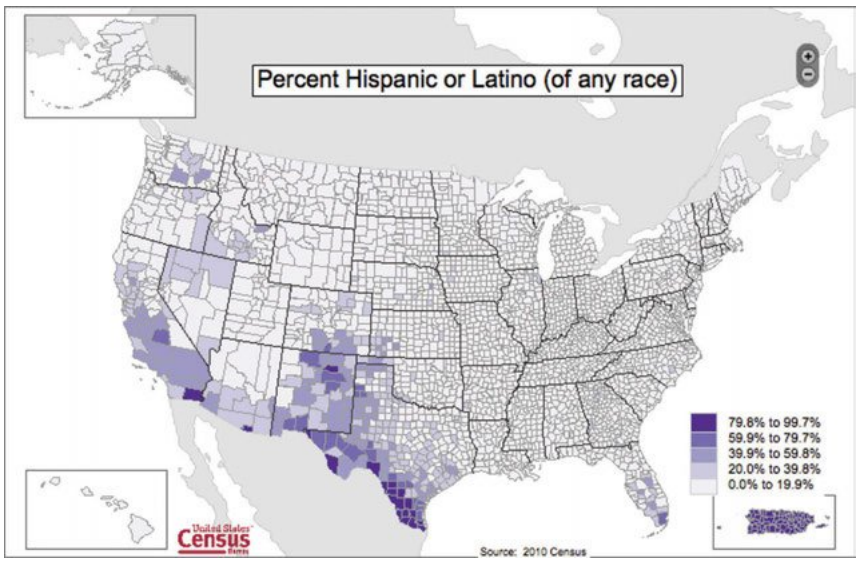

Figure 9.2g Distribution of Hispanic Americans, 2010.

POPULATION DISTRIBUTION OF THE US

The population of the US is not evenly distributed. It tends to concentrate in urban areas, leaving the spaces between them more sparsely inhabited. Most Americans live in or near cities. Today 53 per cent live in the 20 largest cities. Seventy-five percent of Americans live in metropolitan areas. This means that more than three-quarters of the US population shares just 3 percent of the land area.

The most densely settled parts of the US are the northeast, the southeast (especially Florida), the state of Texas in the Gulf of Mexico, and the west coast (one in nine Americans live in the west coast state of California, the US's most populace state). The central plains of the US are the least densely settled parts of the country. Coastal areas are home to more than half the US population.

African Americans are heavily concentrated in the southern states (in the east), where they once worked as slaves on plantations. America's Hispanic population is concentrated in the states lining the Mexican border (in the west). Indigenous Americans are concentrated in the plain states east of the Rocky Mountains.

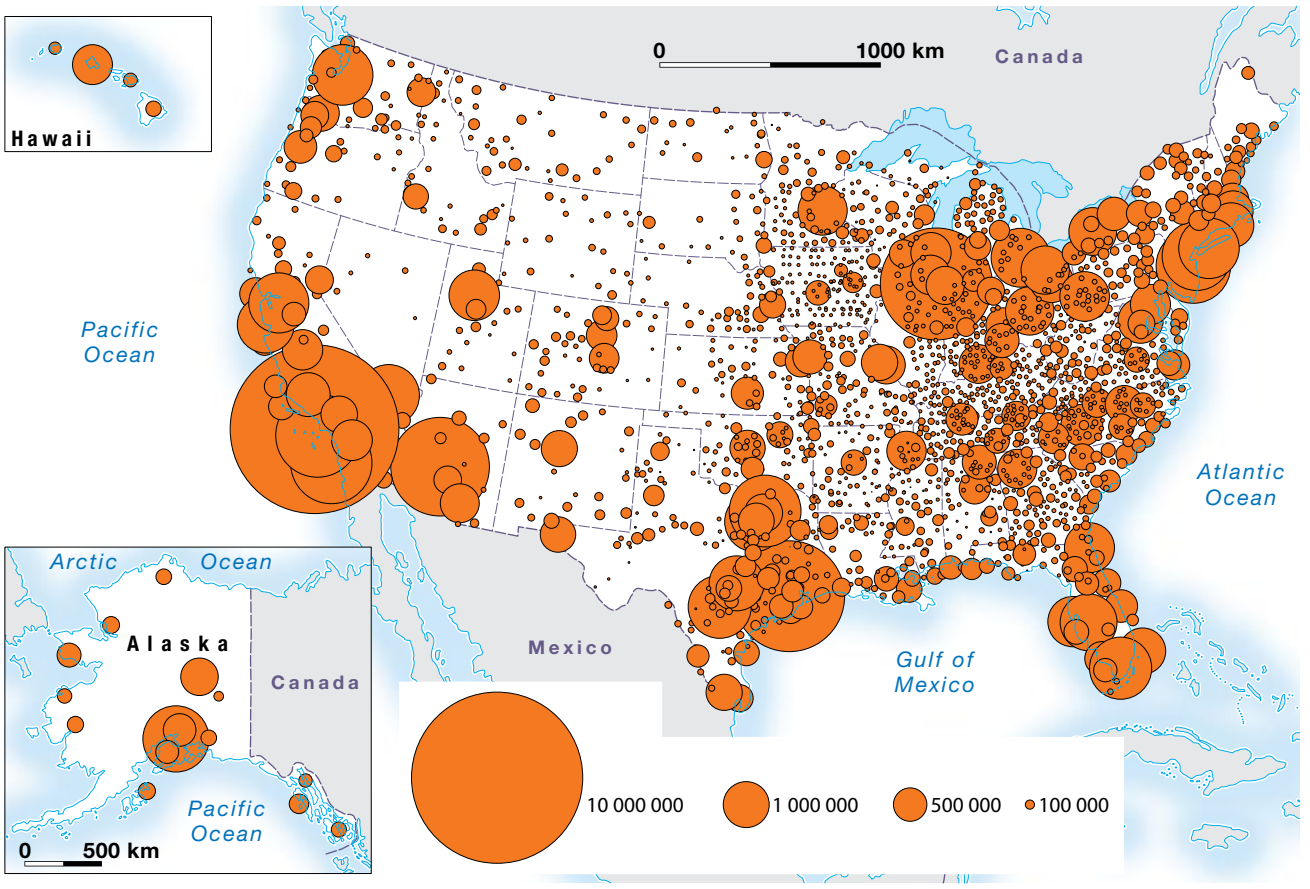

Figure 9.2h Distribution of the US population, 2010.

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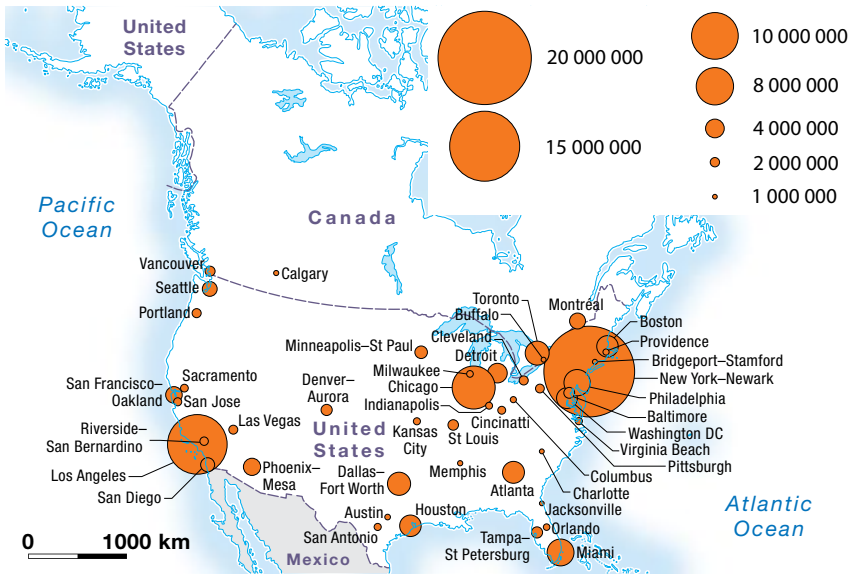

Figure 9.2i Proportional circle graph showing distribution of major North American urban concentrations, 2012.

