



SKILLS IN GEOGRAPHY

Second
Edition

GRANT KLEEMAN

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Skills in Geography Second Edition has been prepared for Australian students studying Geography in Years 7–10.

Featuring more than 400 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 the geographical themes addressed in Years 7–10.

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: Key skills in geography** provides a comprehensive coverage of the geography tools and skills students are expected to master in 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: Key themes in geography** provides students with a skill-based approach to the themes addressed in Geography Years 7–10. The themes addressed are landscapes and landforms, place and liveability, water and the world, interconnections, sustainable biomes, changing places, environmental change and management, and human wellbeing.
- **Section Three: Australia** provides students with the opportunity to apply their geography skills. It includes 23 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 section is a focus on Gallipoli, a place that is special to many Australians.
- **Section Four: 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 Five: South America** features three topographic map extracts focusing on mountain landscapes. It includes a special focus on Machu Picchu, the internationally famous World Heritage site and the spectacular Cordillera Huayhuash. This section of the text also features an activity based on the interpretation of satellite photographs.
- **Section Six: United Kingdom** features eight topographic map extracts highlighting the country's diverse urban and biophysical landscapes.
- **Section Seven: North America** includes seven topographic map extracts and associated activities focusing on mountain and river landscapes.

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.

For a list of links to all the websites referred to in this book, go to www.cambridge.edu.au/skillsgeo2weblinks

Grant Kleeman



About the author

Grant Kleeman is one of Australia's leading geography educators. 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 25 years, and is currently a director and immediate past Chairperson of the Australian Geography Teachers Association (AGTA) and Vice President of the Geography Teachers' Association of NSW (GTA NSW). In 2007, the Geographical Society of NSW and the GTA NSW awarded Grant the McDonald Holmes Medal for his 'Distinguished contribution to Geographical Education in Australia'. Grant is a Fellow of Macquarie University, the Royal Geographical Society and the GTA NSW.

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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 km²

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

hydrological hazard hazardous events originating in the hydrosphere; linked to changes to the water cycle (e.g. floods and droughts)

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 provides 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

wellbeing the quality of life experienced by people

SECTION 1

Key skills in geography

1.1

Maps

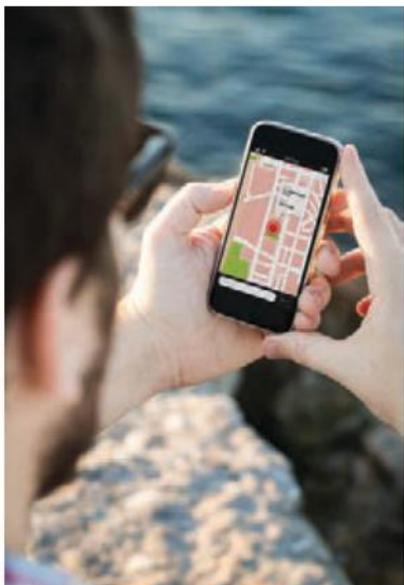


Figure 1.1a Maps – you would be lost without them.

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.

Map essentials

Map essentials usually include a title, direction indicator, scale, legend, border and an indication of latitude and longitude. (See Figure 1.1b.) When drawing your own maps make sure that you include each of these map essentials.

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.

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.

Topographic map of Blue Lake



Figure 1.1b Map essentials

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 1.1c Physical map showing selected features of the physical environment of south-eastern Australia. 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 south-eastern Australia. Political maps show different political units (for example, countries and states), including their borders and capital cities.

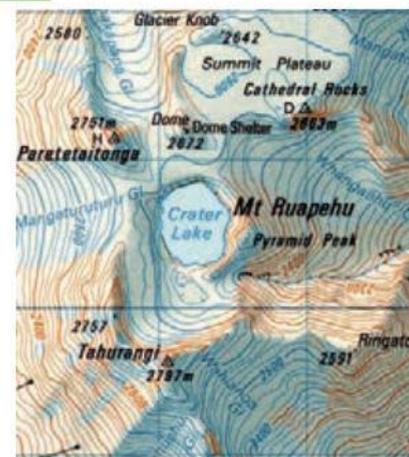


Figure 1.1e Extract from the topographic map sheet for Mt Ruapehu, New Zealand. A topographic map is a detailed, large-scale map of part of the Earth's surface, showing selected features of the biophysical, managed and constructed environments. It shows the height, relief and slope of the land; drainage 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 biophysical, managed and constructed environments, describe distributions and patterns, and identify relationships between features.

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, temperature, 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 20–21.)

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 (see Unit 1.2, pages 4–5) and the contour interval used (see Unit 1.5, pages 10–12). When working with maps always check these details. Never assume that the cartographer has used a particular scale or contour interval.

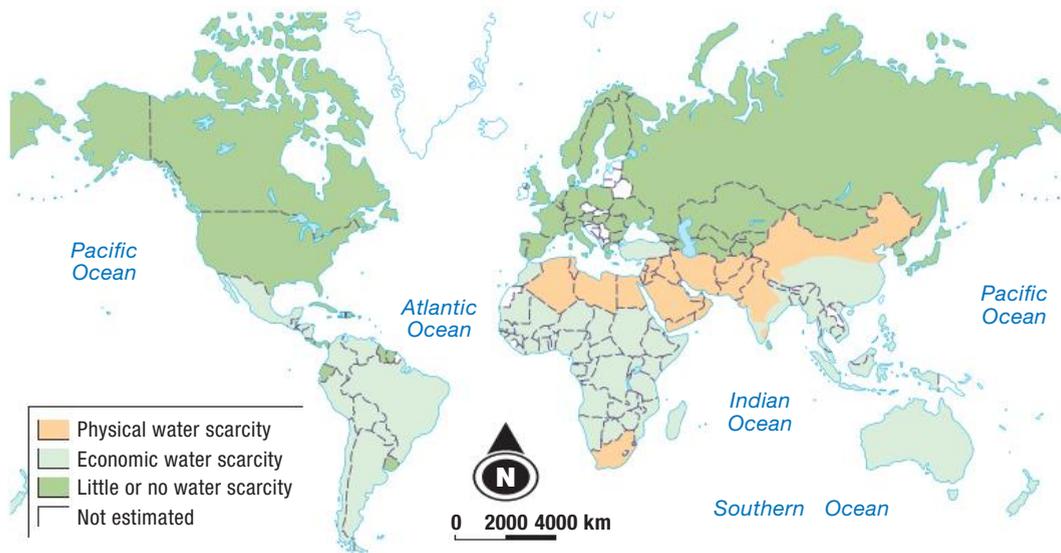


Figure 1.1f Thematic map showing projected water scarcity, 2025. A thematic map illustrates a particular theme or issue. Thematic maps may be used to show the distribution of one or more of the following: climate, vegetation types, average rainfall, average temperature, various development indicators,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

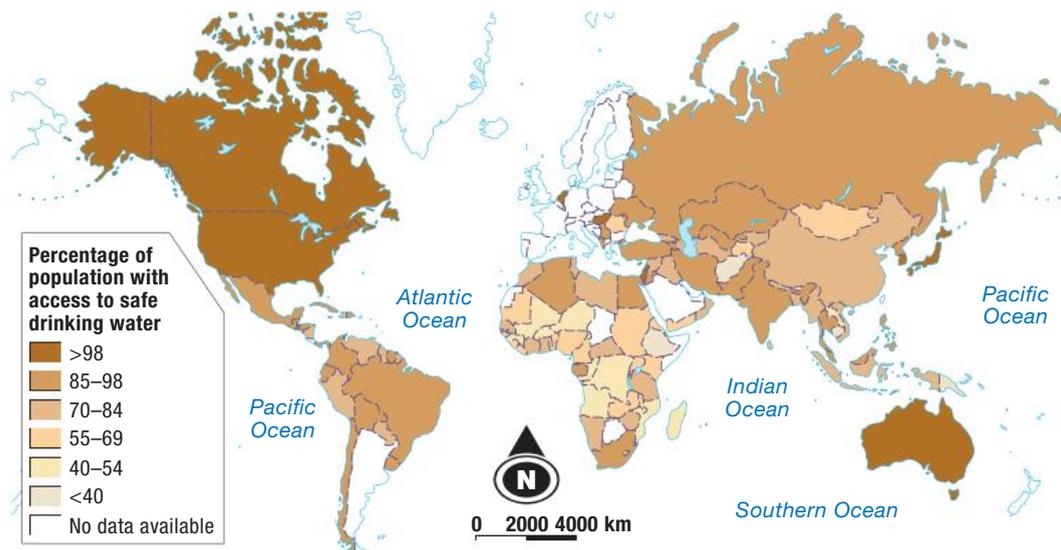


Figure 1.1g Choropleth map showing access to safe drinking water, 2015. Choropleth maps are often used to show thematic material. They use different shades of the one colour to show a pattern. The darker shades show the highest values and the lighter shades show the lowest values.

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 maps in Units 3.2 and 3.3 (pages 80 and 82) 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.

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 and 21–30.
- 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.

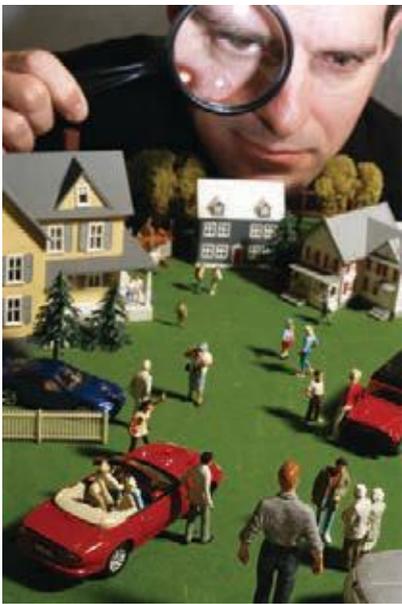


Figure 1.2a 'I've been scaled!'

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



Figure 1.2b Linear scale

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 the Camden Haven area. At a scale of 1:100 000 (top map) we can see all of the Camden Haven township. At a scale of 1:25 000 (bottom map) only part of the township can be seen.

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, which will work for both print and digital documents.

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.)

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.)

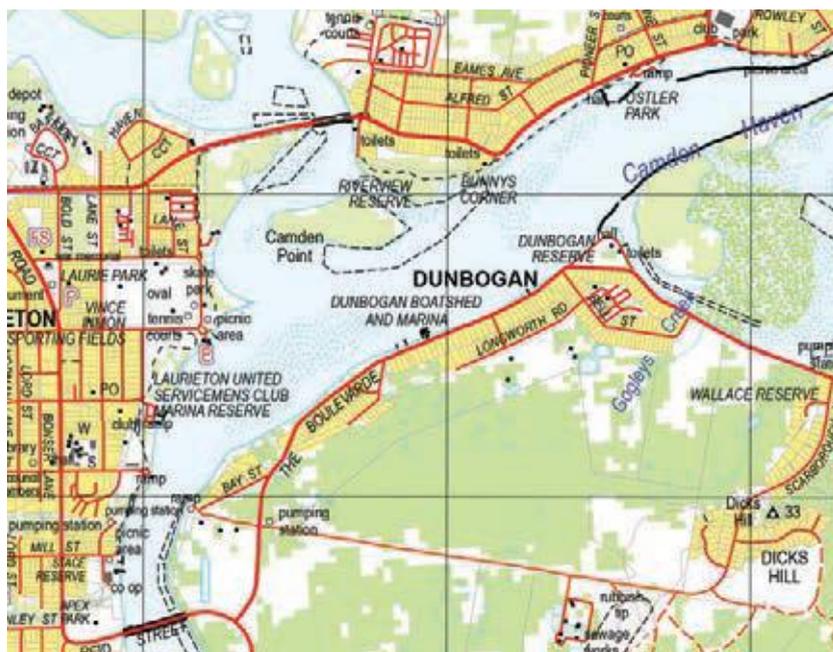


Figure 1.2c Different scales can show different levels of detail. The top map is drawn at a scale of 1:100 000 and the bottom map at 1:25 000.

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 × 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 to map Australia.

MAPS IN DIGITAL DOCUMENTS

If you are using a print map, you can use a ruler to measure distance, and then do a mathematical calculation, using the scale statement or ratio, to calculate the real-world size.

However, if you are looking at a map in a digital document (for example, if you are using the PDF version of this textbook) you will be able to zoom or shrink the map display so that the statement or ratio no longer applies. The amount of area covered in measurements of 1 cm will vary

depending on how much you have zoomed in on the display.

Therefore, if you are using a digital document, you should only use the linear scale when working out distances on the map. The linear scale on the map will shrink and grow in the same proportion as the map when you zoom in or out of the page.

Most maps will include a linear scale in addition to, or in place of, a statement or ratio.



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

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 1.2g.)

Example

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

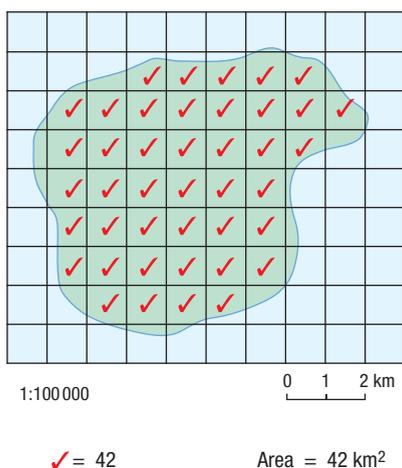


Figure 1.2g Estimating area

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 1.2h.) Answers should be expressed in terms of the number of features per square kilometre.

Example

The density of buildings in AR 2736 is $7/\text{km}^2$.

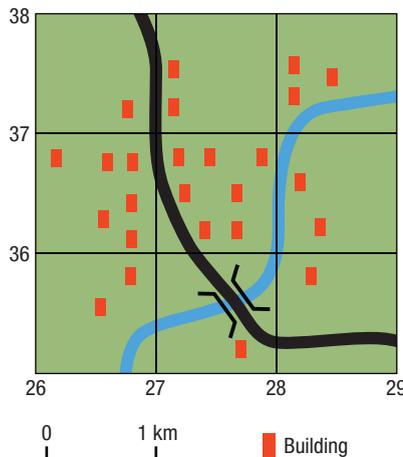


Figure 1.2h Calculating density



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

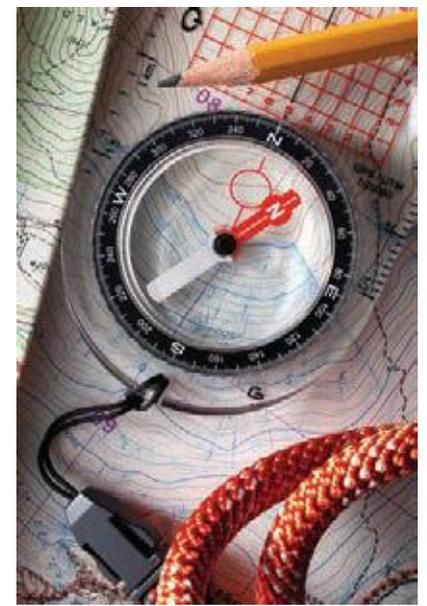


Figure 1.2f Don't get lost!

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.

Divide 60 (minutes) by 80 (speed in km/h).
 $= 0.75$ of a minute (that is, 45 seconds)

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 .

- 2 Multiply the time taken to travel 1 km by the distance to be travelled.

$= 0.75 \times 30 \text{ km}$

$= 22.5 \text{ minutes}$

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	$\frac{1}{50000}$ or 1:50 000	
c		0 1 2 km

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



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



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 and direction 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 1.3b.) Using the grid is easy. For example, on the map shown in Figure 1.3b, 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 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 1.3d.) 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

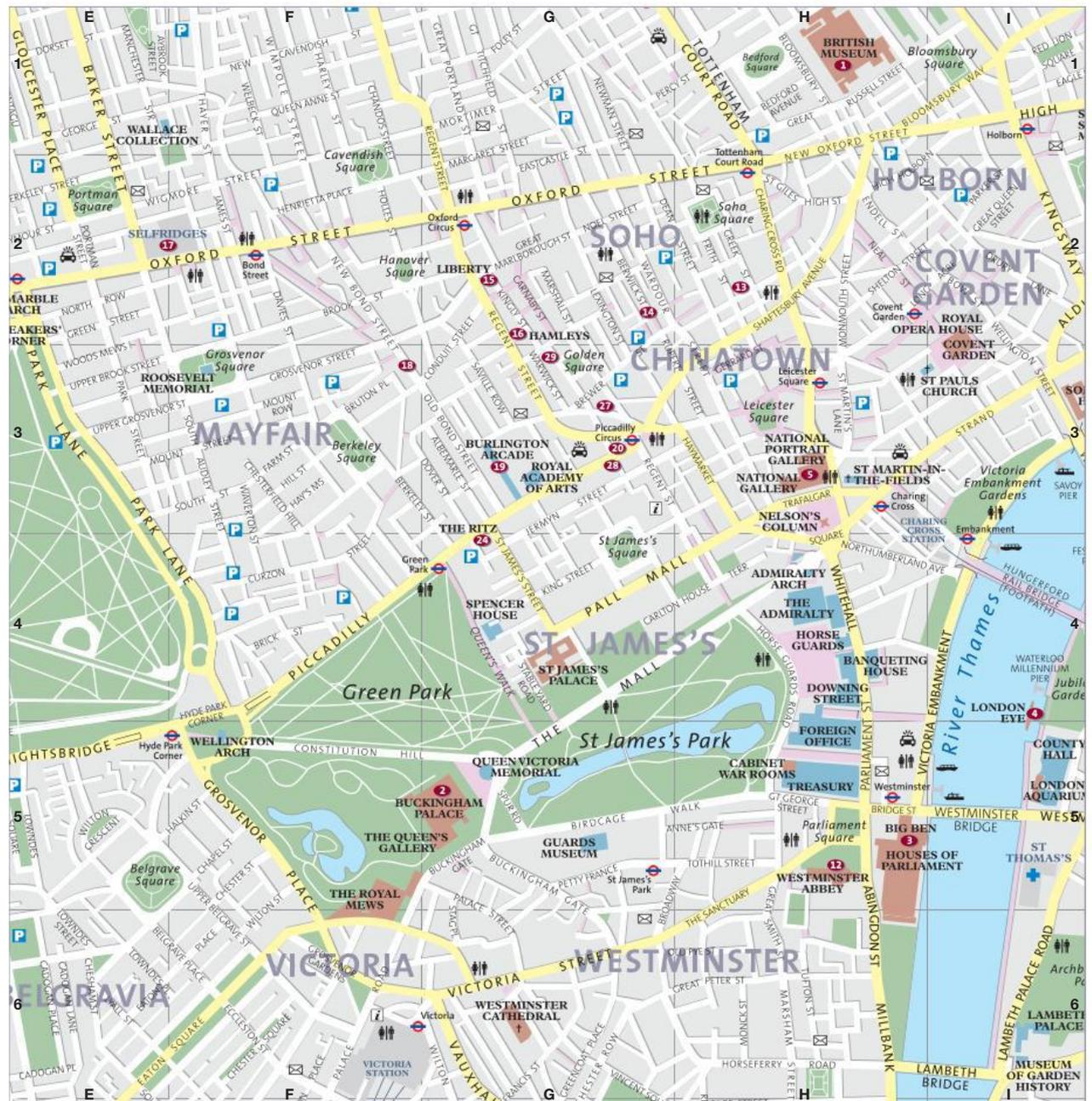


Figure 1.3b Extract from a London street directory

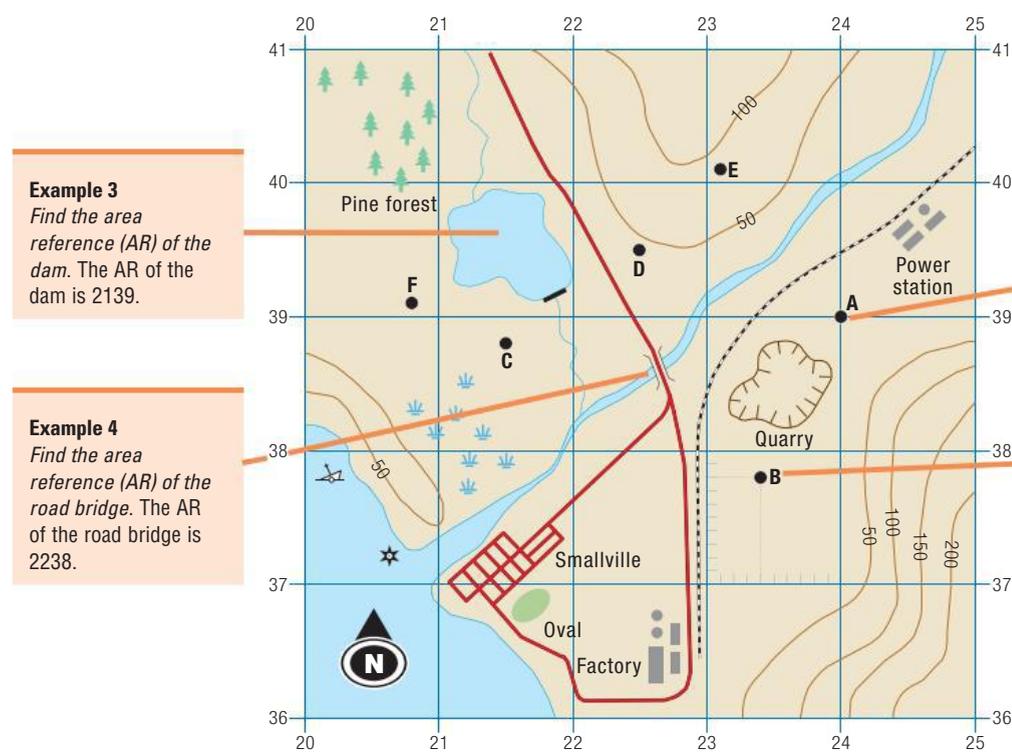


Figure 1.3c Grid reference example

Example 1

Find the grid reference (GR) for point A. Point A is located exactly on the intersection of easting 24 and northing 39. The easting is, therefore, 240 (24 and no tenths towards 25). The northing is 390 (39 and no tenths towards 40). The GR of point A is expressed as 240390.