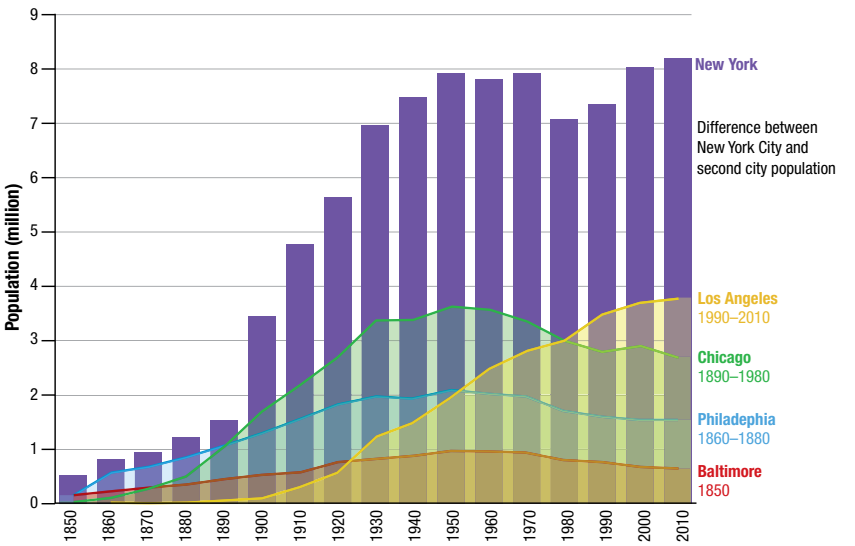

Figure 9.2j Population trends: selected US cities, 1860–2010.

NORTH AMERICA'S URBAN CONCENTRATIONS

The distribution of large urban centres in North America is quite different from that found in Australia. North America has a significant number of large, inland cities. Other than Canberra, Australia has none.

About 82 per cent of the population of the United States lives in urban areas. These occupy just 2 per cent of the country's land surface. The majority of urbanised residents live in the suburbs; those living in the inner city make up just 30 per cent of the urban population (about 60 out of 210 million people).

The largest city in the United States is New York City. The population of its metropolitan area is almost 19 million. The next five largest urban areas are Los Angeles, Chicago, Washington, DC, Philadelphia and Boston.

Canada's largest city is Toronto (5.1 million). Of the others, only Montreal (3.4 million), Vancouver (see Unit 9.3, page 160) and Calgary (1.1 million) have more than a million residents.

Figure 9.2k Aerial view of a Chicago suburb.

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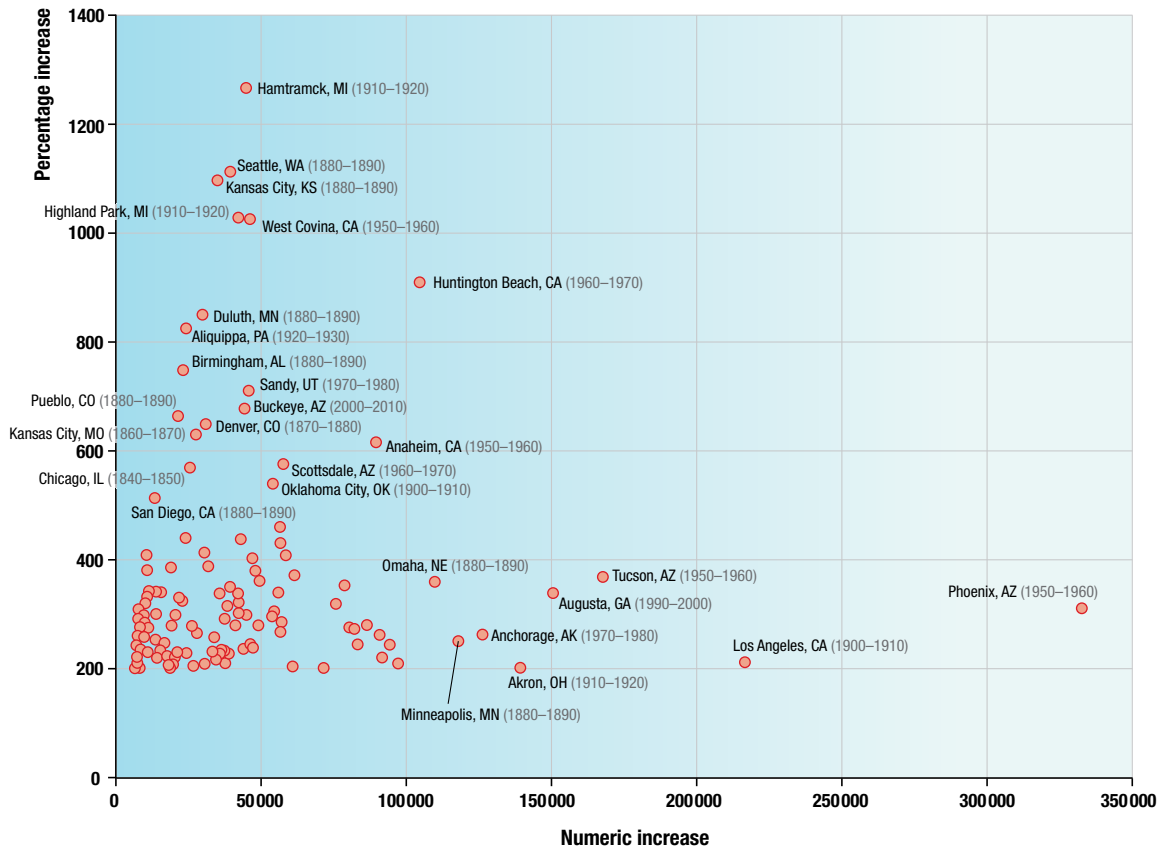

Figure 9.2l Growth of US cities, 1830–2010.

Figure 9.2m Grand Central Terminal, Manhatten, New York.

Figure 9.2n Cable Car bus, San Francisco, California

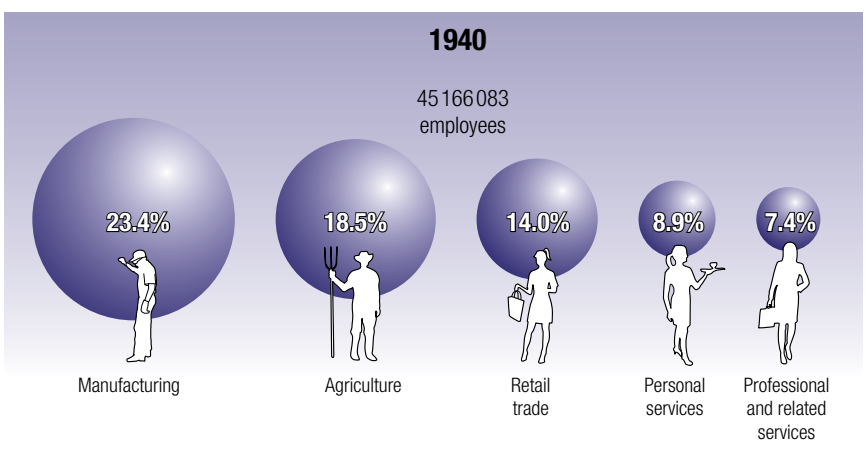

Figure 9.2o Changing structure of US employment 1940–2010.

Figure 9.2p US Capitol Building, Washington D.C.

ACTIVITIES

1. Describe the general trend in the rate of US population growth since 1790.
2. Study Figure 9.2b (page 156). Estimate the number of Americans under the age of 15 years in 2012. What percentage of the total population did this represent?
3. Study Figure 9.2b (page 156). Estimate the number of Americans over the age of 65 years in 2012. What percentage of the total population did this represent?
4. Using data from Figure 9.2c (page 156) describe the projected changes in the racial composition of the US population between 2010 and 2050.
5. Study Figures 9.2e to 9.2g (page 157). Describe the distribution of:
   - **a** Indigenous Americans
   - **b** African Americans
   - **c** people of Hispanic origin.
6. Undertake research into the reasons for the distribution of African Americans and those of Hispanic origin.
7. With the aid of an atlas describe the distribution of the US population in 2010. Explain how the population distribution of the United States differs from that of Australia.
8. Study Figure 9.2i. Identify North America's largest urban concentration. Which cities are expected to show the most significant growth between 2010 and 2025?
9. Study Figure 9.2j. Describe how the trends in New York's population compare with those of Los Angeles, Chicago, Philadelphia and Baltimore. After declining in the 1970s, the population of New York resumed its growth in the 1980s.
10. Study Figure 9.2o. Using data from the graphic, describe the change in the structure of US industry and employment in the period 1940 to 2010.

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9.3 Vancouver, Canada, topographic map extract

VANCOUVER

With a population of 2.3 million people, Vancouver, British Columbia, is the third largest Canadian city and the country's major urban concentration on the west coast. Vancouver ranks as one of the most 'liveable' cities in the world.

The city occupies one of the most spectacular settings of any large city. The city itself is located on the Burrard Peninsula, which also features one of North America's largest urban parks, the 404.9-hectare Stanley Park. The park is among the city's most popular recreational areas.

The North Shore Mountains dominate the cityscape. On a clear day visitors to the mountain can see as far as Mount Baker, the snow-capped volcano in the state of Washington to the south. Also visible is Vancouver Island across the Strait of Georgia to the west.

Because of its coastal location Vancouver's climate is quite mild, especially by Canadian standards. The summer months are typically dry, with an average of only one in five days receiving rain in July and August. Between November and March, however, rain or snow fall on nearly half the days.

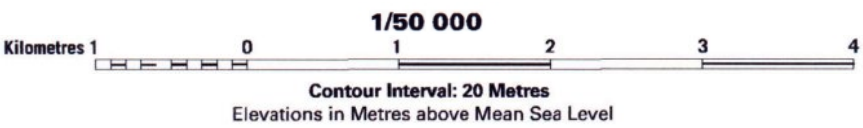
Vancouver is one of the most ethnically diverse cities in Canada. For 52 per cent of the population, English is not their first language. Almost 30 per cent of the city's population has Chinese heritage. Other significant Asian communities in Vancouver are the South Asian (mainly Punjabi) (5.7 per cent), Filipino (5.0 per cent), Japanese 1.7 per cent) and Korean (1.5 per cent).

Figure 9.3a Vancouver.

Principal Vancouver 2010 Winter Olympic Games venues

1 BC Stadium – opening and closing ceremonies
2 General Motors Place
3 Hillcrest/Nat Bailey Stadium Park – curling
4 Pacific Coliseum – short-track speed skating, figure skating
5 University of British Columbia Winter Sports Centre – ice hockey
6 Richmond – speed skating
7 Cypress Mountain (see Figure 2.22b) – snowboarding, freestyle skiing
8 Whistler Creekside (see the map extract on page 163) – alpine skiing: downhill, super-g, giant slalom, slalom
9 Whistler Sliding Centre (Blackcomb Mountain – see the map extract on page 163) – bobsleigh, luge, skeleton
10 Whistler Nordic Venue – Callaghan Valley: cross-country, biathlon

Figure 9.3b The location of Vancouver and Whistler.



ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the Winter Olympic facilities located in each of the following area references:
   a AR 9158
   b AR 9659.
4. Identify the feature of the biophysical environment located at each of the following grid references:
   a GR 911603
   b GR 915609
   c GR 898613
   d GR 886617
   e GR 893586.
5. Identify the feature of the constructed environment located at the following grid references:
   a GR 899625
   b GR 911604
   c GR 900637
   d GR 916619
   e GR 905609.
6. Identify the land use at the following area references:
   a AR 9357
   b AR 9559
   c AR 9262.
7. What creek flows into Vancouver Harbour in AR 9362?
8. What is the area reference of False Creek's Granville Island?
9. What is the direction of flow of the Capilano River in AR 9164?
10. What is the direction of Prospect Point (AR 8962) from Brockton Point (AR 9160)?
11. What is the bearing of Elsje Point (GR 8958) from Brockton Point (AR 9160)?
12. What is the bearing of Jericho Beach navigation light (AR 8658) from the Prospect Point navigation light (AR 8962)?
13. Estimate the distance travelled by the ferry from GR 921593 to GR 939619.
14. Calculate the time it would take for a ferry to travel from GR 921593 to GR 939619 at an average speed of 20 km/h.
15. Estimate the elevation of the water tank in AR 8766.
16. Estimate the elevation of the base of the communication tower in AR 9566.
17. What is the density of storage tanks in AR 9959?
18. Identify the recreational facility located in the following area references:
   a AR 8960
   b AR 9060.
19. What is the area of Stanley Park?
20. What is the aspect of the slope in AR 9662?
21. What is the general aspect of North Vancouver?
22. In what general direction was the camera facing when Figure 9.3a was taken?
23. Study the climate graph of Vancouver on the topographic map extract and then complete the following tasks:
   a What is the hottest month?
   b What is the coldest month?
   c What is the seasonal range of maximum and minimum temperatures?
   d Which are the wettest and driest months?
   e Describe the seasonal distribution of rainfall.
24. Use Google Earth to locate and observe the features of the physical and human environments identified in Activities 3–6.

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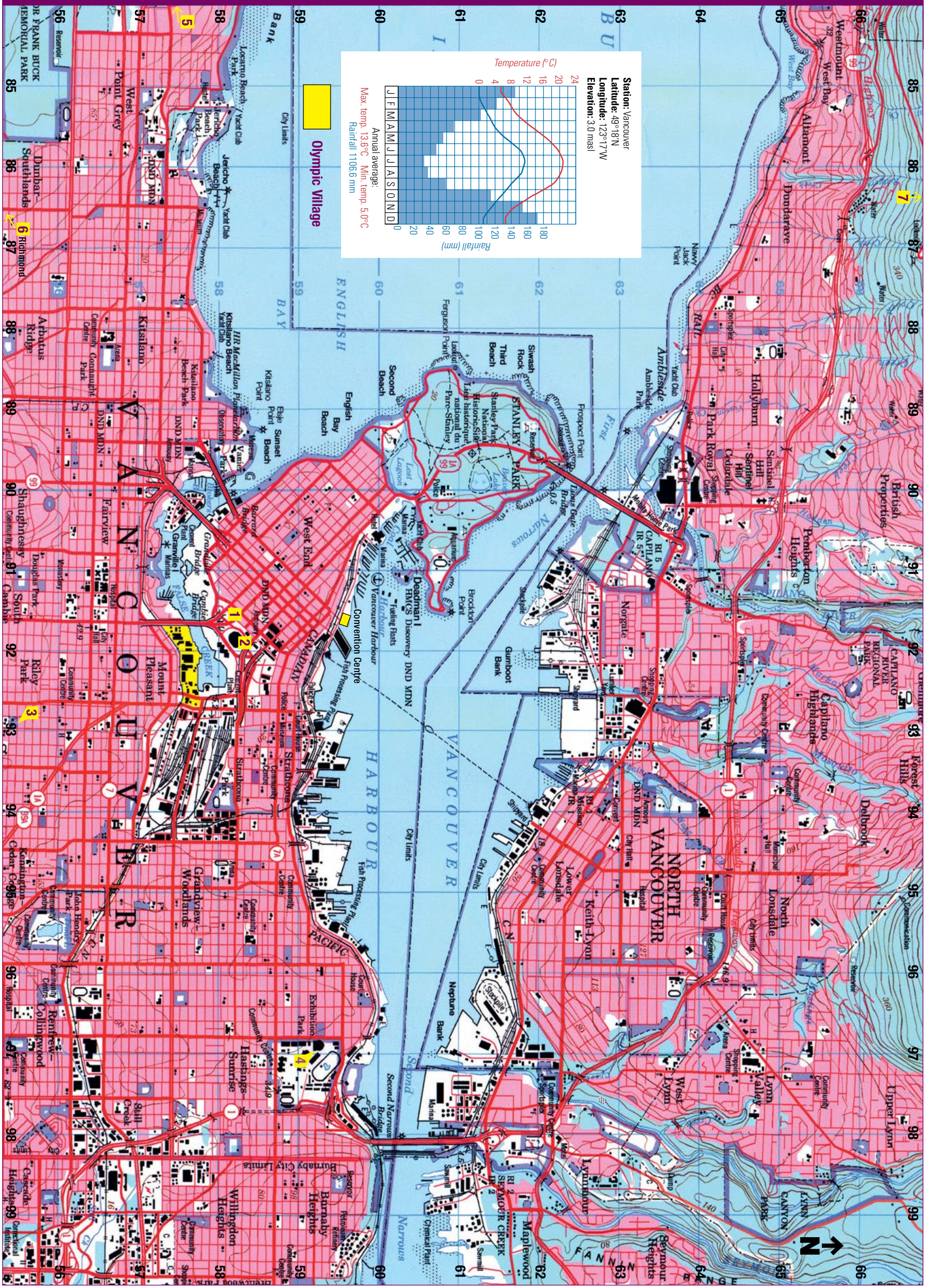
Vancouver topographic map extract (Vancouver: latitude 49°13′N, longitude 123°06′W)