Example 2

Find the grid reference (GR) of point B. Point B is located four-tenths of the way between eastings 23 and 24. The easting is, therefore, 234 (23 and 4 tenths towards 24). The northing is approximately eight-tenths of the way between northings 37 and 38; therefore, it is 378. The GR of point B is expressed as 234378.

Example 3
Find the area reference (AR) of the dam. The AR of the dam is 2139.

Example 4
Find the area reference (AR) of the road bridge. The AR of the road bridge is 2238.

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 1.3c.) 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

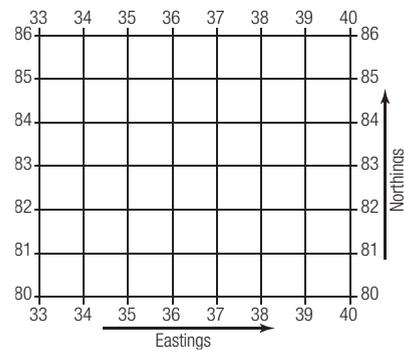


Figure 1.3d Grid lines

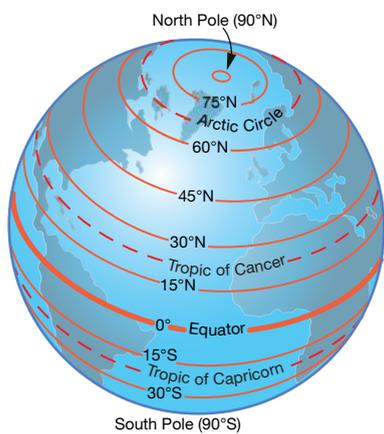


Figure 1.3e Parallels of latitude

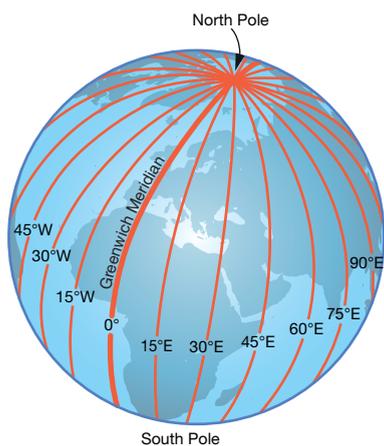


Figure 1.3f Meridians of longitude



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

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*.

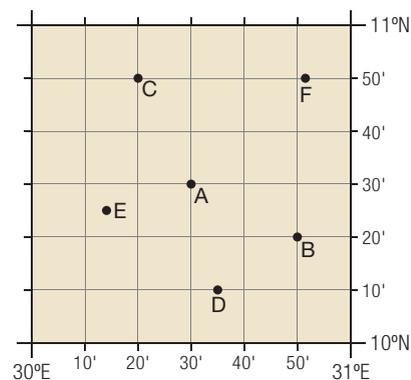


Figure 1.3h A latitude and longitude grid showing minutes

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.)

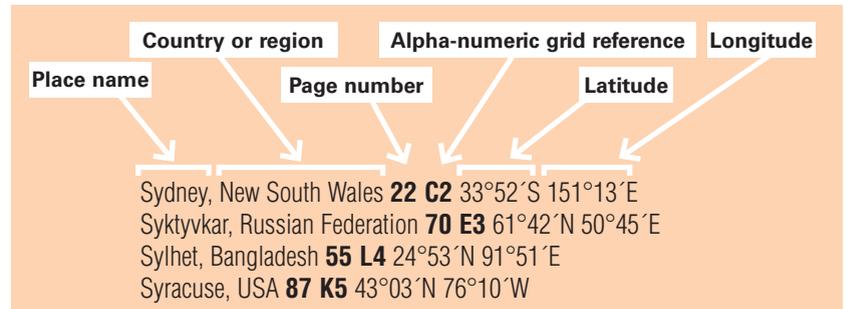


Figure 1.3i Extract from the index of an atlas

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 1.3b 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.
- 5 Identify the circumstances in which area references are used instead of grid references.
- 6 Study Figure 1.3c 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.

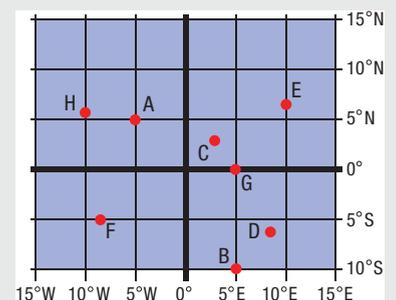


Table 1.3a Latitude and longitude of selected landform features

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 Mt McKinley, North America	
i Niagara Falls, North America	
j	79°04'S 86°21'W

Direction

Direction is important because, together with distance, 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

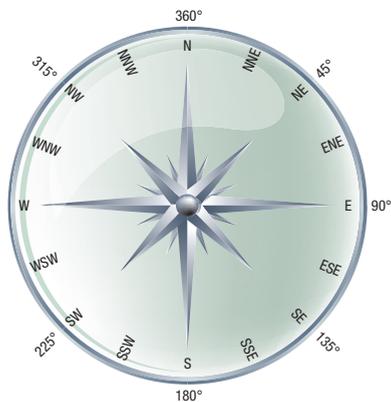


Figure 1.4a The 16 points of the compass

these points to describe the direction of one place or feature in relation to another. Figure 1.4a 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, and so that one set of grid lines runs north–south. Just to make sure, check the direction arrow, which is usually located near the legend.



Figure 1.4b A compass helps us navigate with a map.

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.)

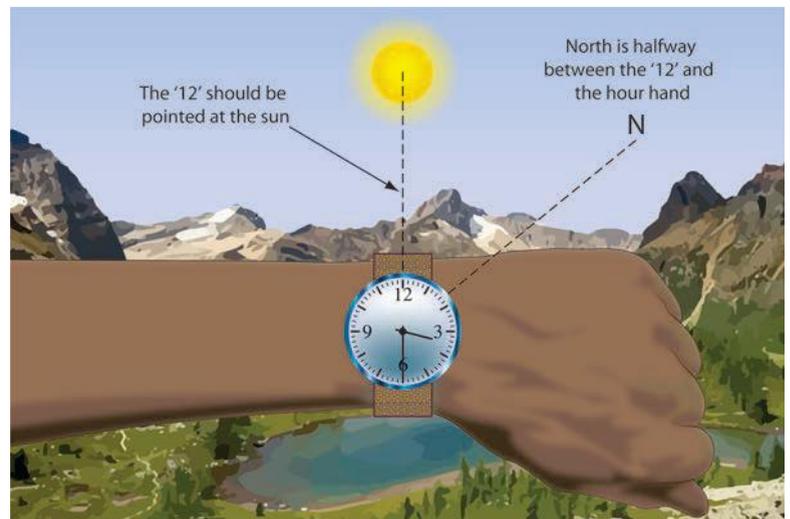


Figure 1.4d Finding north with the aid of a watch

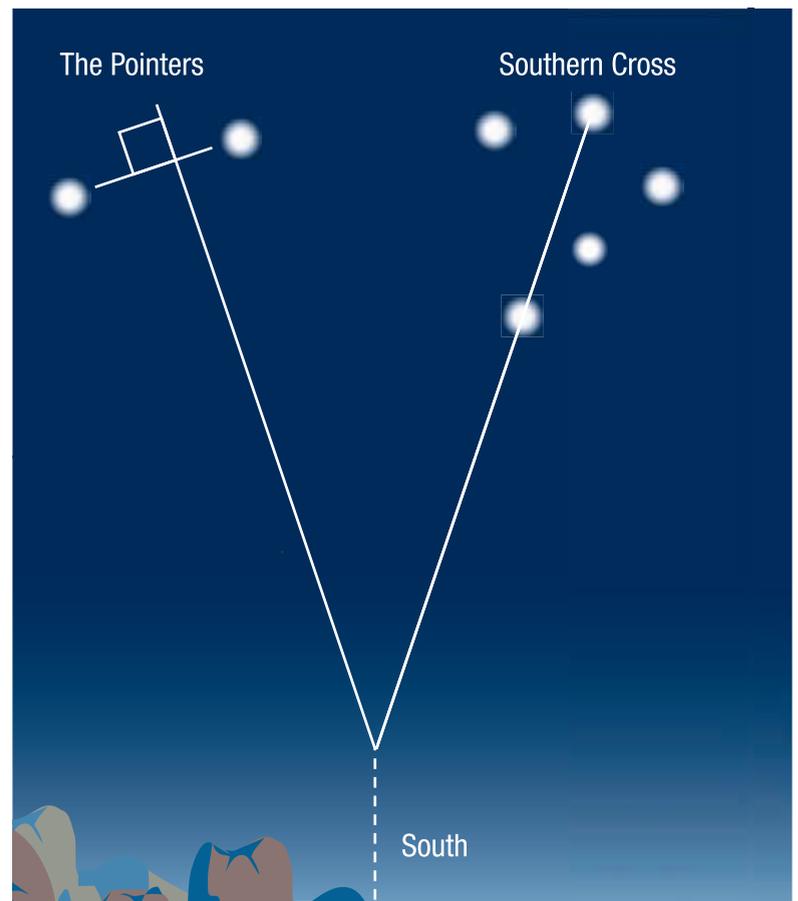


Figure 1.4e Finding direction at night

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.

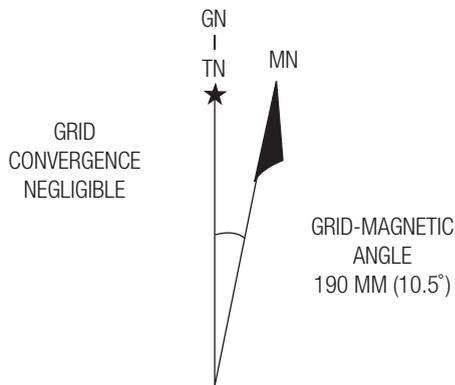
LOCATING NORTH ON TOPOGRAPHIC MAPS

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 changes 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.)



TRUE NORTH, GRID NORTH AND MAGNETIC NORTH ARE SHOWN DIAGRAMMATICALLY FOR THE CENTRE OF THIS MAP. MAGNETIC NORTH IS CORRECT FOR 1980 AND MOVES EASTERLY BY 2 MM (0.1°) IN ABOUT TWO YEARS. TO CONVERT A MAGNETIC BEARING TO A GRID BEARING ADD GRID-MAGNETIC ANGLE.

Figure 1.4f Direction indicator from an Australian topographic map sheet

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°.

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 centre point of 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.

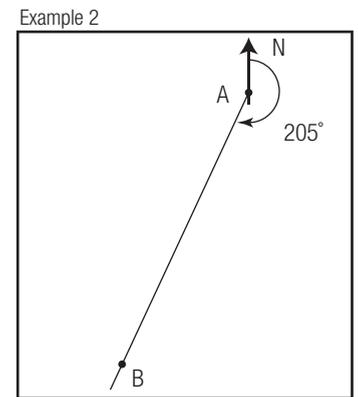
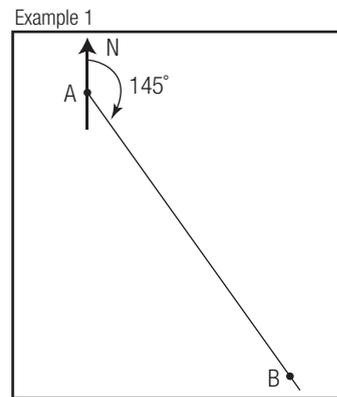


Figure 1.4h Finding bearings

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.

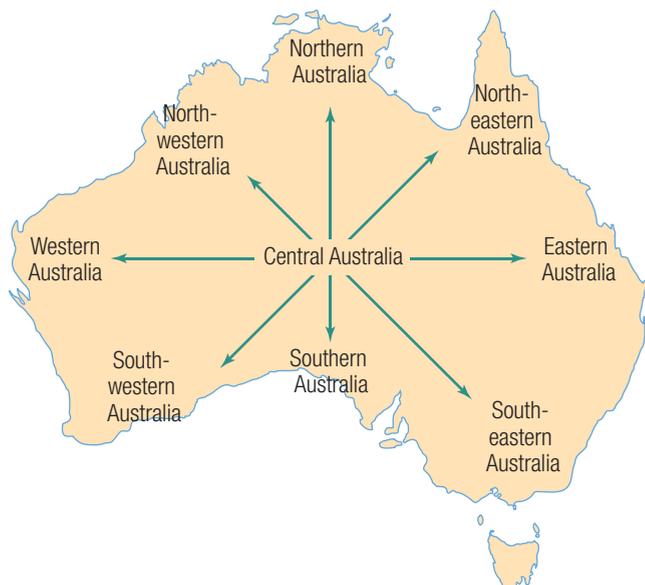


Figure 1.4g The compass points can be used to describe and locate regions of Australia.

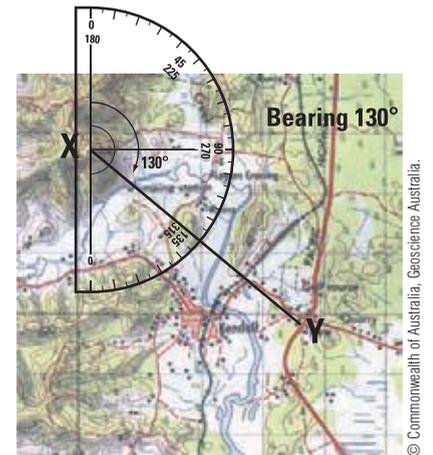


Figure 1.4i Using a protractor to determine the bearing of point Y from point X

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.

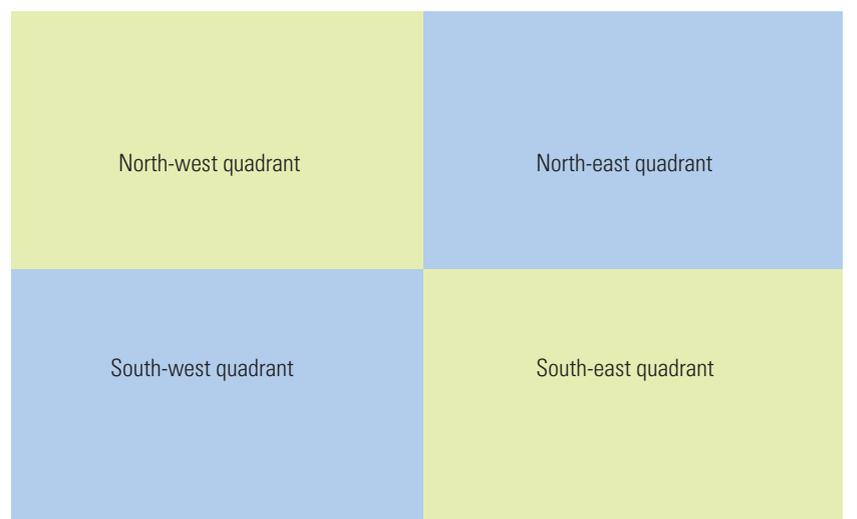


Figure 1.4j The quadrants of a map

ACTIVITIES

- 6 State why geographers use bearings. Explain how bearings are calculated.
- 7 Explain what is meant by the term 'quadrant'.





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.)

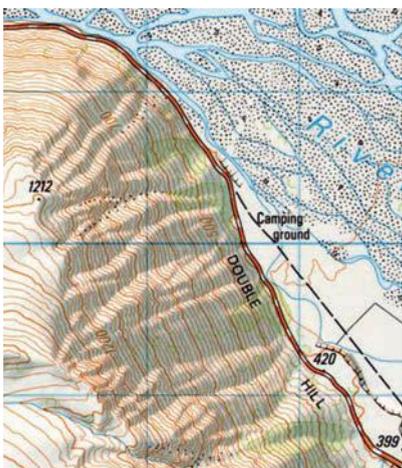


Figure 1.5b Shading on Lake Coleridge topographic map extract. Shading creates a three-dimensional visual effect.

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.)

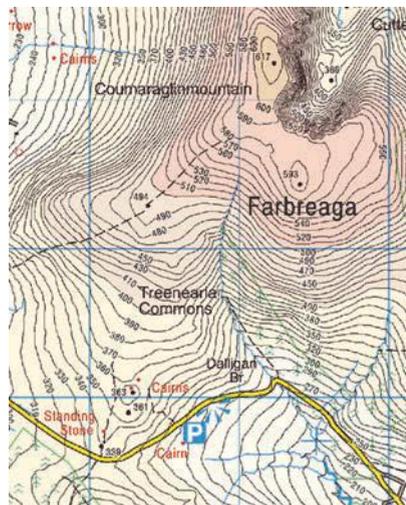


Figure 1.5c Colour layering on Dungarvan topographic map extract © Crown Copyright 2013 Ordnance Survey licence number 100043500

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 *bathotherms*). 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.

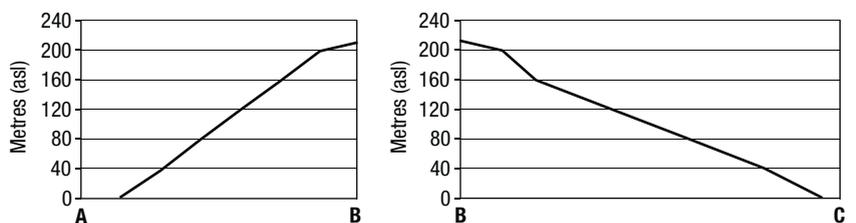
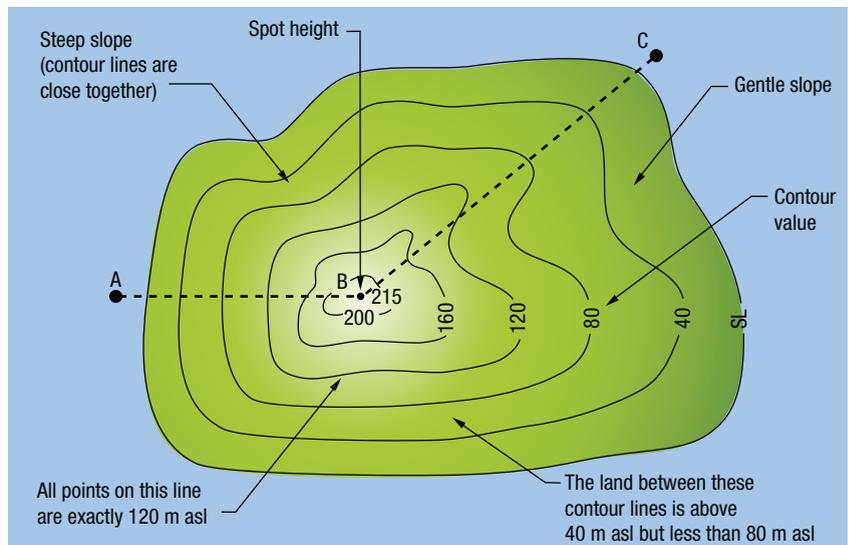


Figure 1.5d Features of a contour line. The cross-sections A-B and B-C show the shape and steepness of selected slopes.

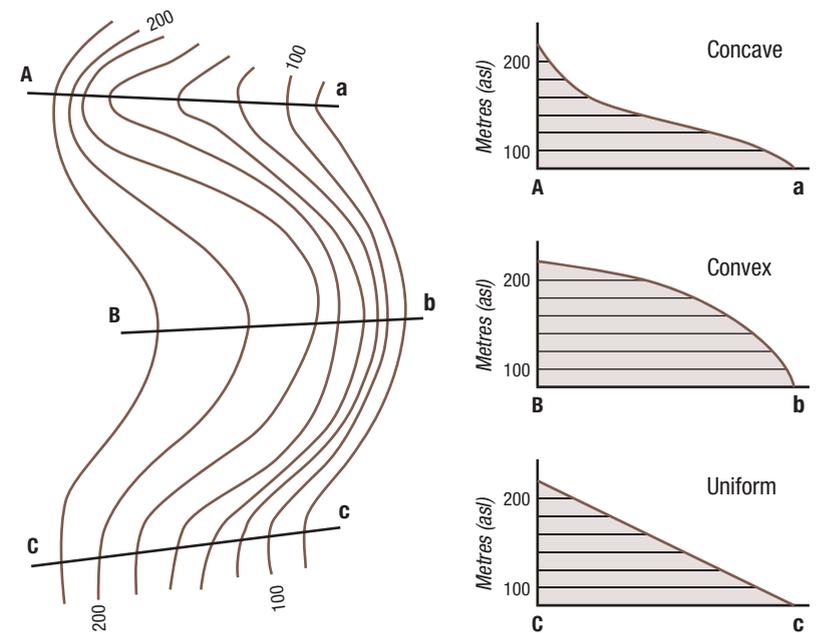


Figure 1.5e Contour patterns and the shape of slopes

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

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.

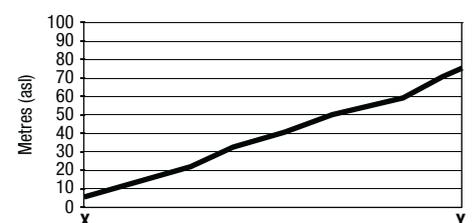


Figure 1.5f Determining aspect

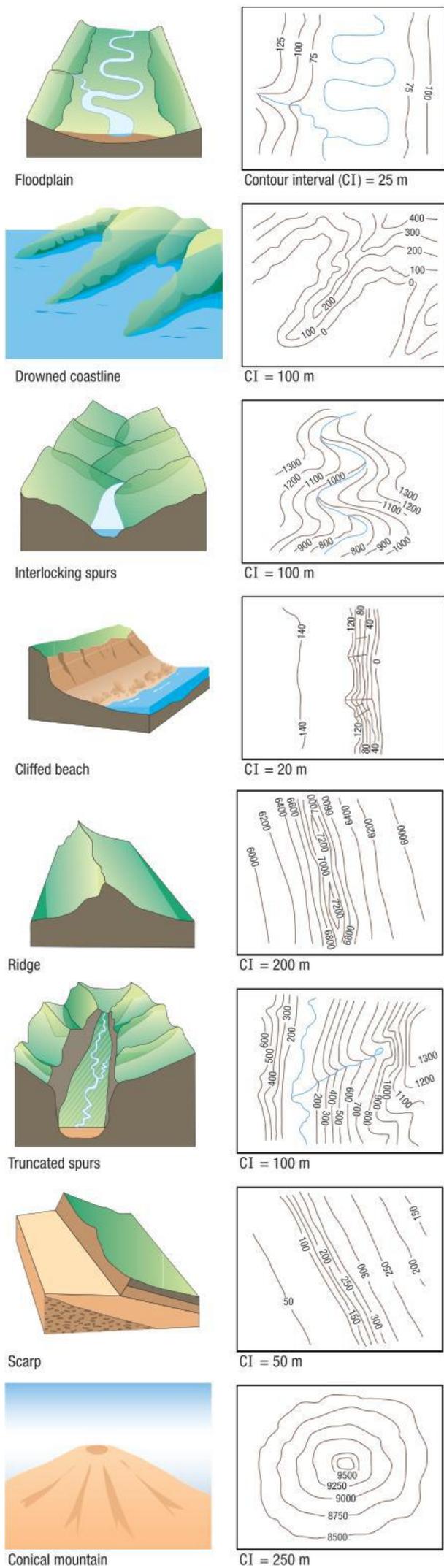


Figure 1.5g Common landform features and their contour patterns

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 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'.

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).

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'.

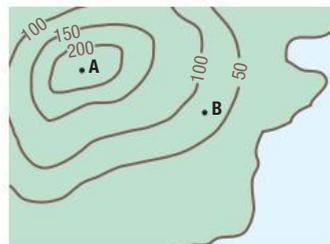


Figure 1.5h Contour sketch

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.

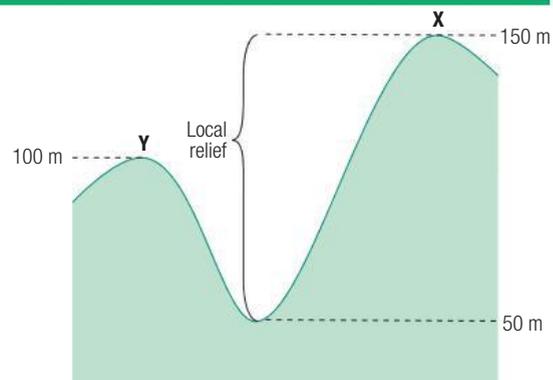
Example

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

$$150 \text{ m} - 50 \text{ m} = 100 \text{ m}$$

(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



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.

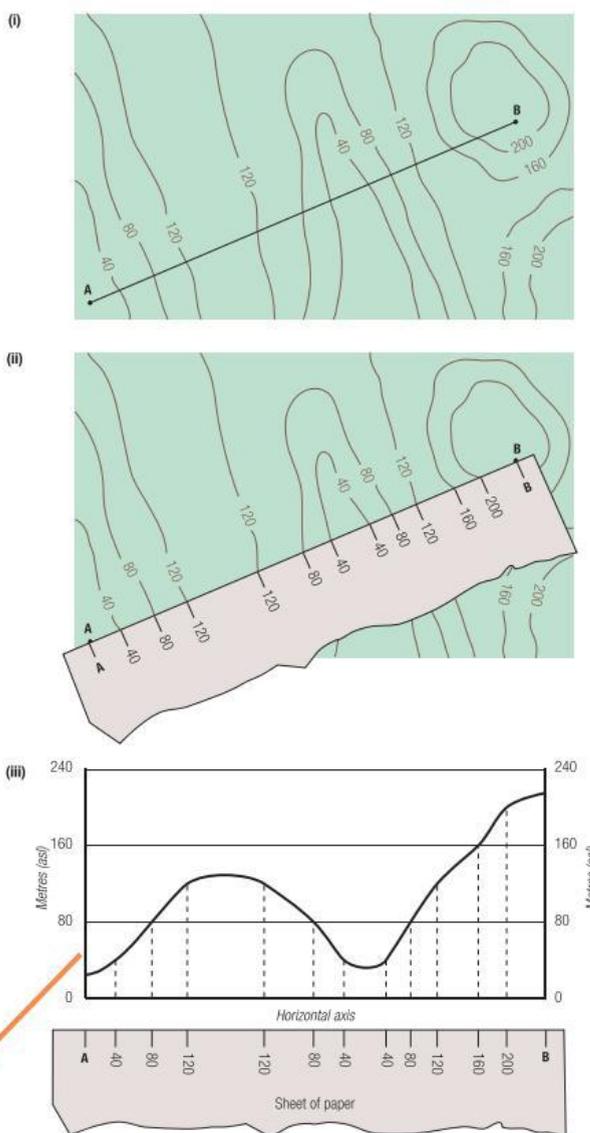


Figure 1.5j Steps in drawing a cross-section

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.

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

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

$$\begin{aligned} &= \frac{1 \text{ cm represents } 80 \text{ m}}{1 \text{ cm represents } 1000 \text{ m}} \\ &= \frac{1}{\frac{80}{1000}} \end{aligned}$$

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 two 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.

Example

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

$$\begin{aligned} \text{Gradient} &= \frac{\text{Vertical interval (rise)}}{\text{Horizontal distance (run)}} \\ &= \frac{70}{4500 \text{ m}} \\ &= \frac{7 \text{ (numerator)}}{450 \text{ (denominator)}} \\ &= 1 \text{ in } 64 \text{ or } 1:64 \end{aligned}$$

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.

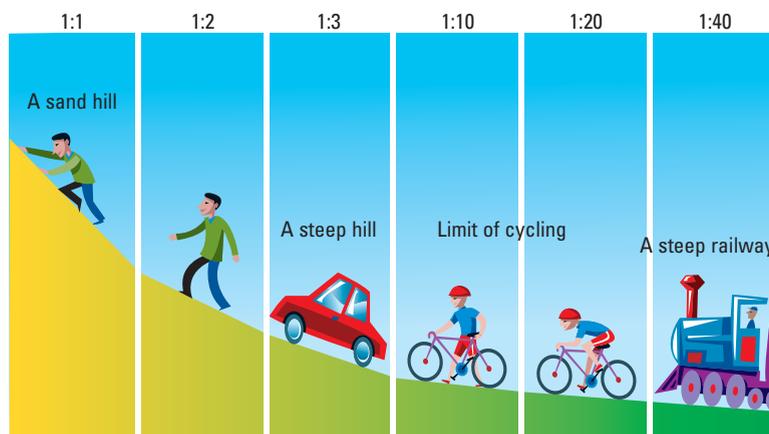


Figure 1.5k Gradients

ACTIVITIES

- Explain what is meant by the term 'relief'.
 - Identify the technique used to show relief on maps.
 - State what contour lines represent.
 - Explain what the interpretation of contour lines tells us about relief.
 - Explain what is meant by the term 'contour interval'.
 - Explain what is meant by the term 'local relief'.
 - Explain why geographers construct cross-sections from topographic maps.
 - State what is meant by the term 'vertical exaggeration'.
 - Explain what is meant by the term 'aspect'.
 - Explain what is meant by the term 'gradient'.
- Study Figure 1.5l and then complete the following tasks.
- What is the contour interval on the Blue Lake topographic map?
 - Identify the feature of the physical environment located at:
 - GR 283681
 - GR 295635
 - GR 232698
 - GR 260670.
 - Identify the feature of the human or built environment located at:
 - GR 252679
 - GR 251668.
 - What is the physical landform feature located at AR 2363?
 - What is the land use found in AR 2970?
 - What is the vegetation type found in AR 2668?
 - What is the direction of Hope Island from the summit of Mt Smith?
 - What is the direction of Duck Island from the summit of Mt Brown?
 - In what direction is Duck Creek flowing in AR 2865?
 - What is the bearing of Mt Smith from Mt Brown?
 - What is the straight-line distance between the summits of Mt Brown and Mt Smith?
 - What is the difference in elevation between Mt Brown and Mt Smith?
 - 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).
 - Calculate the local relief experienced on a traverse from Mt Brown to Mt Smith.
 - What is the aspect of the slope in each of the following locations?
 - AR 2670
 - AR 2766
 - Construct the cross-section between point A (AR 2868) and point B (AR 2963), using a vertical scale of 1:40 m.
 - Construct the cross-section between point C (GR 2566) and point D (AR 2763), using a vertical scale of 1:80 m.

- Calculate the vertical exaggeration of the cross-section A–B.
- Calculate the gradient of the slope C–D.
- Calculate the vertical exaggeration of the cross-section C–D.

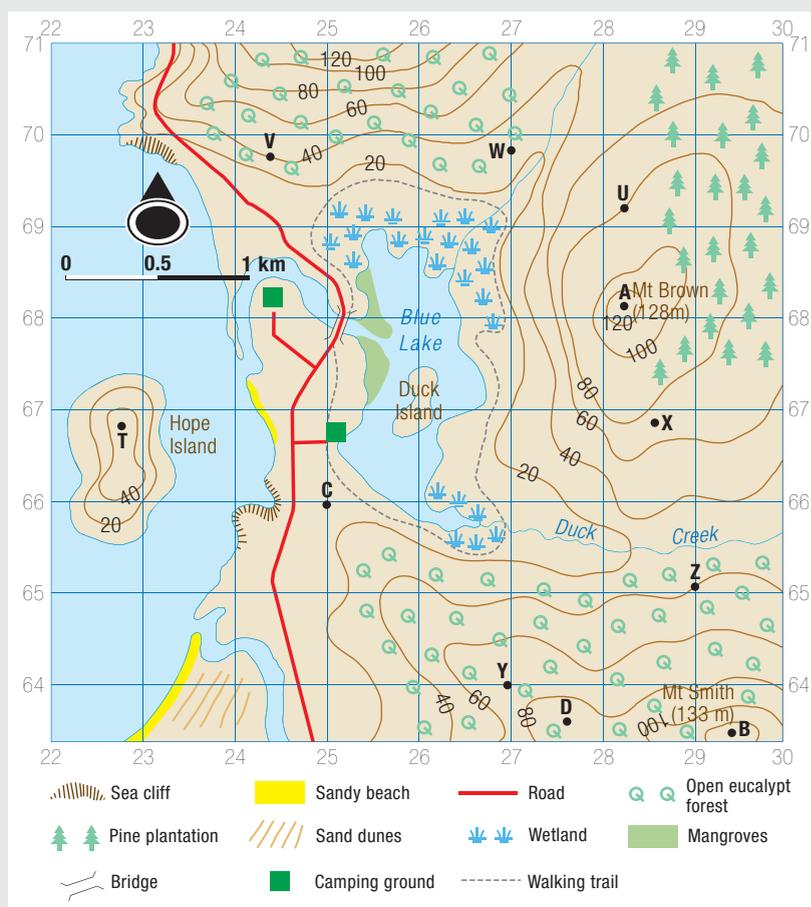


Figure 1.5l Topographic map of Blue Lake. Scale 1 cm = 40 000 cm

Maps have traditionally been a paper-based representation of part of the Earth's surface. Today, however, we are just as likely to access maps in a digital form on our laptops, smartphones or in-car navigation systems.

Geospatial technologies

Geospatial technologies are often described as the tools of the modern geographer. The term 'geospatial technologies' can, however, be applied to a range of different tools. The one you are most likely to be familiar with is a *Global Positioning System* (GPS) or what is sometimes known as a *global navigation satellite system* (GNSS).

GPS/GNSS satellites circle the Earth and allow the user on the ground, with a receiver such as a 'satnav' or smartphone, to locate their position and record locational data. In general, most in-car

units and smartphones have an accuracy of plus or minus 5 m.

Another geospatial technology that geographers use is a *geographic information system* (GIS). A GIS is a database that can be used to present information and view relationships between different layers of data (see Figure 1.6c). If you have used Google Earth you have already used a GIS.



Figure 1.6a A GPS-based, in-car navigation system

The third geospatial technology of interest to geographers is *remote sensing*. Remotely sensed data is information collected from space remotely. It includes satellite imagery and aerial photography.

The analysis of satellite imagery is an essential skill in today's world and a whole range of information about a place can



Figure 1.6b Smartphone map applications are an increasingly popular way of finding out how to get from place to place.

be gained using satellites. This includes information about land use, vegetation, the water content of vegetation and soil, and bushfire activity in an area.

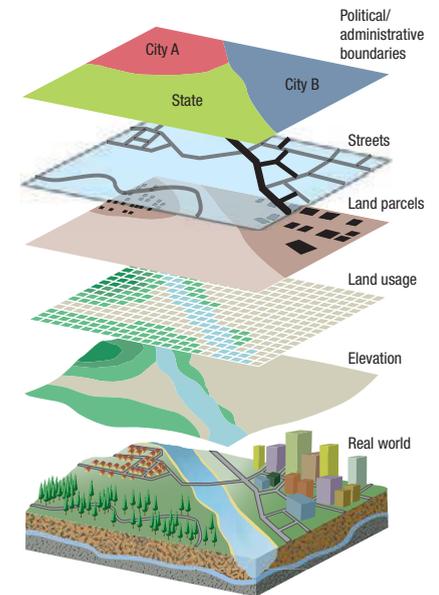


Figure 1.6c A GIS allows layers of data to be analysed in order to identify relationships.



Figure 1.6d Google Earth is a virtual globe, map and geographical information system. Google Earth, image © 2016 TerraMetrics © 2016 Google

Google

The giant US-based technology company Google Inc. has transformed the way people engage with spatial tools. In 2005, Google launched Google Earth. Since then it has developed other spatial technology applications including Google Maps, My Maps and Google Street View.

Google was one of the first providers to make spatial tools free and relatively easy to use. The software is freely available online and is user-friendly. Today, most government agencies and organisations that provide spatial data for public use do so using Google Earth.