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9.4 Whistler, Canada, topographic map extract

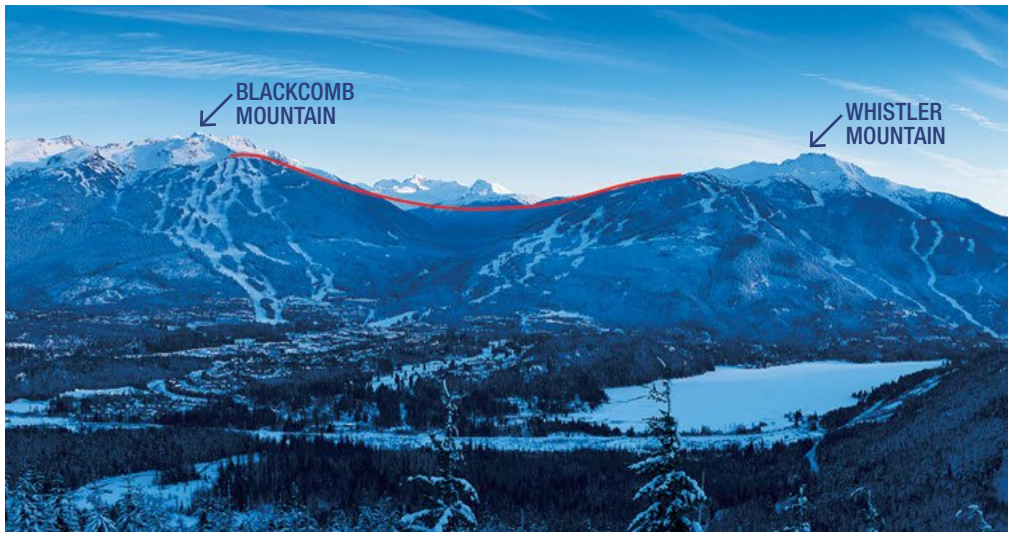


Figure 9.4a Whistler–Blackcomb showing the location of the peak-to-peak gondola.

WHISTLER–BLACKCOMB

Whistler is one of the world's leading winter sports resorts. Over two million people visit Whistler each year, primarily for skiing and snowboarding and, in summer, mountain bike riding, golfing and hiking. During the 2010 Winter Olympics, Whistler hosted most of the alpine, Nordic, luge and bobsled events.

Whistler is located approximately 125 kilometres to the north of Vancouver and has a permanent population of about 10 000 people, plus a larger seasonal worker population, typically young people from Australia, New Zealand and Europe.

SCALE 1:50 000
(1CM = 500M)
CONTOUR INTERVAL 100 FEET
0 1km 2km 3km

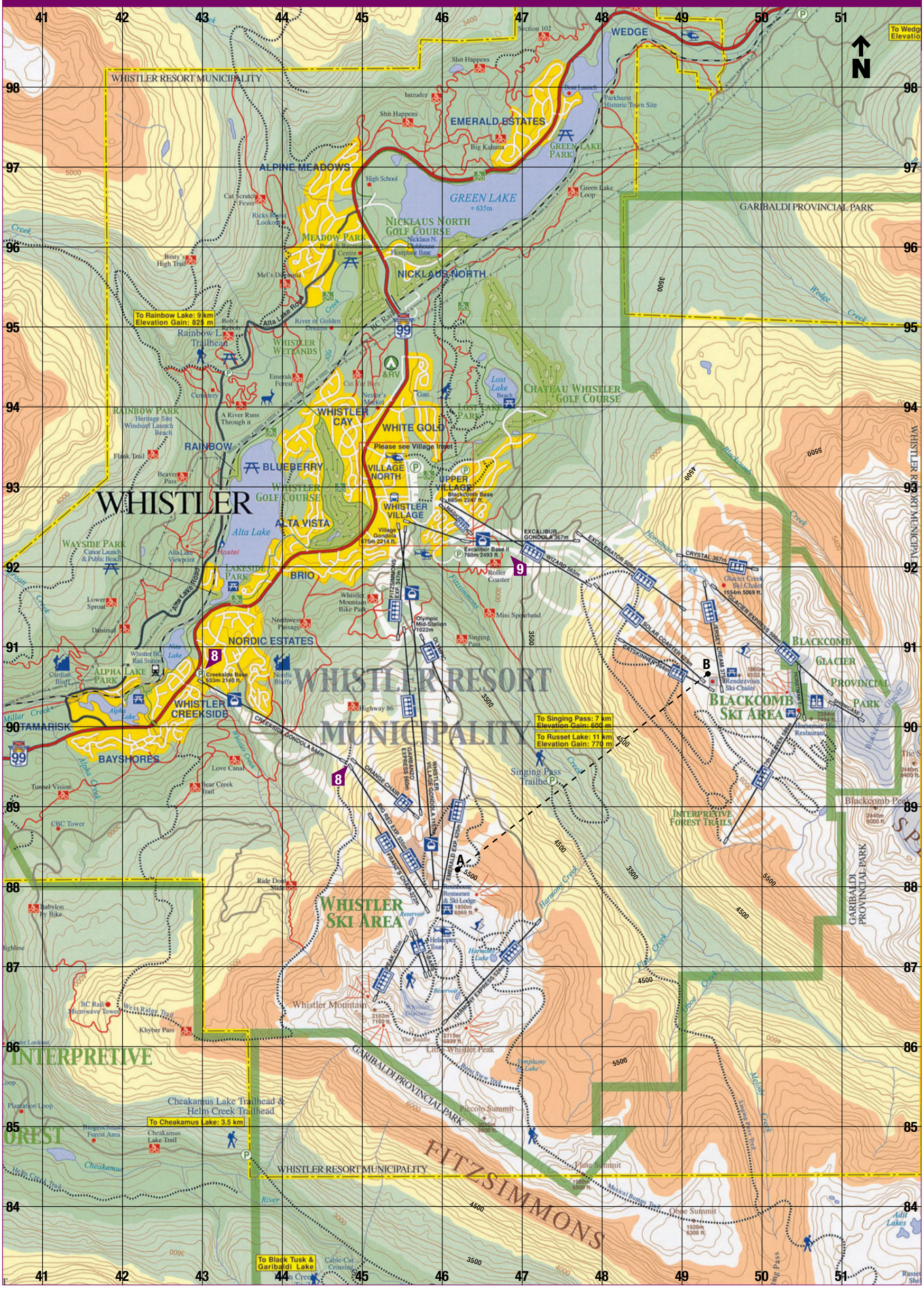
ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the features of the bio-physical environment located at:
   - **a** GR 452865
   - **b** GR 514890
   - **c** GR 425909
   - **d** GR 470857
   - **e** GR 457862
   - **f** GR 465851.
4. Identify the features of the constructed environment located at:
   - **a** GR 452916
   - **b** GR 495918
   - **c** GR 424908
   - **d** GR 494906
   - **e** GR 451969
   - **f** GR 454953.
5. What is the grid reference of the base station of the Whistler Creekside Gondola?
6. Name the biophysical feature(s) that are found in:
   - **a** AR 5189 and AR 5190
   - **b** AR 4586.
7. What type of land use is found in AR 4794?
8. What type of alpine transport links Whistler Village to the Roundhouse restaurant and Ski Lodge (GR 459881)?
9. What type of ski lift is Harmony Express in the south-east quadrant of the map extract?
10. How many golf courses are there in Whistler? Why do you think there would be so many courses in an alpine resort destination?
11. Identify the winter recreational activities available at:
    - **a** AR 4687
    - **b** AR 4694.
12. Using area references, identify at least six recreational activities available to tourists during summer.
13. Into what waterway does Harmony Creek flow at GR 481889?
14. What is the name of the waterway joining Green Lake and Alta Lake?
15. What creek flows into Nita Lake in AR 4290?
16. What is the direction of:
    - **a** Whistler Mountain (AR 4586) from Blackcomb Peak (GR 514890)
    - **b** Blackcomb Peak (GR 514890) from the Upper Village (AR 4693)?
17. In what direction is Wedge Creek flowing in AR 5095?
18. In what direction is Oboe Creek flowing in AR 4986?
19. What is the bearing of Whistler Mountain (GR 453864) from Blackcomb Peak (GR 514890)?
20. What is the aspect of the slope in:
    - **a** AR 4297
    - **b** AR 5087?
21. Estimate the straight-line distance between Whistler Mountain (AR 4586) and Blackcomb Peak (GR 514890).
22. What is the difference in elevation of Whistler Village Gondola's base (GR 455926) and its terminus at the Roundhouse Restaurant and Ski Lodge?