Google Earth consists of thousands of satellite images of the Earth's surface of varying resolution. It allows users to get a bird's-eye view of places. The degree of resolution varies but places such as Melbourne, Victoria, Australia; Las Vegas, Nevada, United States; and Cambridge in the United Kingdom are examples of places featured at the highest resolution. Google Earth allows users to search for addresses for some countries, enter

coordinates or simply use the mouse to browse to a location.

Google Street View provides a 360-degree panorama of streets in many countries including Australia, France, the United Kingdom, the Republic of Ireland, Italy, Japan, New Zealand, Spain, the United States, Portugal, Brazil, the Netherlands, Taiwan, Switzerland, Canada, Mexico, Sweden, Norway, South Africa and Finland.

Historical imagery can also be accessed via Google Earth. This allows users to look through past images and study the development of a place over time.

Like other GIS-based applications, Google Earth features different layers of data.

Drones

Technological advances are providing us with new ways of measuring and representing the world around us. Unmanned aerial vehicles (UAVs), or drones with mounted sensors, will be able to record digital information. We will soon be able to access three- and even four-dimensional spatial information.



Figure 1.6e A drone-based thermal detector used by firefighters to search for survivors near the Italian village of Amatrice, after a 6.2-magnitude earthquake struck the region on 27 August 2016. The disaster killed nearly 300 people.

ACTIVITIES

- Read the introductory text and answer the following questions:
 - Identify three geospatial tools used by geographers.
 - What is a geographic information system?
 - What is remote sensing?
- Study Figure 1.6c. Use the illustration to explain the reasons why geographers use GIS.
- Read the information on Google and complete the following tasks:
 - Use Google Earth to explore one of the following high-resolution destinations: Melbourne, Victoria, Australia; Las Vegas, Nevada, United States; or Cambridge in the United Kingdom.
 - Using Google Earth, explore either Portofino or the Amalfi Coast on the Italian west coast. Describe the nature of the relationship between the biophysical and constructed environments.
- Using Google Street View, explore your local neighbourhood. Try to identify places you are familiar with.
 - Using Google Street View, explore the streets of one of the world's great cities.
- Read the information on drones. Investigate the potential of drones to collect geographical data. How might they be used in fieldwork?





Figure 1.7a What landform is that?

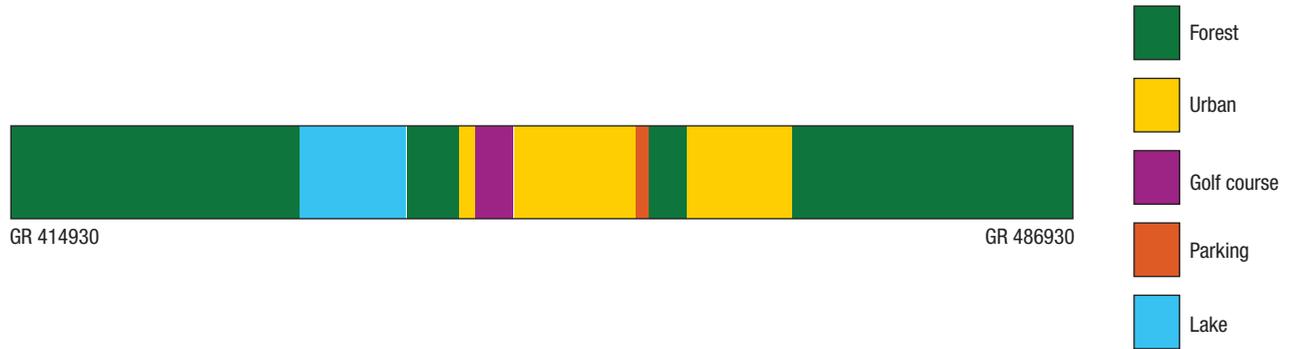


Figure 1.7c Transect along northing 93 between GR 414930 and GR 486930 on the Whistler topographic map extract. (See page 171.)

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 Cairns topographic map extract. (See page 121.)

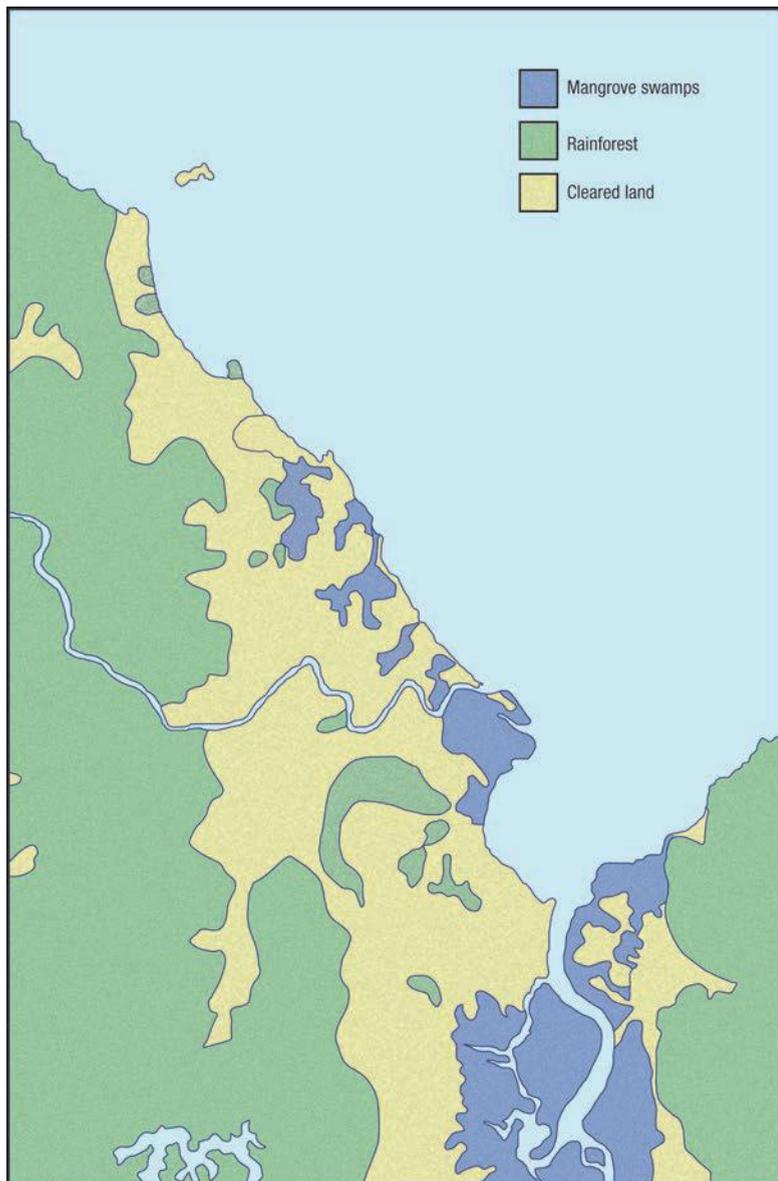


Figure 1.7b Precis map of the Cairns topographic map extract showing the pattern of vegetation

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 171.)

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).)

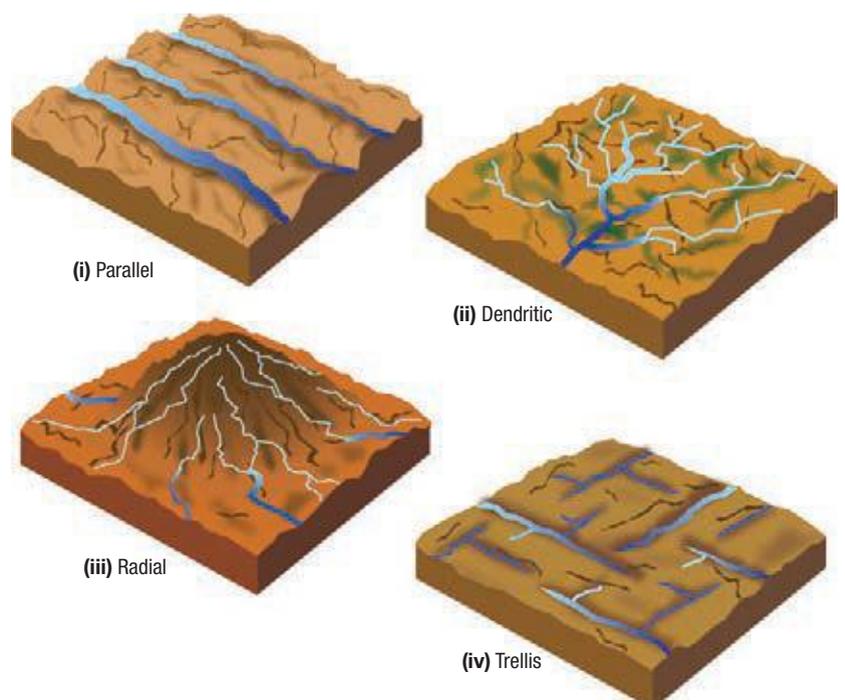


Figure 1.7d Types of drainage patterns

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 1.7f Hilltop village, Callian, southern France



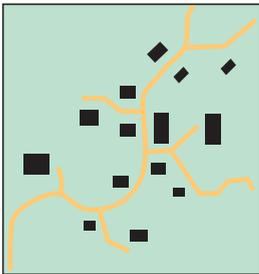
Figure 1.7g A linear (string) village, Saint Louis, north-east France



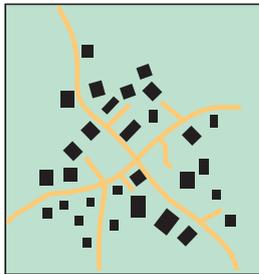
Figure 1.7h A cluster village in south-west France

Nucleated

(i) Grouped hamlet



(ii) Cluster village

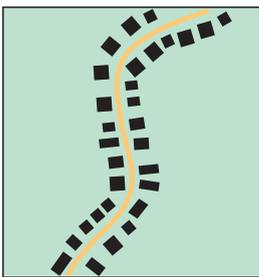


(iii) Skeleton grid

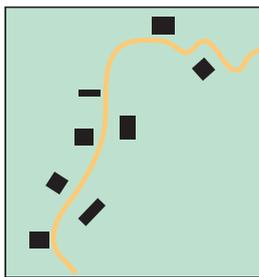


Linear

(iv) String village



(v) Linear hamlet



Dispersed

(vi) Rural dispersal

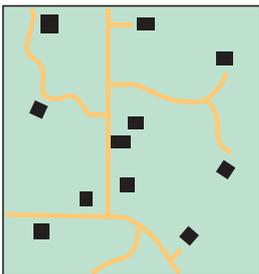


Figure 1.7e Some of the settlement patterns found on maps

ACTIVITIES

- 1 Explain why geographers draw precis maps.
- 2 Outline the purpose of transects.
- 3 Study the Enard Bay topographic map extract on page 161. Construct a precis map showing the relationship between transport and topography.
- 4 Study the Wallis Lake topographic map extract on page 91.
 - a Construct a precis map showing the pattern of vegetation found in the area covered by the map.
 - b Construct a transect from GR 390330 to GR 590330.
- 5 Study the Mt Ruapehu topographic map extract on page 141. Identify the drainage pattern evident on the map extract.
- 6 Study the Barossa Valley topographic map extract on page 111. Identify the general pattern of settlement found on the map.
- 7 Study the Barossa Valley topographic map extract on page 111. Identify the settlement type found in AR 1373.
- 8 Study the Wallis Lake topographic map extract on page 91. Identify the settlement type found at AR 5032.





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

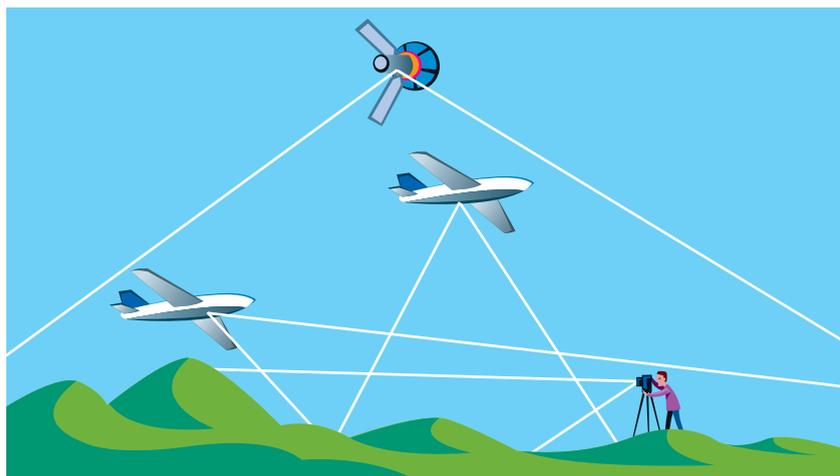


Figure 1.8b Types of photographs



Figure 1.8c Ground-level photograph of New York's Central Park



Figure 1.8d Oblique aerial photograph of Central Park, New York



Figure 1.8e Vertical aerial photograph of Central Park, New York

scale. Features in the foreground appear larger than those in the background.

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 Figure 1.8e.)

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

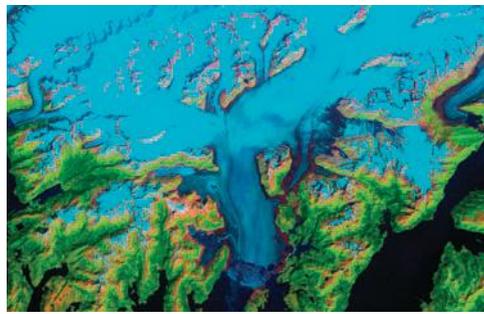
Satellite images are different from the photographs you take with a digital camera because they are created from data

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



Figure 1.8f Satellite image of New York City



1986



2005



2014

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	Drier 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

represents in order to interpret the image (see Table 1.8a). 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

a 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 the human eye. We still, however, need to know what each colour represents (see Table 1.8b).



Figure 1.8h True-colour image of Yakutat Glacier, Alaska, one of the world's fastest-retreating glaciers

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:

- Determine whether the photograph is a vertical aerial photograph or an oblique aerial photograph.
- Look for evidence of location and time. Often the caption provides some relevant information about the photograph, especially about the location.
- Look for a familiar feature of the built environment that will give you some indication of scale.
- 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.
- 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.
- 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.

Taking a photograph that is of use to geographers involves the following steps:

ACTIVITIES

- Outline how satellite images differ from photographs.
- Study Figure 1.8b. Based on your knowledge of the types of photographic images, complete the following tasks:
 - Identify the type(s) of images that result in no distortion of the scale of the objects on the ground.
 - Identify the type of image that is likely to give the greatest distortion of the features in the foreground.
 - Identify the type of image that might block out views of distant features.
 - Identify the type of image that is likely to cover the largest area of the Earth's surface.
- Use the internet to locate examples of ground-level, oblique and vertical aerial photographs.
- Use Google Earth to explore some of the landscapes featured in the topographic maps in Sections 3 and 5–9 of this text.
- Study Figure 1.8g. Trace the retreat of the Columbia Glacier.
- Use NASA's Earth Observatory website 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.





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.)

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.
- 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.

COMPUTER-GENERATED PHOTO SKETCHES

There are now a number of software applications that will transform your photographs into sketches. Figure 1.9d is

an example of a sketch generated from a photograph.



Figure 1.9c Moraine Lake, Banff National Park, Canada



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



Figure 1.9e Lake Angus, Banff National Park, Canada

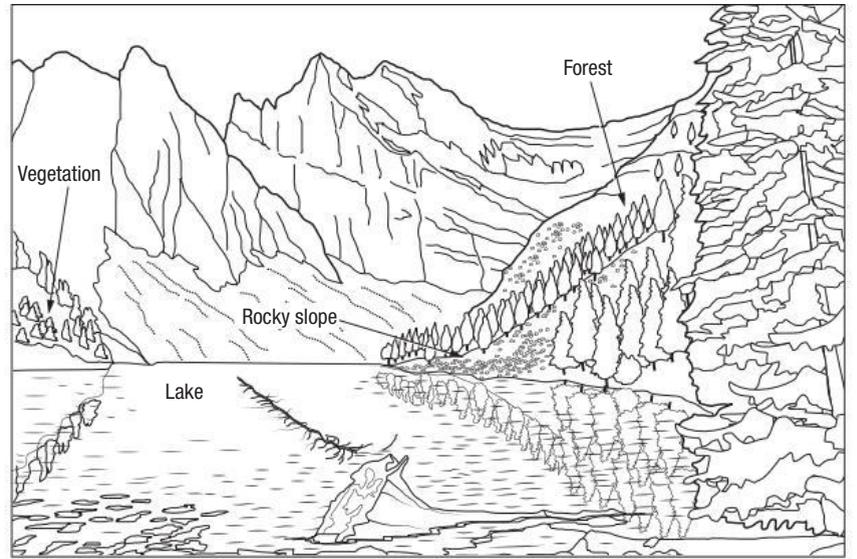


Figure 1.9f A sample field sketch of Lake Angus, Banff National Park. Field sketches such as this are a popular way to record information during fieldwork.

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 Decide on the amount of detail required and add it 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 14) is a type of sketch map. Precis maps are used to illustrate the relationship between elements of a topographic map; for example, landform and settlement patterns.

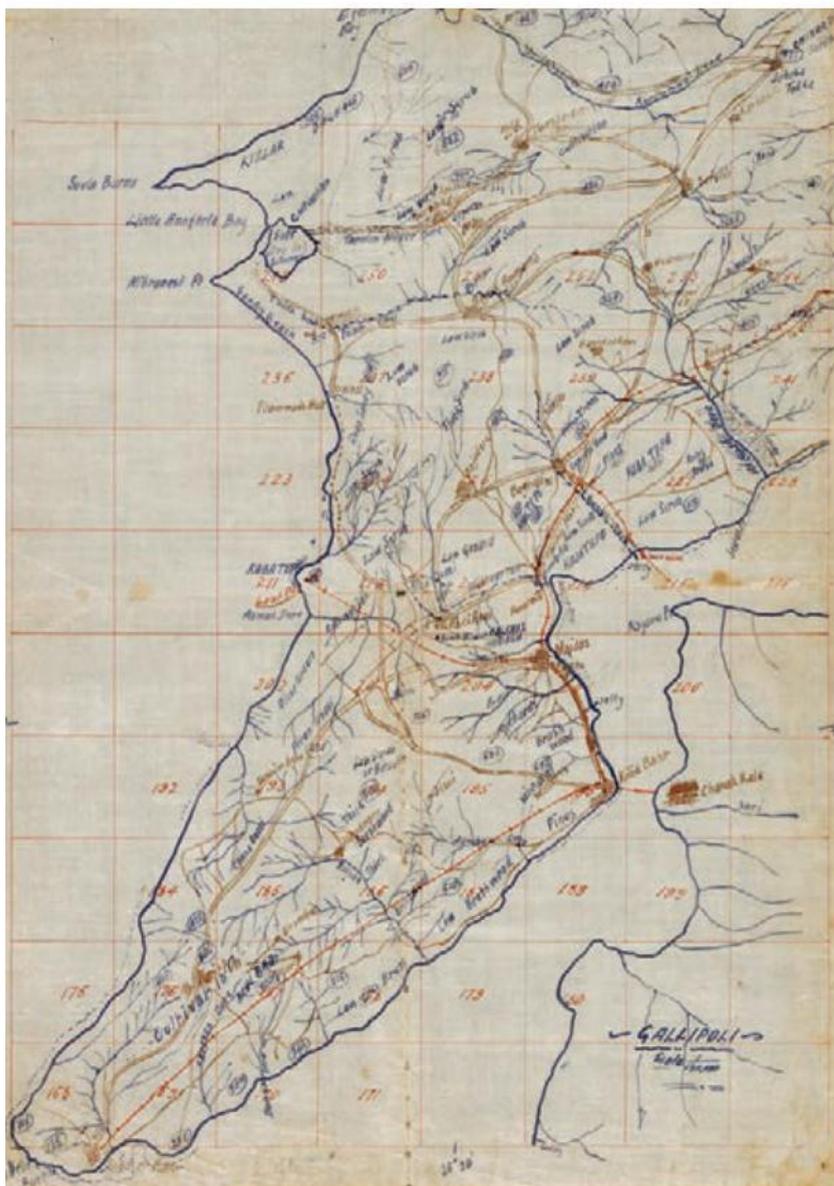


Figure 1.9g This small, 1 inch: 120 000 inch sketch map of Gallipoli was drawn by Private Sydney Callaghan. Callaghan carried the map in his tunic pocket at the landing at Anzac Cove on 25 April 1915 [AWM/RC05680].

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 landform features and important elements of the biophysical and constructed environments.



Figure 1.9h(i) Matterhorn, Switzerland



Figure 1.9h(ii) Monument Valley, United States



Figure 1.10a Four seasons

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. 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. The climate data for São Paulo, Brazil, is shown in Table 1.10a.

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

Table 1.10a Climate data for São 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

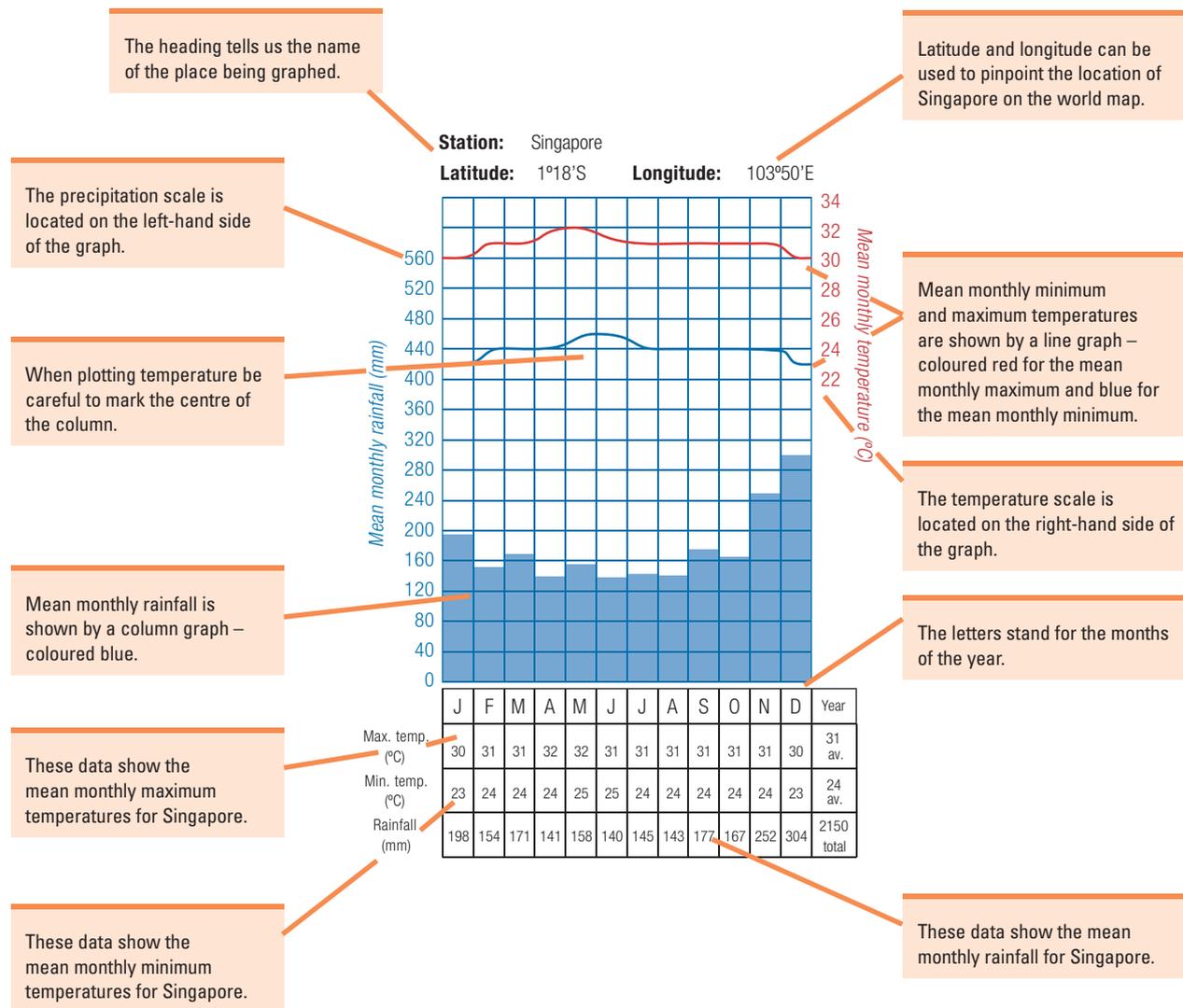


Figure 1.10b Climate graph of Singapore

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 left-hand side of the graph and the temperature scale on the right-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.

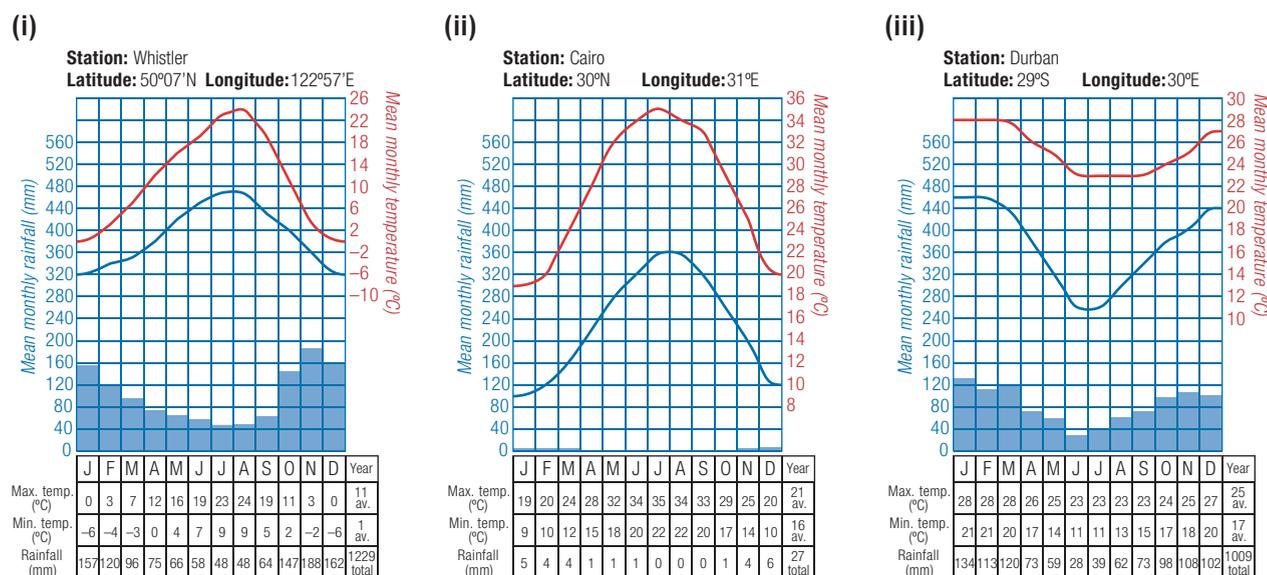
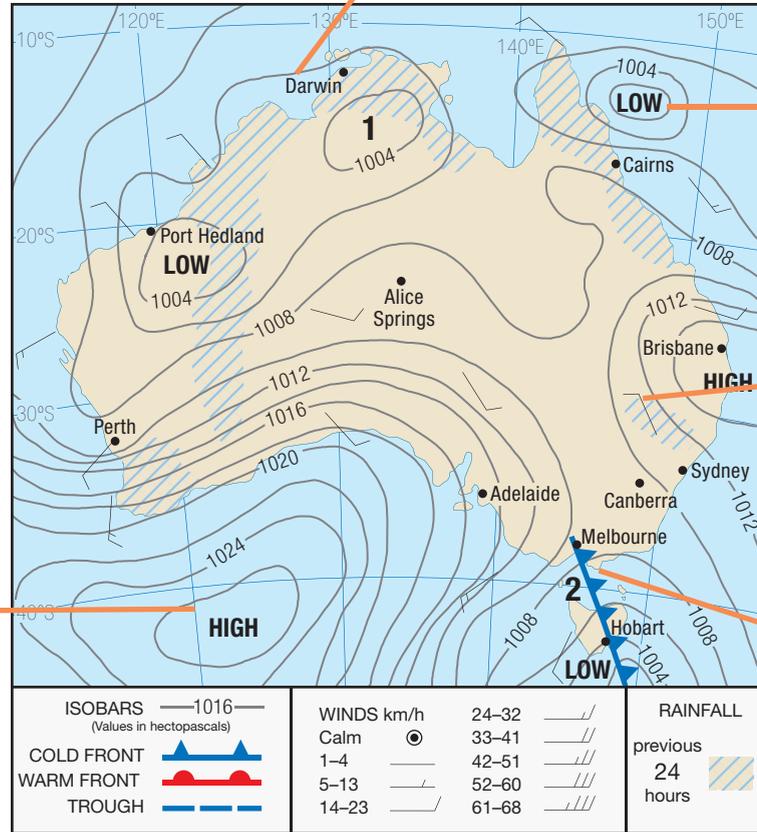


Figure 1.10c Climate graphs for Whistler, Canada (i), Cairo, Egypt (ii) and Durban, South Africa (iii)

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.

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'.

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.



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.

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.

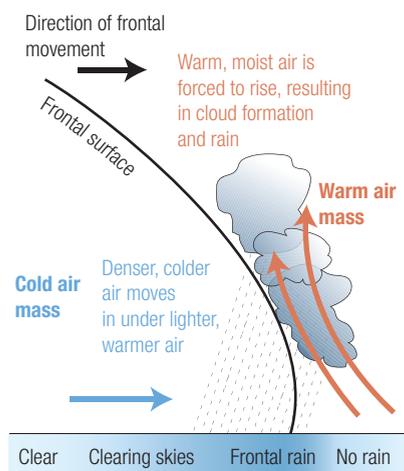


Figure 1.10e Cold front

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 air 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° away from a high, or 10–30° 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 and then answer the following questions:
 - a Which station has the highest mean monthly 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?
- 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.





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.

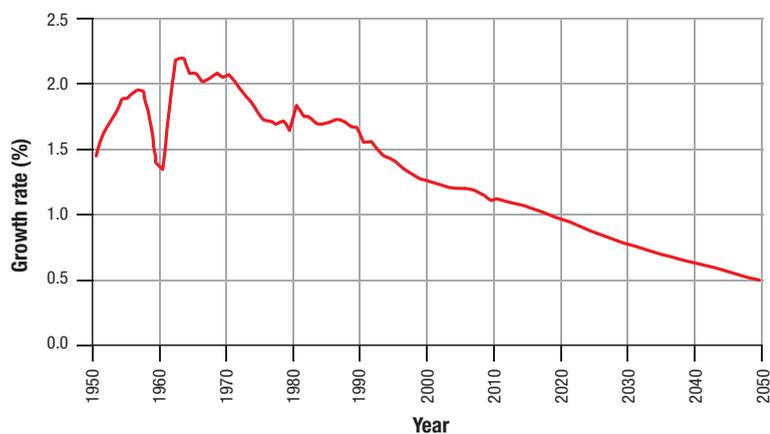


Figure 1.11b Simple line graph showing the annual growth rate in the world's population between 1950 and 2050

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.

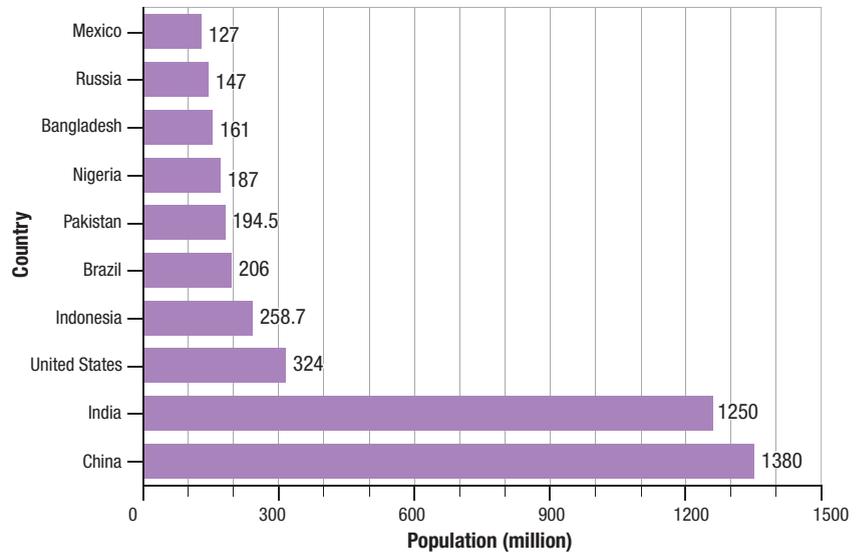


Figure 1.11c Simple bar graph showing the population of the world's 10 most populous countries, 2015

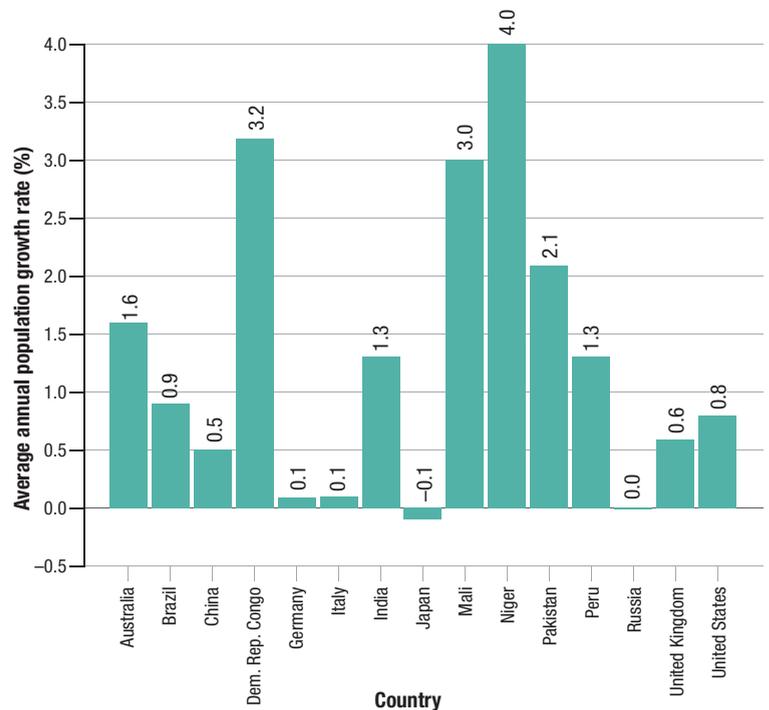


Figure 1.11d Simple column graph showing the average annual population growth rate for selected countries, 2010–2015

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.

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 quantifiable value and tend to rise and fall. For bar graphs it is 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.

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.) 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, $20 \times 3.6 = 72^\circ$.
- 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.

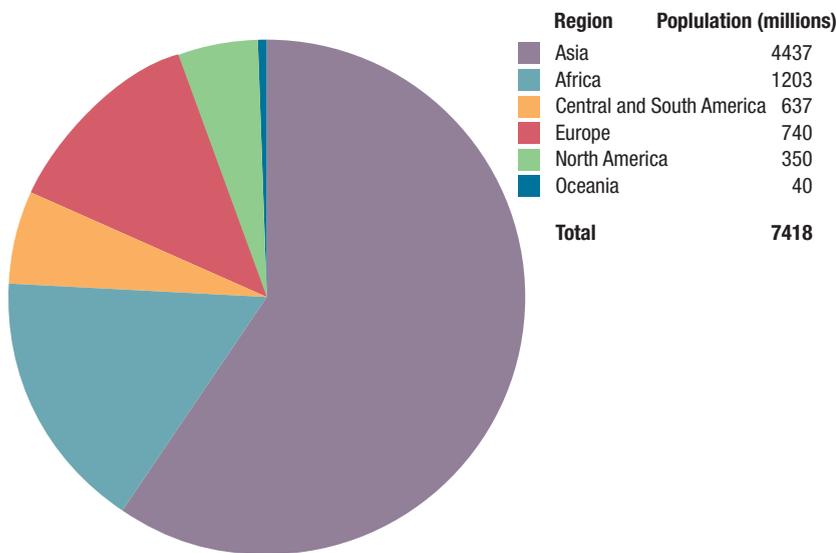


Figure 1.11e Pie graph showing the distribution of the world's population, 2016

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 Figure 1.11f, 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 the smallest. For example:3 Determine a scale that allows the circles to be a suitable size. In this example 1 mm = 100 units.
- the area of Asia: 44 614 000 km²
 - the area of Africa: 30 319 000 km²
 - the area of North America: 24 710 000 km²
 - the area of South and Central America: 18 036 127 km².4 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 America: 4971/100 = 49.7 mm
 - Central and South America: 4247/100 = 42.5 mm.
- 2 Calculate the square root of each value.*5 Draw four circles that have a radius of 66.8 mm, 55.1 mm, 49.7 mm and 42.5 mm.
- For example: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.
- Asia: the square root of 44 614 000 = 6679
 - Africa: the square root of 30 319 000 = 5506
 - North America: the square root of 24 710 000 = 4971.
 - Central and South America: the square root of 18 036 127 = 4247.7 Label each circle and record the actual area of each continent in brackets next to each name.
- *You can use an internet-based square root calculator to complete this step.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. In Figure 1.11g, a column graph showing the proportion of the population living in urban centres by continent in 2016, pictorial elements have been used to communicate information.