Figure 9.4b Snowboarder gets clean air.

23. What is the length of the Whistler Village Gondola?
24. What is the elevation of Symphony Lake (GR 470857)?
25. What is the difference in elevation (in metres) between Blackcomb Peak (AR 5189) and Whistler Mountain (AR 4586)?
26. What is the height of the landform feature located at GR 517885?
27. Estimate the area of Alta Lake.
28. Construct the cross-section of the valley over which the new peak-to-peak gondola will pass (that is, from point A to point B). Use a vertical scale of 1 cm = 2000 ft.
29. Visit the Whistler Blackcomb website (refer to www.cambridge.edu.au/skillsgeo1weblinks for link) and then complete the following tasks:
    - **a** Locate the resort's weather statistics. Construct a column graph showing the monthly snowfall totals for the most recent season for which complete data are available.
    - **b** Using the resort's weather statistics, construct a line graph showing the average low and high valley temperatures.
    - **c** View the resort's webcams. Use the topographic map extract to locate the positioning of these webcams.

Whistler topographic map extract (Whistler: latitude 49°58′N, longitude 123°09′W)



9.5 Banff, Canada, topographic map extract

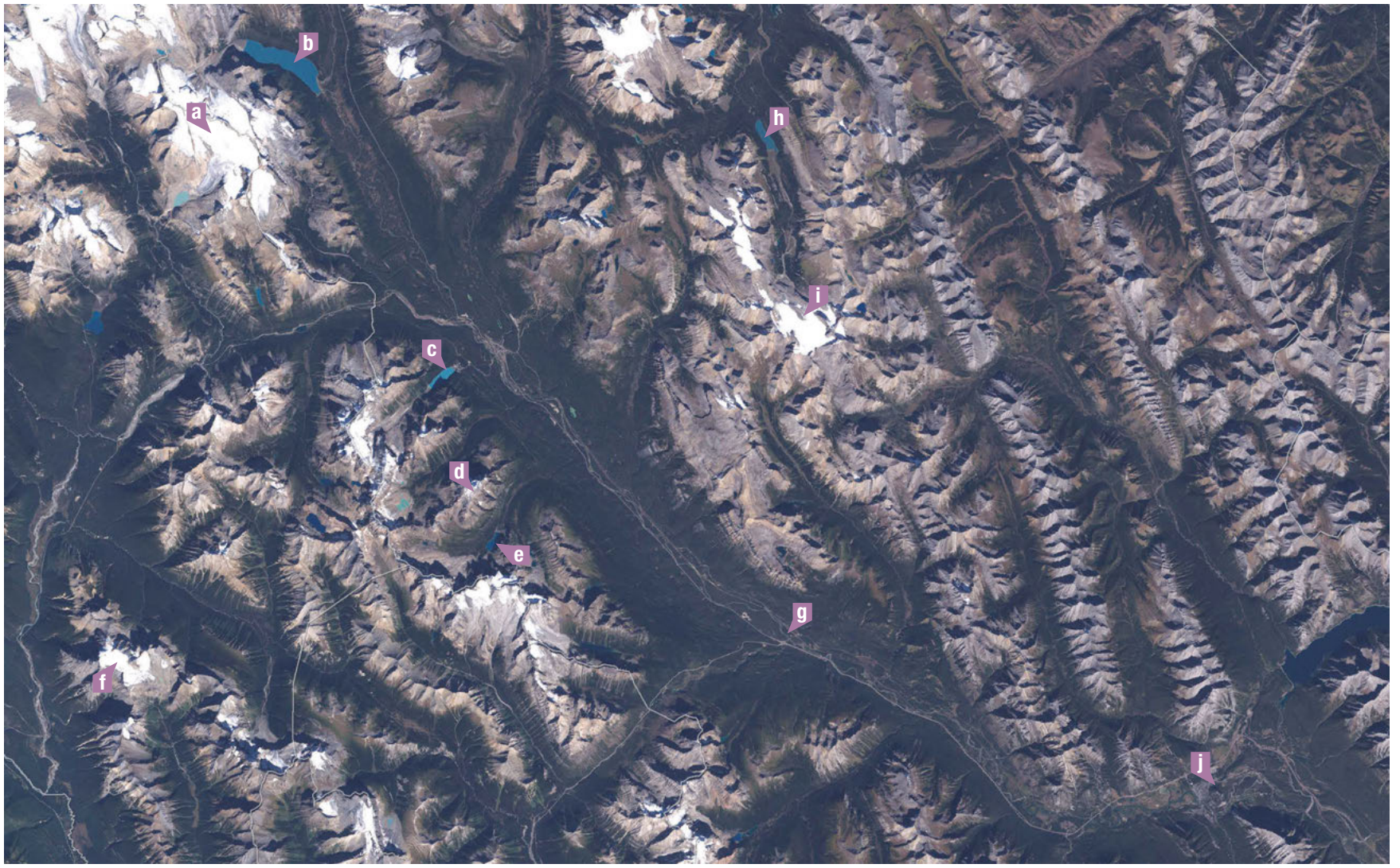
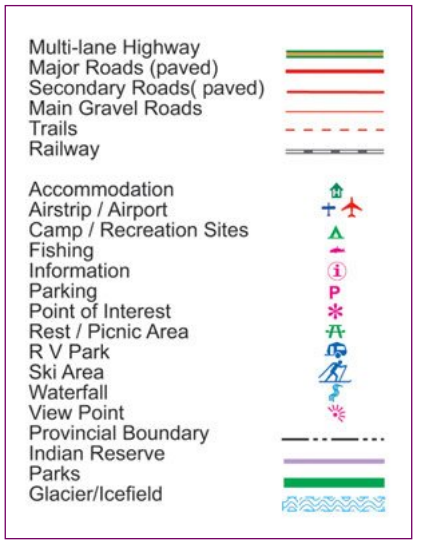


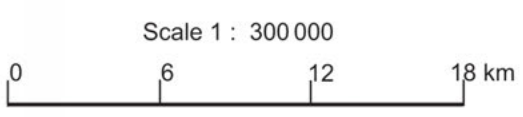
Figure 9.5a Satellite photograph of Banff National Park.