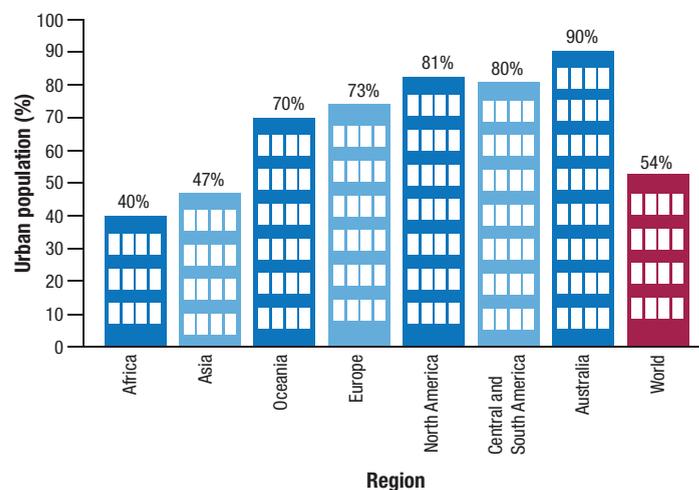


Figure 1.11g Picture graph showing the percentage of the population living in urban centres by continent, 2016

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 24) 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 2.6.1n on page 60.
- If the upper part is relatively wide, then the population is said to be 'old' or 'aging'. An example is Figure 2.6.1n on page 60.
- 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 1.11j (page 24) 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.

$$\text{Percentage change} = \frac{\text{Difference between the two values}}{\text{Original value}} \times \frac{100}{1}$$

Example

In 1950, the world's population was 2.55 billion. In 2016, it was 7.4 billion. Calculate the percentage increase between 1950 and 2016.

$$\text{Difference: } 7.4 \text{ billion} - 2.55 \text{ billion} = 4.85 \text{ billion}$$

$$\text{Original value: } 2.55 \text{ billion}$$

$$\text{Percentage change: } \frac{4.85}{2.55} \times \frac{100}{1} = 190.2\%$$

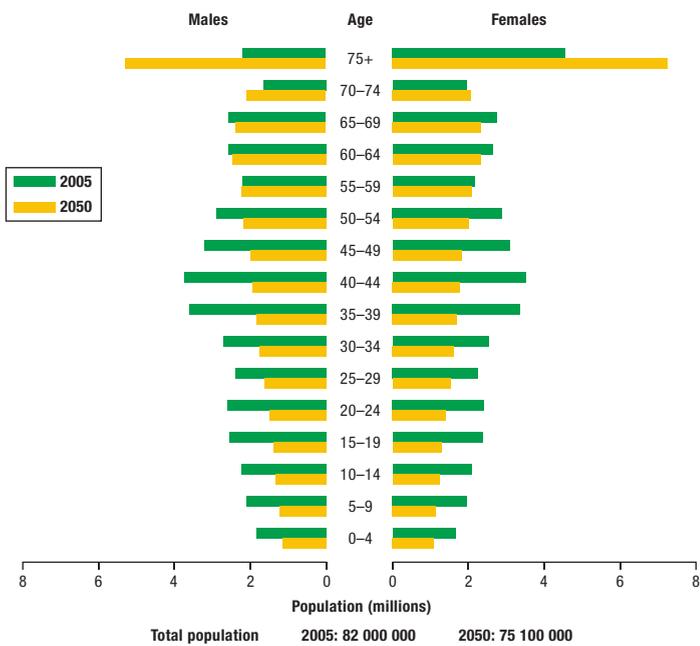


Figure 1.11h Population pyramid comparing the age and sex structure of the German population in 2005 and the projected structure for 2050

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.

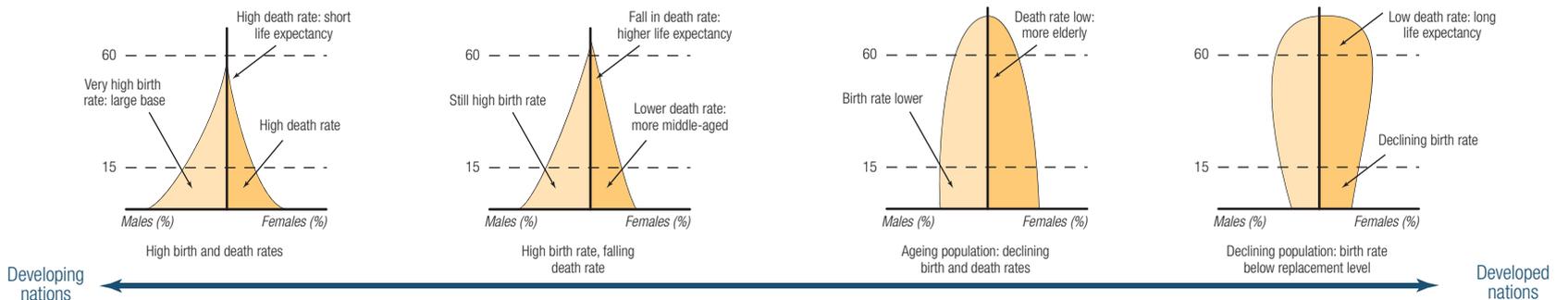


Figure 1.11j Common population pyramid shapes and the conditions under which they develop

ACTIVITIES

- Name the graph best suited to showing values that change over time.
- Distinguish between bar and column graphs.
- Name the two types of proportional graphs.
- Outline the key features of a pie graph.
- Explain what proportional circle graphs are used to show.
- Outline why picture graphs are commonly used to present information.
- State what population pyramids show.
- Explain what the shape of a population pyramid tells us about a population.
- Study Figure 1.11b (page 22) and then complete the following tasks:
 - State the year in which the annual rate of world population growth rate peaked.
 - Identify the trend in the annual rate of world population increase since the late 1980s.
- Study Figure 1.11c (page 22) and then complete the following tasks:
 - State the population of China.
 - Estimate the number by which the population of China exceeded that of India in 2015.
- Study Figure 1.11d (page 22) and then complete the following tasks:
 - Name the country with the greatest annual rate of population increase.
 - Name the countries with a negative annual rate of population increase.
- Study Figure 1.11e (page 23) and then complete the following tasks:
 - State the proportion of the world's population found in Asia.
 - State the number of people living in Africa.
- Study Figure 1.11f (page 23) and then complete the following tasks:
 - State which has the larger area: South America or Antarctica.
 - State the area of Asia.
- Study Figure 1.11g (page 23). Identify the continents with the percentage of their population living in urban centres below and above the world's average.
- Study Figure 1.11h and then complete the following tasks:
 - Estimate the number of Germans under the age of 15 years in 2005 and 2050.
 - Estimate the number of Germans aged 75 years and over in 2005 and 2050.
 - Estimate the proportion of the German population under the age of 15 years in 2005 and 2050.
 - Estimate the proportion of the German population aged 75 years and over in 2005 and 2050.

- Use the data in Table 1.11a to construct a line graph showing the growth in the world's population since 1800.
- 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.

- Use the data in Table 1.11c to construct a column graph showing the rate of natural population increase for selected countries in 2015.
- 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 2015.

Table 1.11a Actual and projected world population, 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 (billion)
India	1628
China	1437
United States	420
Nigeria	299
Pakistan	295

Table 1.11c Rate of natural population increase for selected countries, 2015

Country	Rate of natural increase (%)
Australia	1.4
Germany	-0.6
India	1.3
Mali	3.3
Russia	-0.5
World	1.2

Table 1.11d Number of people living in developed and developing worlds, 2015

Region	Population (billion)
More developed	1254
Less developed	6082
Least developed	938
Total	7336

Choropleth maps

Choropleth maps use shading, symbols and colour to show the average density, or concentration, of features such as population and rainfall. Figure 1.12a, 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.

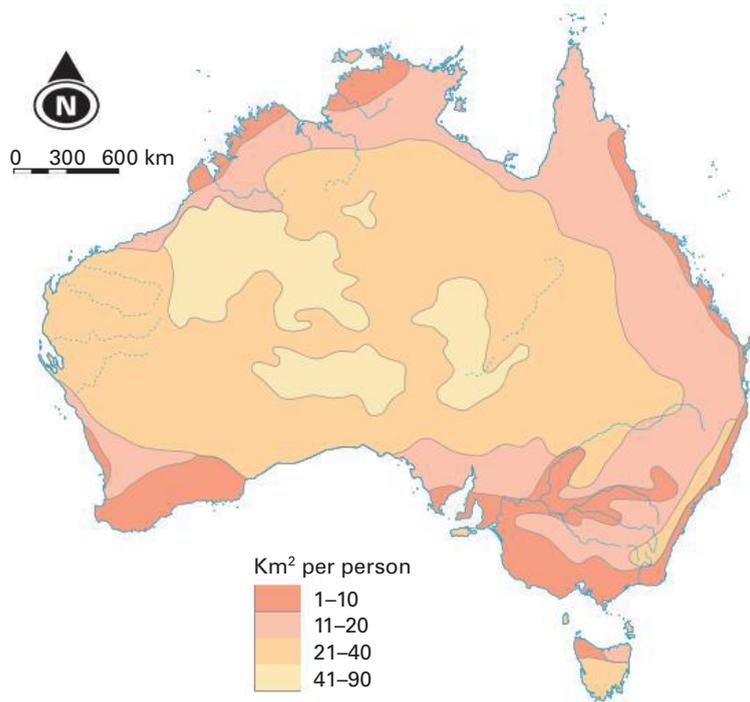


Figure 1.12a Choropleth map showing the population density of the Indigenous Australian population, 1788

Dot maps

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

Figure 1.12d 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.



Figure 1.12c The remote Mantamaru Community in Western Australia



Figure 1.12b Maps can be used for many different purposes.

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.

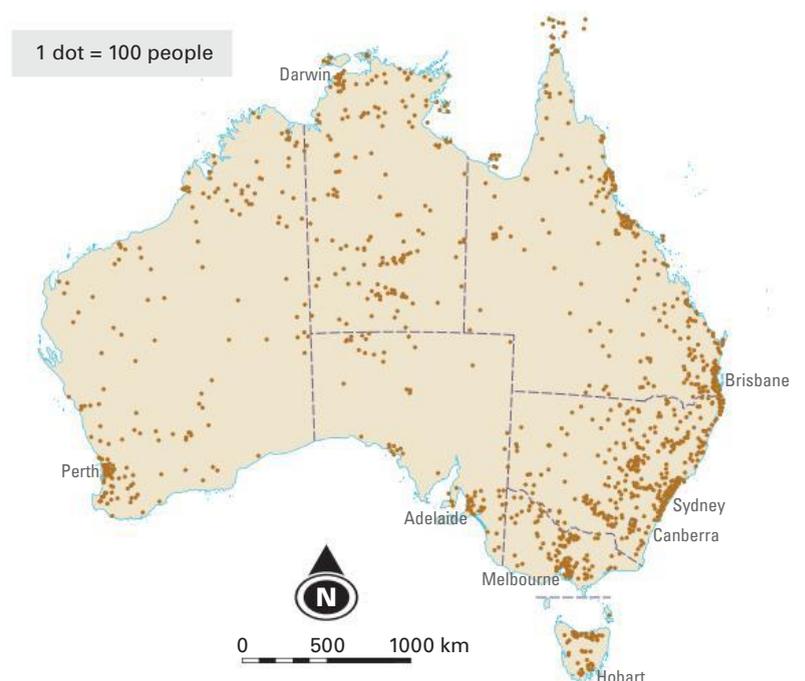


Figure 1.12d Dot map showing the population distribution of Indigenous Australians, 2011 Census

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. (See Figure 1.12e.)

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.

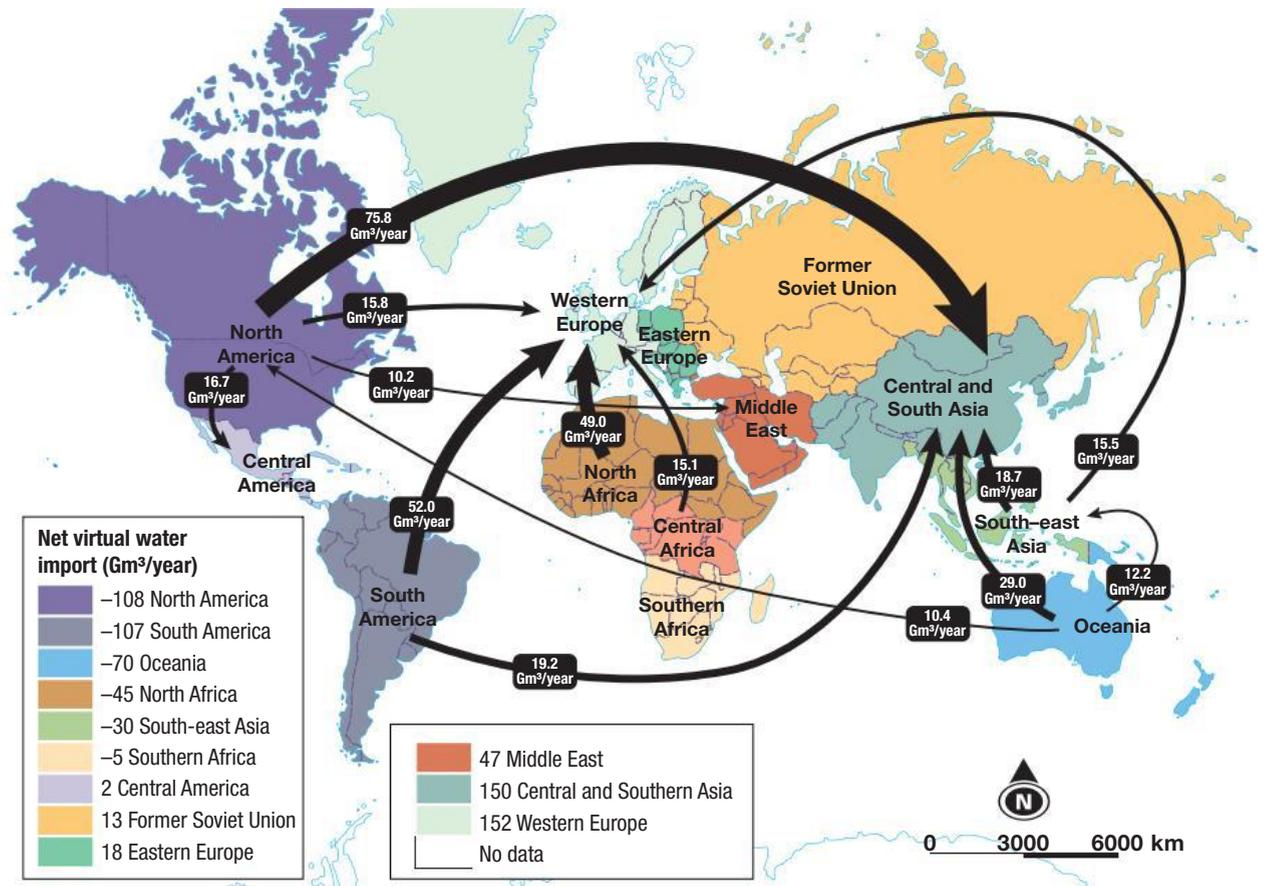


Figure 1.12e Flowline map showing net importers and exporters of virtual water

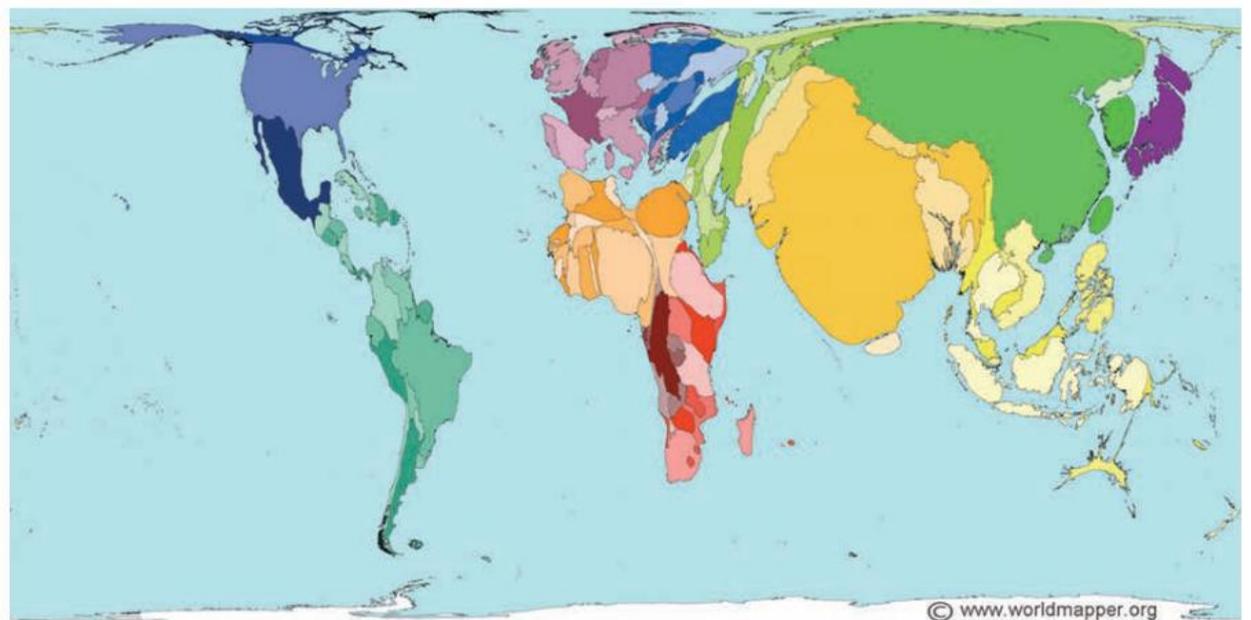


Figure 1.12f Worldmapper cartogram: population by country

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 1.12f 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 as large an extent as possible, but inevitably a large amount of distortion occurs.

ACTIVITIES



Distinguish between choropleth, dot, flowline and cartogram maps. Using the internet, find examples of each type of map featured on pages 25 and 26.



Figure 1.12g The population of India is predicted to exceed that of China by 2022.

SECTION 2

Key themes in geography

Landscapes and landforms

Landforms

2.1

2.1.1



Figure 2.1.1a Summit of Everest

The landforms and landscapes 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 2.1.1b 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

Figure 2.1.1c shows the distinctive landform features of arid lands. 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 2.1.1c and 2.1.1d, page 28) 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 (see Figure 2.1.1e, page 28).