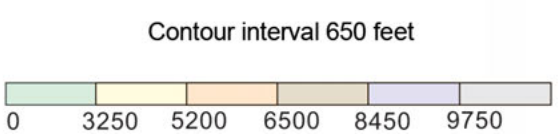
ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Study Figure 9.5a. Identify the features labelled a–j.
4. Identify the feature of the biophysical environment located at:
   - **a** GR 233726
   - **b** GR 267765
   - **c** GR 323717
   - **d** GR 351743.
5. Identify the feature of the constructed environment located at:
   - **a** GR 249723
   - **b** GR 276721
   - **c** GR 313665
   - **d** GR 244721.
6. What is the grid reference of Castle Junction?
7. What biophysical feature is found in AR 3568?
8. What type of recreational land use is found in AR 2872?
9. What is the name of the creek flowing from Kaufmann Lake in AR 2768?
10. What is the name of the tributary that joins the Bow River at GR 327683?
11. What is the direction of Lake Louise (AR 2872) from Banff (AR 3666)?
12. In what direction does Bow River flow in AR 2970?
13. Study Figure 9.5b. In which direction was the camera facing when this photograph was taken?
14. What is the bearing of Mt Brett (AR 3366) from Panther Mountain (AR 3574)?
15. What is the aspect of the slope in AR 3769?
16. What is the straight-line distance from Castle Junction (AR 3168) to Lake Louise (AR 2872)?
17. What is the straight-line distance from the summit of Mt Brett (AR 3366) to the summit of Panther Mountain (AR 3574)?
18. Estimate the area of Bonnet Glacier (AR 3172).
19. Estimate the height of the following landform features:
    - **a** Pulsatilla Mountain (GR 309714)
    - **b** Mt Cory (GR 348674)
    - **c** Lake Louise (GR 274719).
20. Estimate the height of the camping ground at GR 331694.
21. What is the difference in elevation of Mt Brett (AR 3366) and Panther Mountain (AR 3574)?
22. Identify the principal agents of erosion responsible for the landforms featured on the map extract.
23. Describe the relationship between transport and topography on the map extract.
24. Construct a precis map showing the relationship between topography and transport on the map extract.

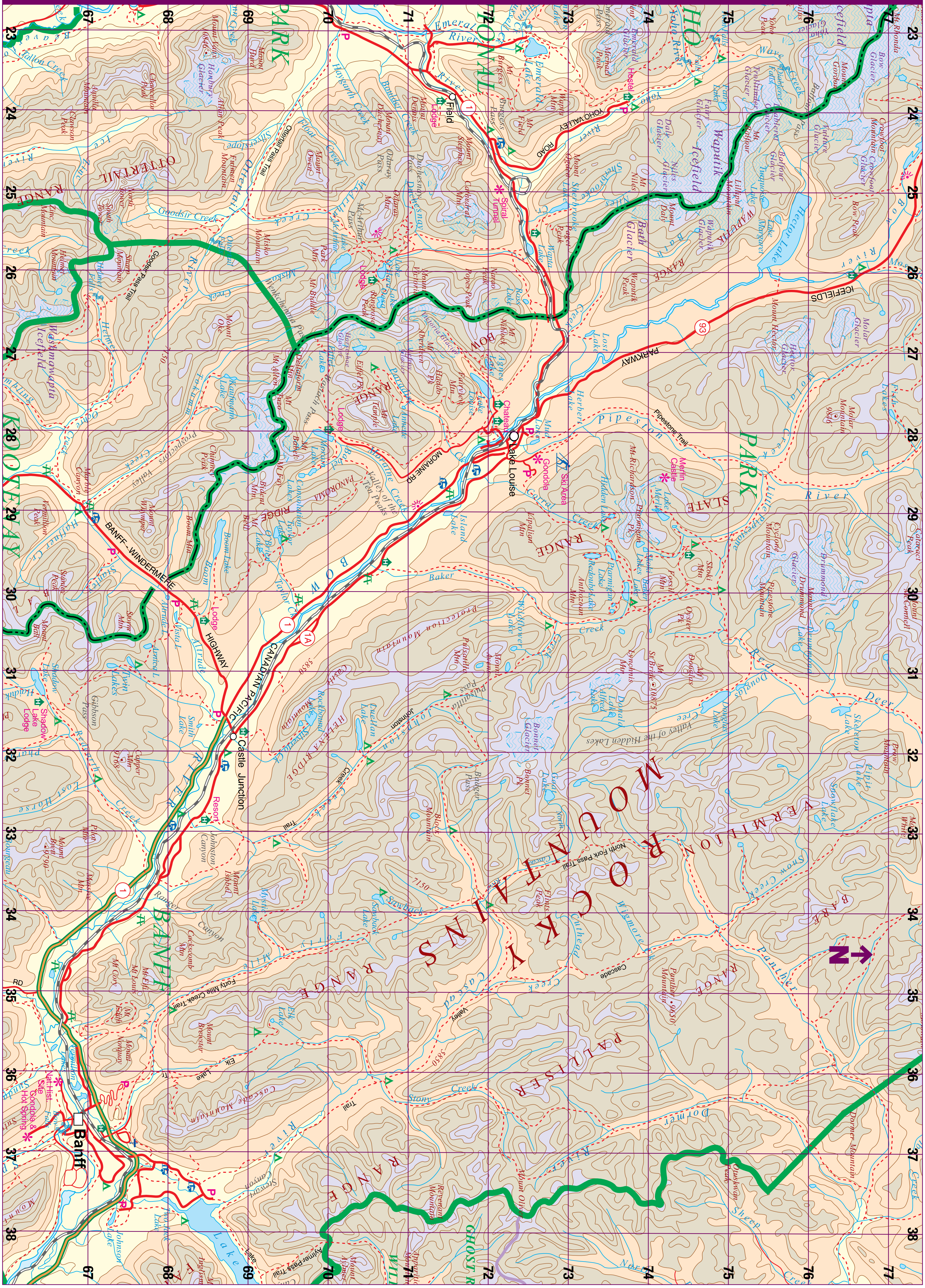
Figure 9.5b Lake Louise and the Chateau Lake Louise.







Banff topographic map extract (Banff: latitude 51°10´N, longitude 115°34´W)



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9.6 Niagara Falls, Canada and USA, topographic map extract

Figure 9.6a Aerial view of Niagara Falls.

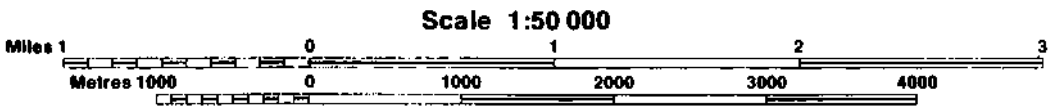
ACTIVITIES

Study the Niagara Falls topographic map extract and complete the following tasks.

1. What is the scale of the Niagara Falls topographic map extract?
2. What is the contour interval of the Niagara Falls map extract?
3. Identify the feature of the biophysical environment located at the following grid references:
   - **a** 569762 **b** 571720
   - **c** 565714 **d** 574717.
4. Identify the feature of the constructed environment located at the following grid references:
   - **a** 527698 **b** 585696
   - **c** 594785 **d** 555730.
5. State the productive activity located in the following area references:
   - **a** 5369 **b** 5482
   - **c** 5669 **d** 5978.
6. Name the three bridges that span the Niagara River.
7. In which nations are the Horseshoe and American Falls located?
8. What is the direction of the Whirlpool (AR 5675) from Navy Island?
9. What is the length of the Queenston–Chippawa power canal from GR 534696 to the generating station located at GR 590793?
10. What is the length of the aerial cableway from GR 571758 to GR 571763?
11. Estimate the area of the reservoir centred on GR 570790.
12. Estimate the area of Navy Island located in the south-east quadrant of the map extract.
13. What is the bearing of Niagara Falls City Hall (GR 575744) from the senior citizens home located at GR 539717?
14. Describe the settlement pattern in the north-west quadrant of the Niagara Falls map extract.
15. Describe the pattern of tourist-related facilities along State Highway 20 in the south-west quadrant of the map extract.
16. Describe the features of the Niagara Falls river channel from American Falls and Horseshoe Falls to GR 588803.
17. What evidence is there that Niagara Falls is a major centre of industrial production?
18. List the range of goods produced by industries in the area covered by the map extract.
19. Describe the extent to which people have modified the water cycle in the area covered by the Niagara Falls map extract.

Study Figure 9.6a and complete the following task.

20. In what direction was the camera facing when the photograph was taken?

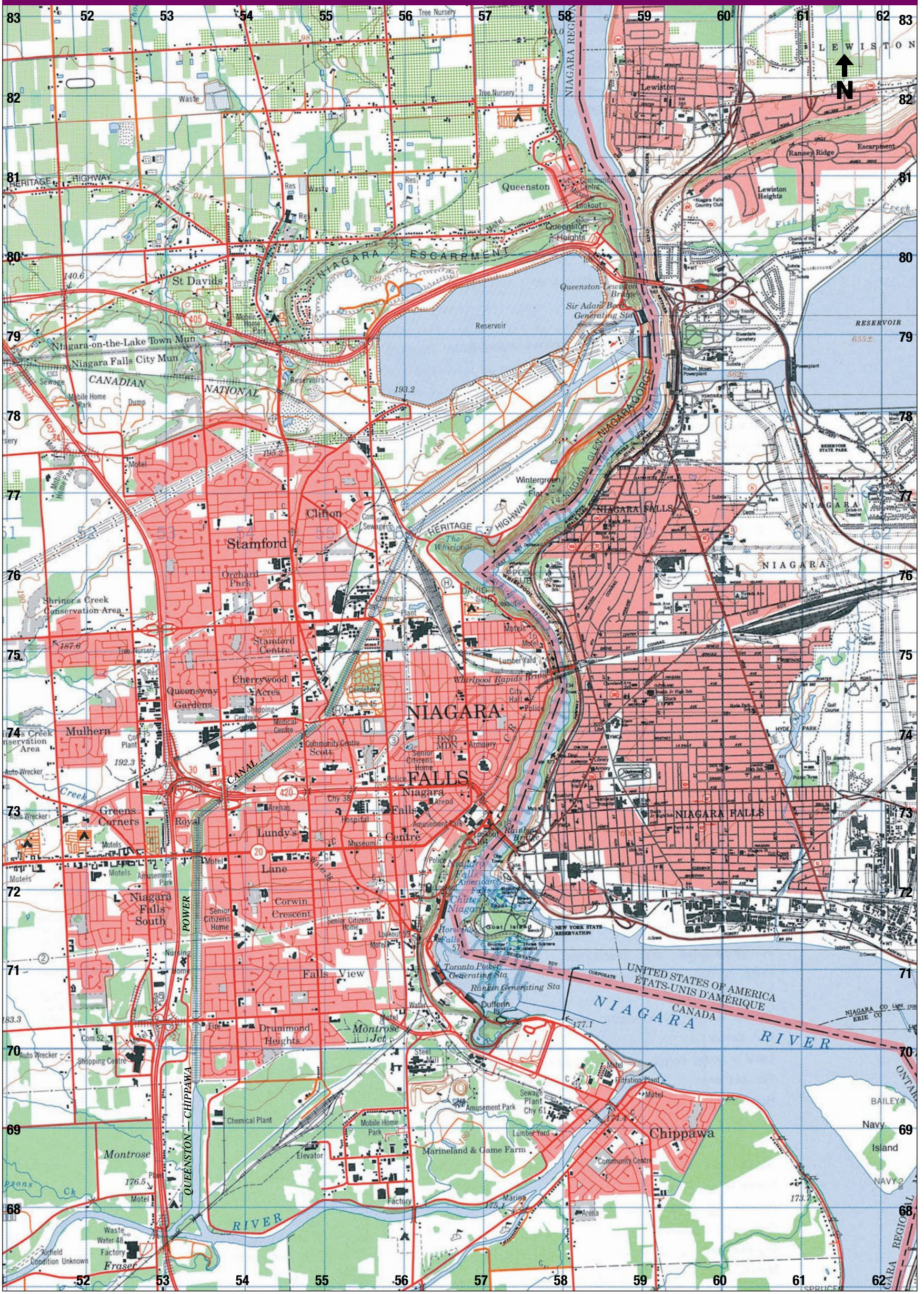


CONTOUR INTERVAL 10 METRES IN CANADA
Elevation in Metres above Mean Sea Level
CONTOUR INTERVAL 25 FEET IN USA

Figure 9.6b Niagara Falls from the US side.

Figure 9.6c Niagara Falls from the Canadian side.

Niagara Falls topographic map extract (Niagara Falls: latitude 43°05'N, longitude 79°00'E)



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9.7 Yosemite, USA, topographic map extract

Located in California's Sierra Nevada Mountains, Yosemite Valley is one of North America's most famous scenic attractions. Its towering cliff faces, massive granite domes and spectacular waterfalls are the result of both fluvial and glacial processes. Yosemite National Park was established in 1890.

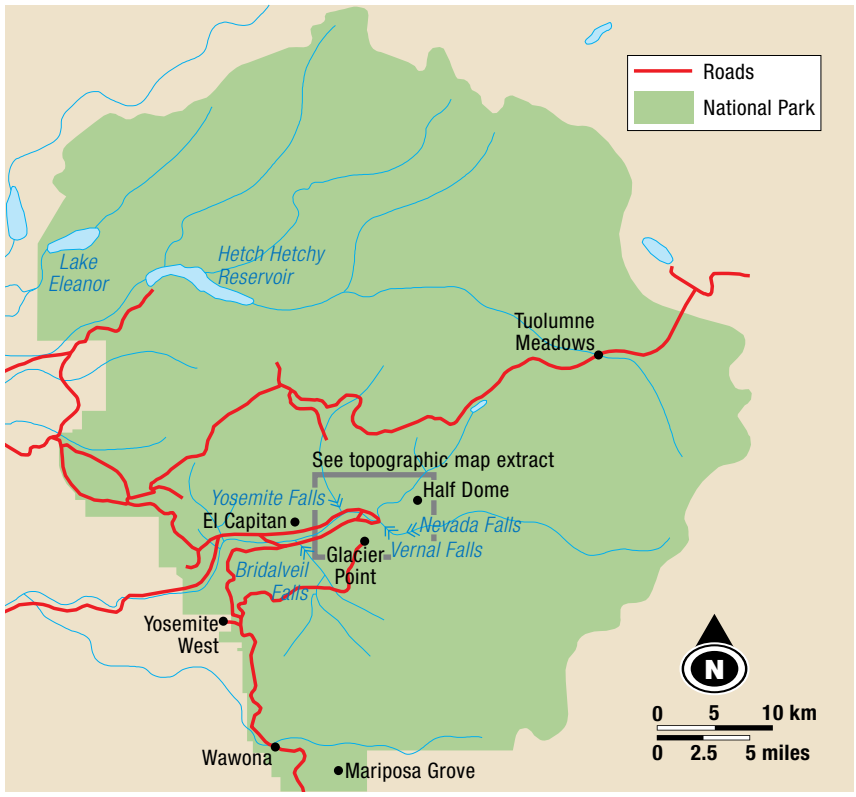


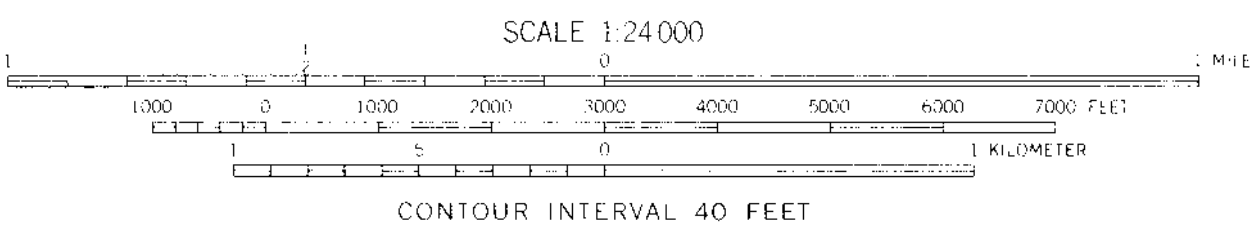
Figure 9.7a Location of key features in Yosemite National Park.