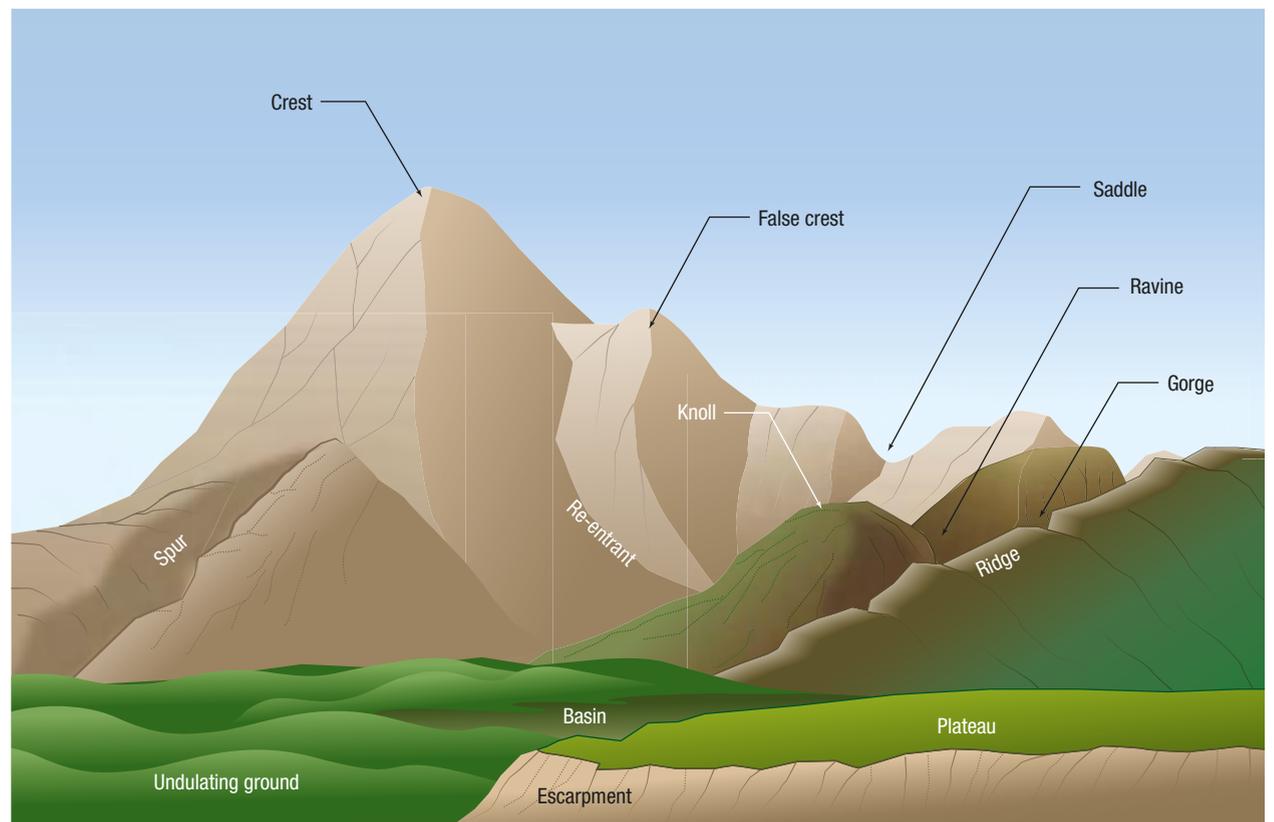


Figure 2.1.1b Some common landform features

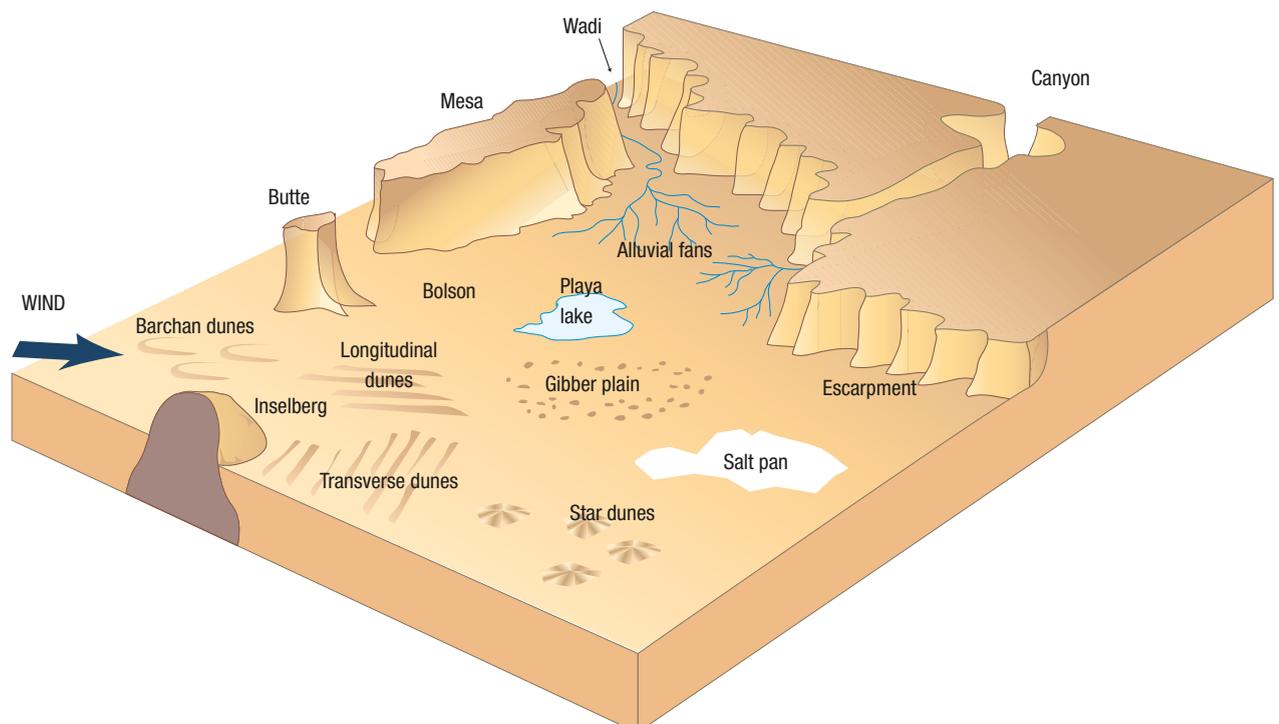


Figure 2.1.1c Landforms of arid environments



Figure 2.1.1d Buttes in Monument Valley, United States

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*.

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 2.1.1f and 2.1.1g.) 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 2.1.1h.)

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.

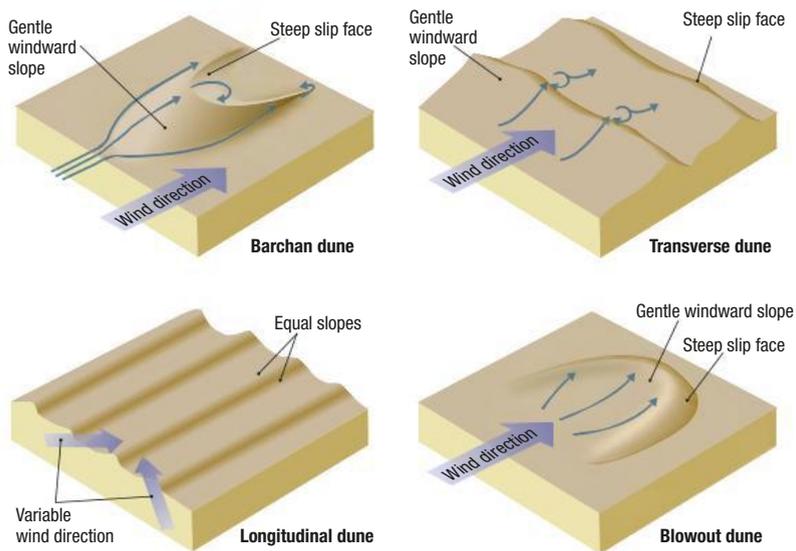


Figure 2.1.1e Dune formation



Figure 2.1.1f The spectacular coastline of Big Sur on the west coast of the United States is dominated by erosional landform features.

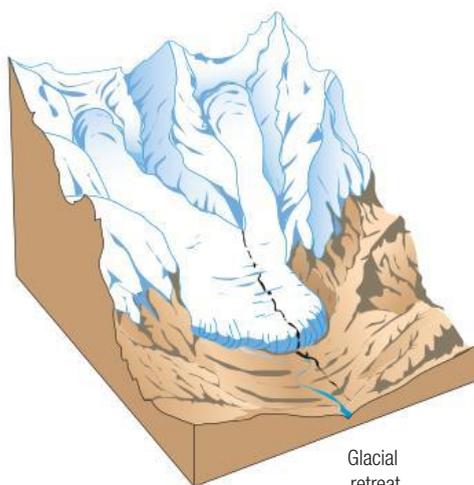


Figure 2.1.1j Glacial landform features

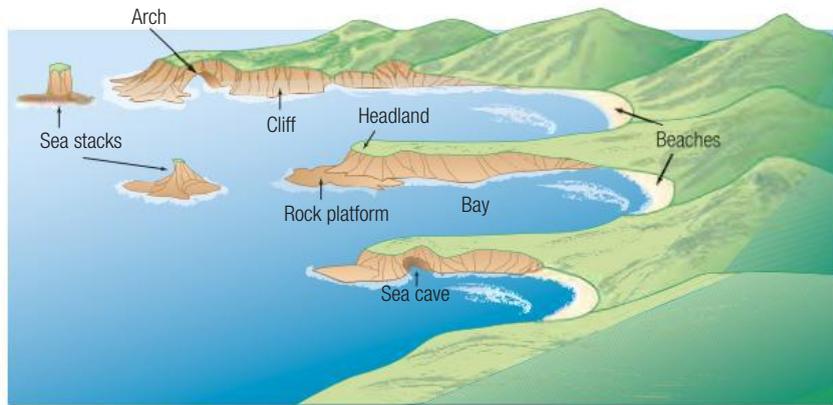
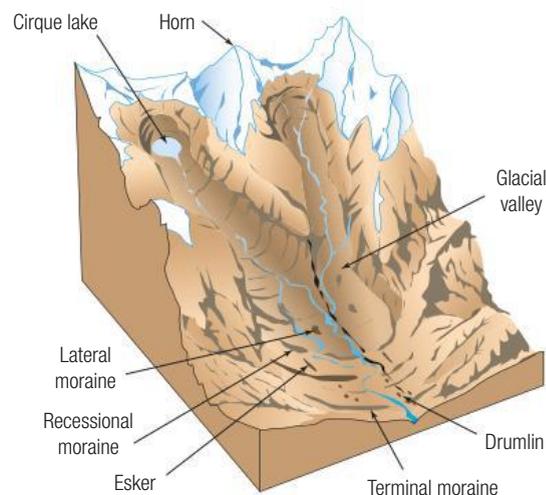


Figure 2.1.1g Erosional features of the coastal environment

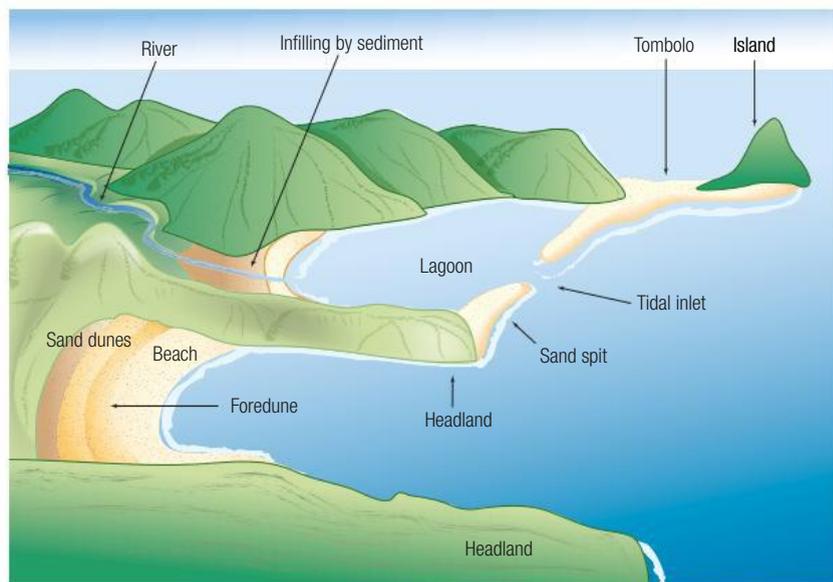


Figure 2.1.1h Depositional features of the coastal environment



Figure 2.1.1i Commonwealth Glacier, Antarctica

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 2.1.1i and 2.1.1j show some

of the distinctive landform features associated with glaciers.

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 2.1.1l.)

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 2.1.1m and 2.1.1n.)

Figure 2.1.1k 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 2.1.1o.) Often, the rock below the more resistant layer will be eroded, creating a cave-like formation or rock shelter.

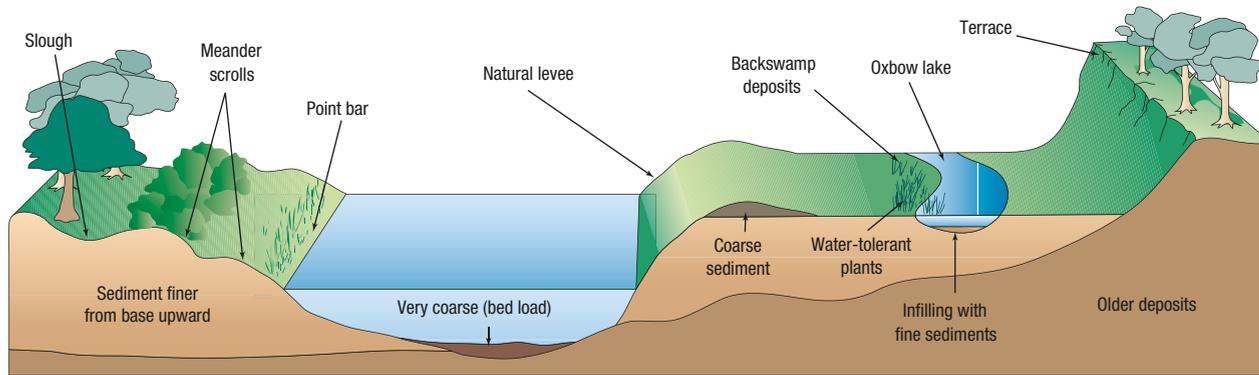


Figure 2.1.1k Landform features of the floodplain of a river

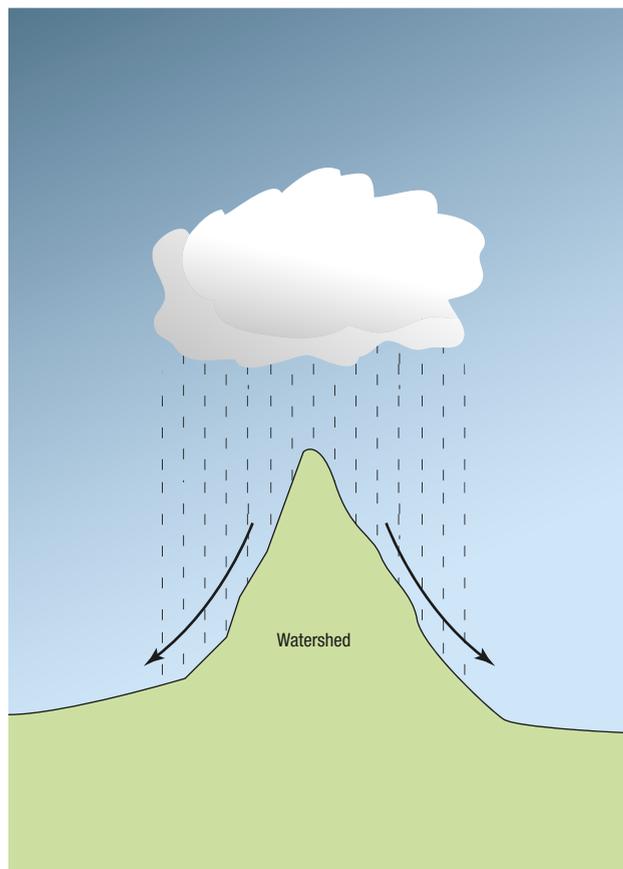


Figure 2.1.1l A watershed divides one catchment from another.



Figure 2.1.1m Meandering river, Tambopata National Reserve, Peru

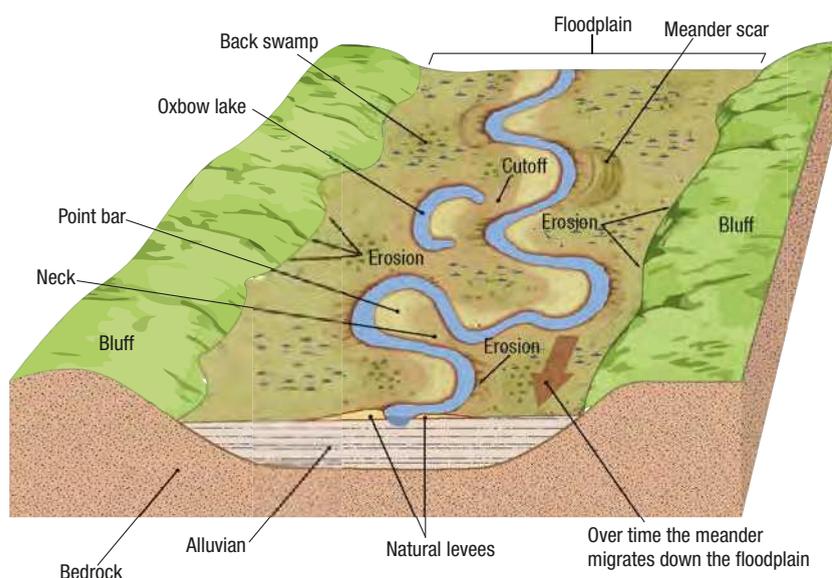


Figure 2.1.1n Formation of river meanders



Figure 2.1.1o The Iguazu Falls 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 Explain the processes responsible for the formation of barchan, longitudinal, transverse and blowout dunes.
- 6 Distinguish between a mesa and a butte.
- 7 What is an inselberg?
- 8 List the landform features commonly associated with:
 - a erosional coasts
 - b depositional coasts.
- 9 What is a glacier? How is it formed?
- 10 What is abrasion? How do glaciers abrade the landscape?
- 11 Research task: investigate how cirque lakes are formed.
- 12 Draw an annotated sketch featuring the landform features associated with the work of rivers.