Figure 9.7b Oblique aerial image of Yosemite National Park.

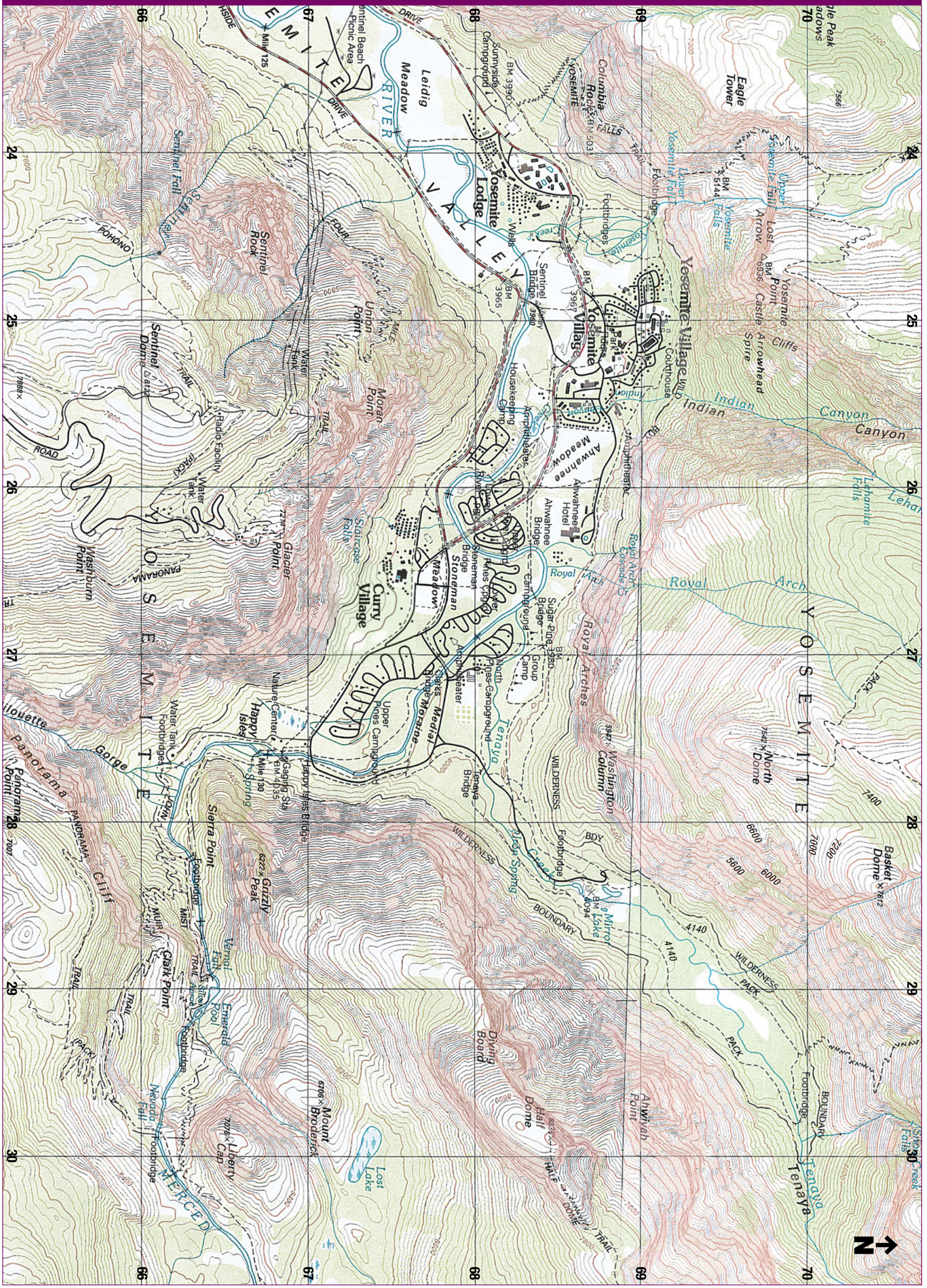
Figure 9.7c Yosemite National Park.

ACTIVITIES

1. What is the scale of the map extract?
2. What is the contour interval used on the map extract?
3. Identify the features of the biophysical environment located at:
   - **a** GR 276688
   - **b** GR 285688
   - **c** GR 243694
   - **d** GR 253660
   - **e** GR 298662
   - **f** GR 272687
   - **g** GR 264668
   - **h** GR 247698.
4. Identify the features of the constructed environment located at:
   - **a** GR 263686
   - **b** GR 269679
   - **c** GR 255665
   - **d** GR 282663.
5. What is the area reference of the Yosemite Lodge?
6. What is the land use in AR 2367?
7. On what creek is the Royal Arch Cascade (AR 2668) located?
8. What creek flows into the Merced River at GR 245682?
9. Name the tributary that joins the Merced River at GR 267683.
10. In what direction is Sentinel Creek flowing in AR 2466?
11. What is the direction of:
    - **a** Glacier Point (AR 2666) from Yosemite Point (AR 2469)
    - **b** North Dome (AR 2769) from Half Dome (AR 2968)?
12. What is the bearing of:
    - **a** Glacier Point (AR 2666) from Yosemite Point (AR 2469)
    - **b** Grizzly Peak (AR 2866) from the summit of Mt Broderick (AR 2967)?
13. Estimate the straight-line distance, in miles, between:
    - **a** the summits of Half Dome (GR 298683) and North Dome (GR 275697)
    - **b** Yosemite Point and Glacier Point.
14. What is the elevation of:
    - **a** Lost Lake
    - **b** Half Dome (AR 2968)?
15. What is the difference in elevation between Mt Broderick (AR 2967) and Liberty Cap (AR 2966)?
16. What is the local relief experienced on a traverse from Grizzly Peak (AR 2866) to North Dome (AR 2769) via Iron Spring?
17. Complete the cross-section from the summit of North Dome to Mirror lake using a vertical scale of 1 cm = 1000 ft.
18. Study Figure 9.7b, which is an illustration based on a photo of Yosemite Valley. State the direction in which the photographer was facing when the photo was taken.
19. Name the features labelled a–f on Figure 9.7b. Locate these features on the map extract and describe their location using area references.
20. Construct a photo sketch of Figure 9.7c. Label any landform features you can identify.
21. Undertake research to investigate the geographical processes responsible for the landform features you drew in Activity 20.
22. View additional photographs of Yosemite National Park at the following websites:
    - YosemiteFun.com (refer to www.cambridge.edu.au/skillsgeo1weblinks)
    - Terragalleria.com (refer to www.cambridge.edu.au/skillsgeo1weblinks).
23. Use Google Earth to explore Yosemite National Park.



Yosemite Valley topographic map extract (Yosemite: latitude 37°45′N, longitude 119°35′W)



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