2.1

Landscapes and landforms

2.1.2

Australia's landscapes and landforms

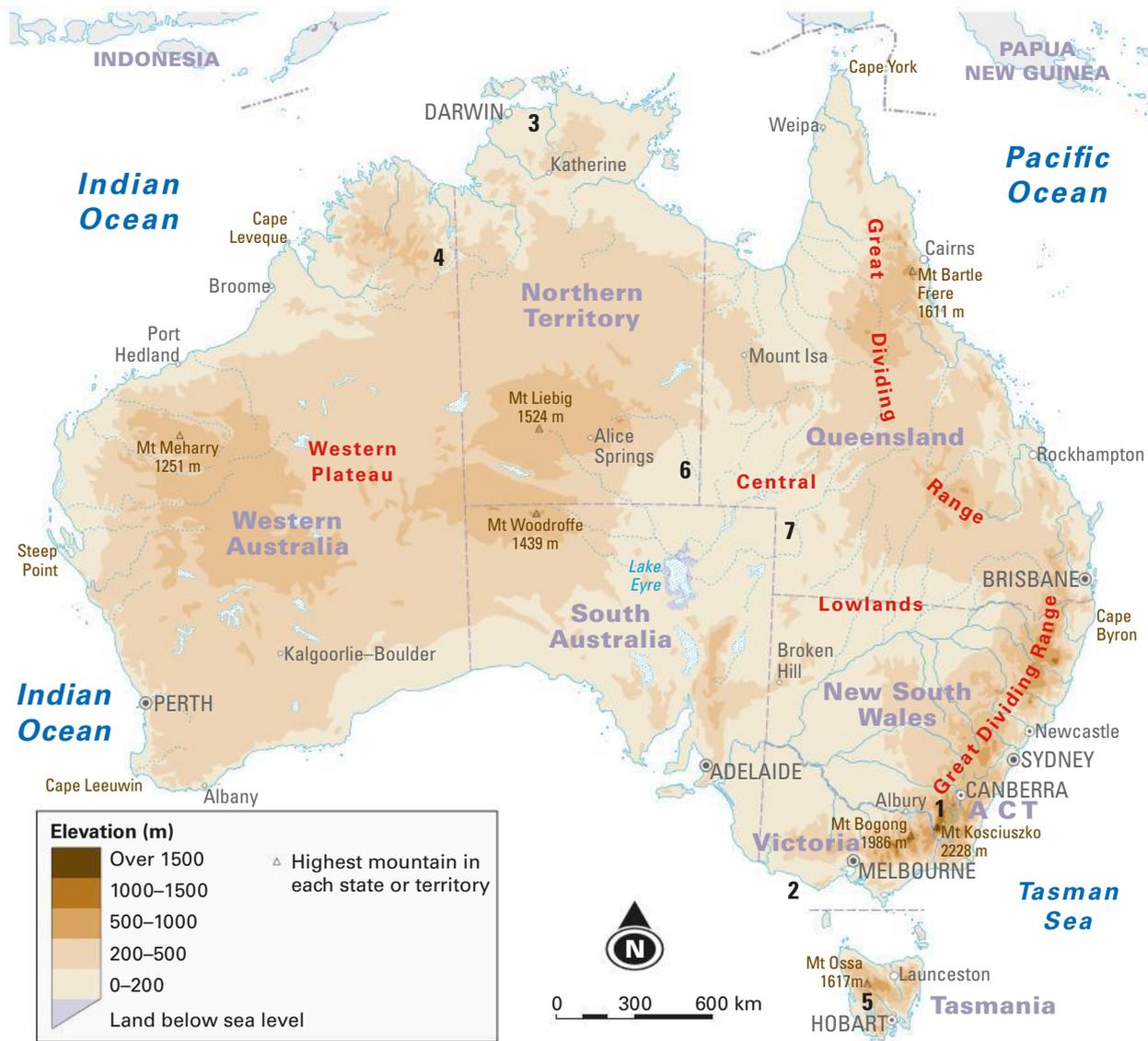


Figure 2.1.2a Australia's elevation



Figure 2.1.2b The Snowy Mountains (Australian Alps)



Figure 2.1.2c The Twelve Apostles



Figure 2.1.2d Kakadu's Jim Jim Falls



Figure 2.1.2e Bungle Bungle Range

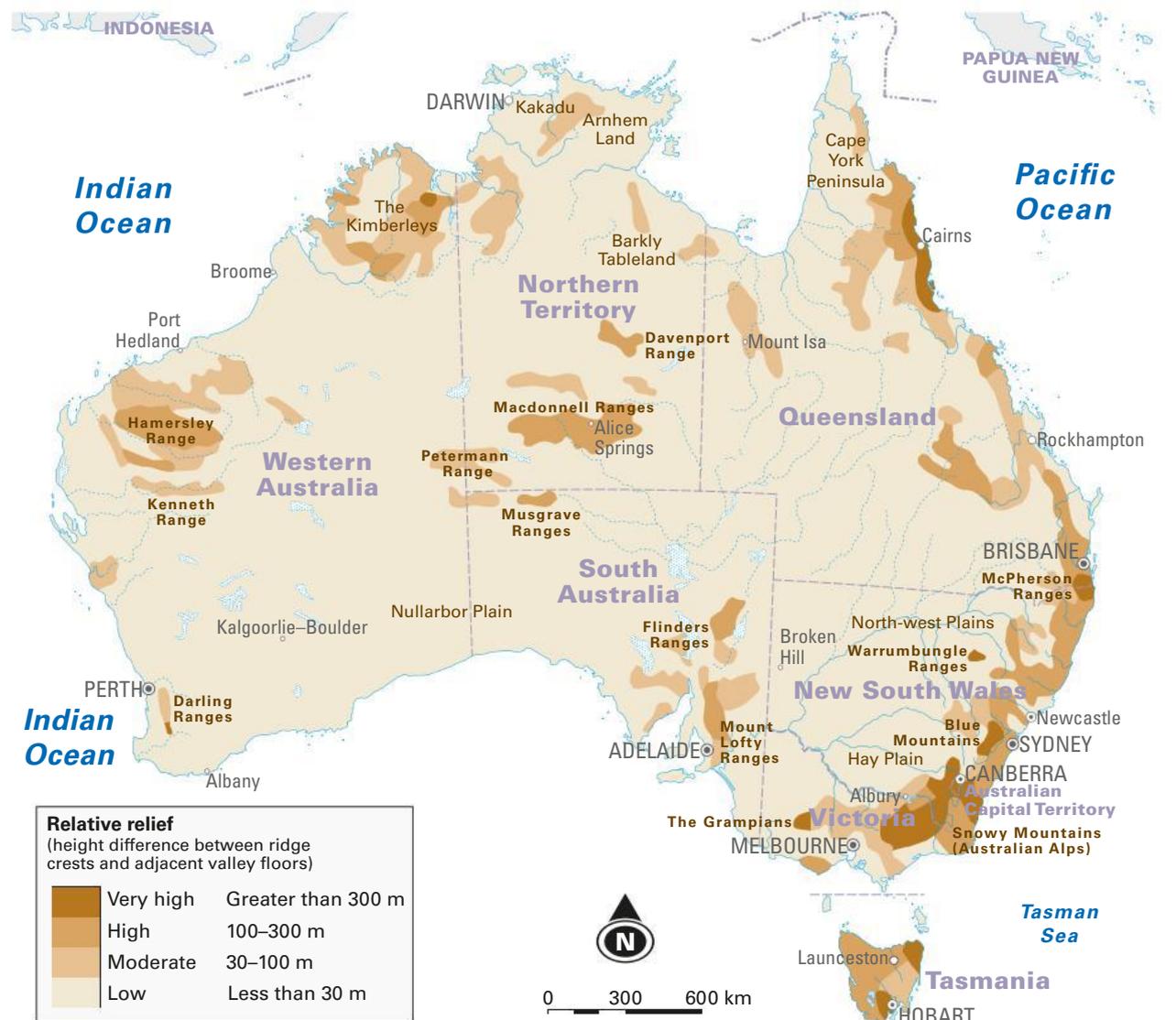


Figure 2.1.2f Australia's relative relief

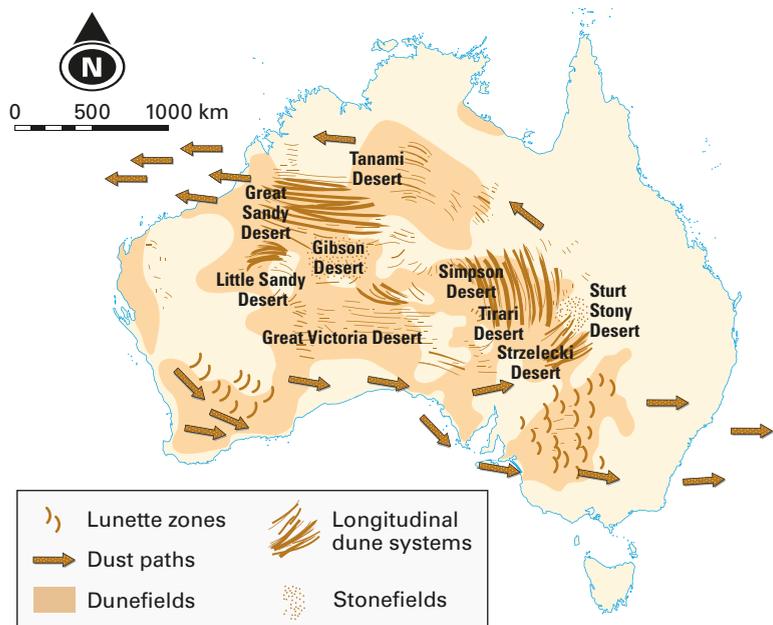


Figure 2.1.2g Australia's deserts: the alignment of dunes and the major dust paths



Figure 2.1.2i Sand dunes of the Simpson Desert



Figure 2.1.2j Sturt Stony Desert



Figure 2.1.2h Franklin River, Tasmania

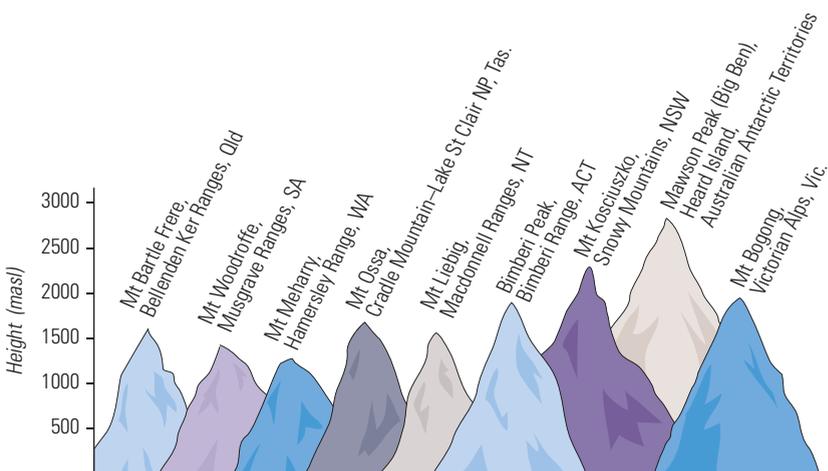


Figure 2.1.2k The highest mountain in each Australian state and territory

ACTIVITIES

- Study Figure 2.1.2a and complete the following tasks:
 - Name the three main landform divisions of Australia.
 - Compare Figure 2.1.2a with an atlas map of the world. What evidence is there to support the observation that Australia is the 'flattest' of the continents?
- Study Figures 2.1.2b to 2.1.2e and 2.1.2h to 2.1.2j. For each photo, identify the agent of erosion most responsible for the formation of the landscape shown.
- Study Figure 2.1.2f. What is meant by the term 'relative relief'? With reference to Figure 2.1.2a, where is relative relief the greatest?
- Study Figure 2.1.2g and Table 2.1.2b and answer the following questions:
 - Where are Australia's deserts found?
 - Which is Australia's largest desert?
 - In which direction are the dunes aligned in the Great Sandy Desert?
 - In which direction are the dunes aligned in the Simpson Desert?
 - Which deserts are dominated by stonefields?
- Select two photographs of contrasting landscapes. Construct photo sketches of the contrasting landscapes.
- Study Figure 2.1.2k and complete the following tasks:
 - What is the highest mountain in the state or territory in which you live?
 - 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.
 - By how much does the elevation of Mawson Peak on Heard Island exceed that of Mount Kosciuszko?
- Study Table 2.1.2a. Construct a bar graph showing the relative size of Australia's plains.
- Study Table 2.1.2b. Construct a column graph showing the relative size of Australia's deserts.

Table 2.1.2a Australia's plains, by size

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

Table 2.1.2b Australia's deserts, by size

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

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 the 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.

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*.

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 weakness) in the rock strata.

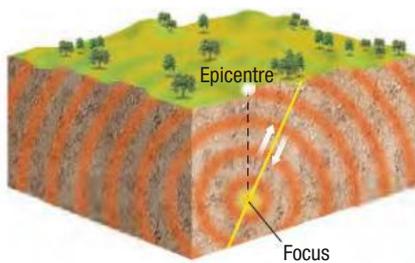


Figure 2.1.3d Earthquake epicentre and focus

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.

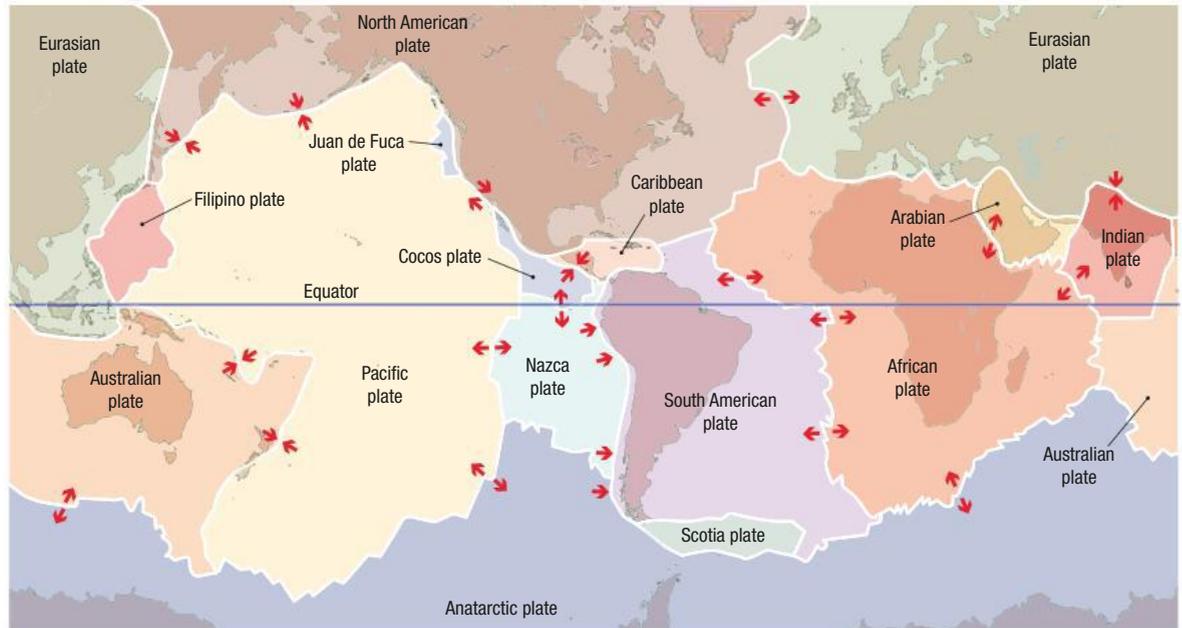


Figure 2.1.3a The Earth's crust is broken into eight vast segments, or plates, and several smaller plates.

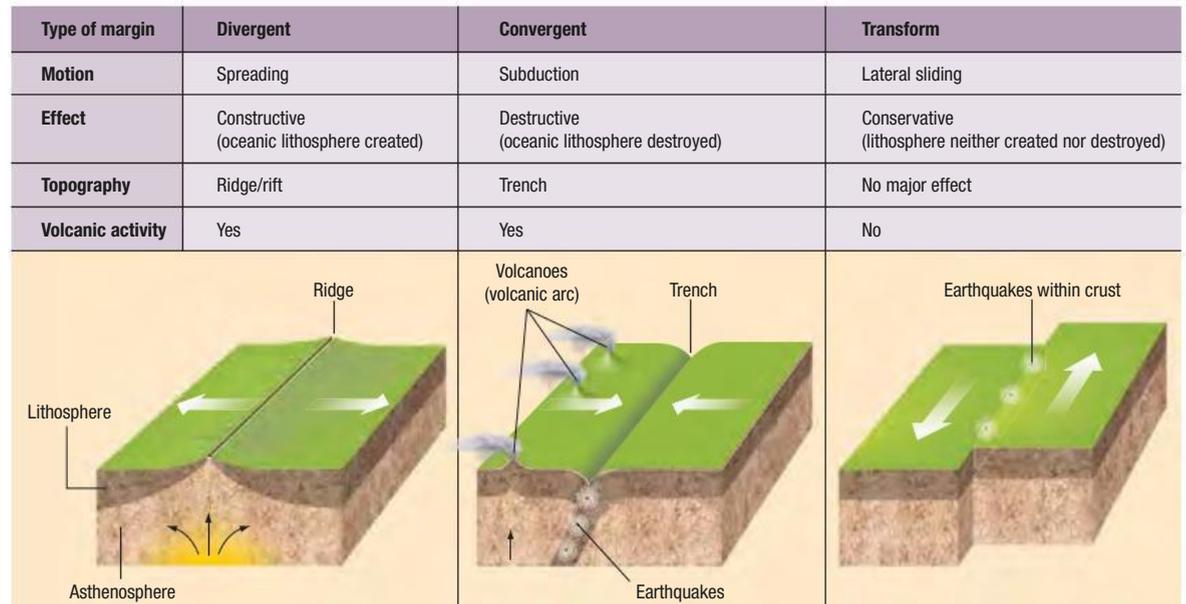


Figure 2.1.3b The three main tectonic plate boundary types

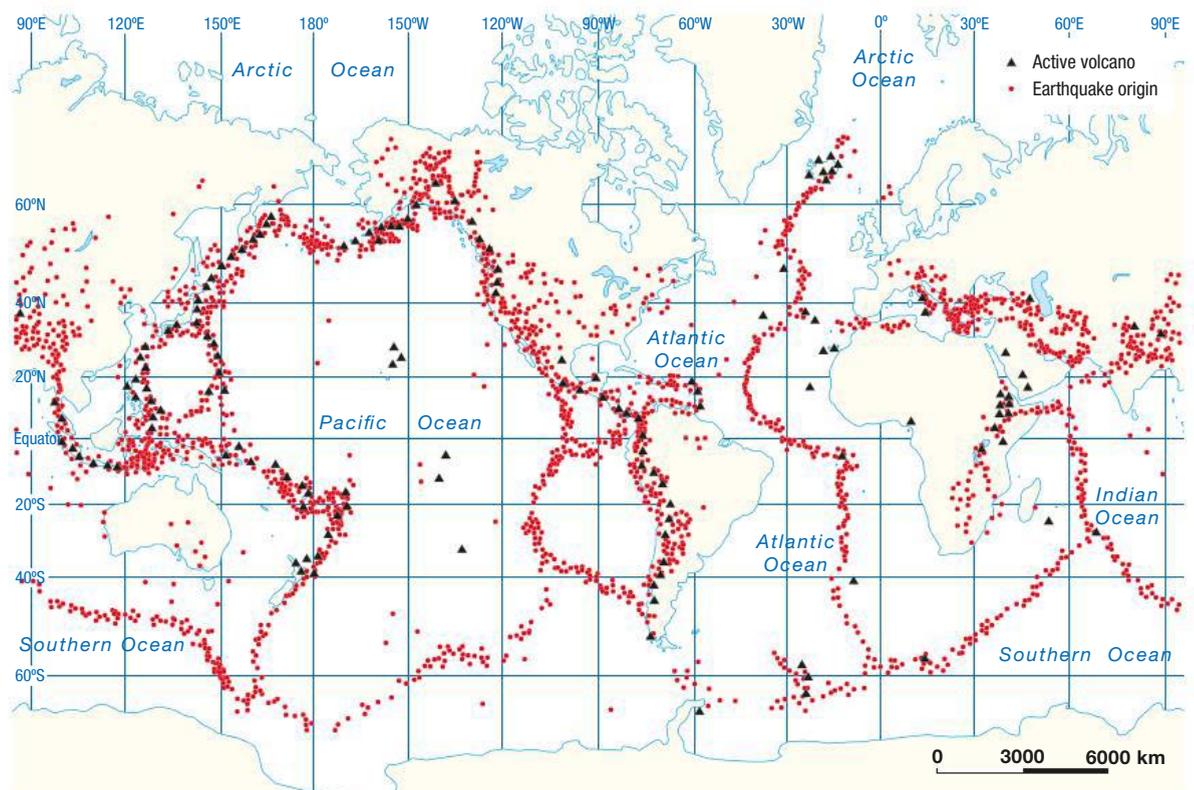


Figure 2.1.3c Recent earthquakes and volcanic eruptions

Table 2.1.3a **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 3.0–3.9	Minor	Often felt by people, but very rarely causes damage. Shaking of indoor objects can be noticeable.	130 000
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.	

Table 2.1.3c **Recent earthquakes and their effects**

Year	Place	Size*	Impacts
1976	Tangshan, China	7.8	250 000 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 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 dead across 11 countries
2008	Sichuan, China	7.9	69 000 dead; 374 600 injured; 4.8 million left homeless
2010	Chile	8.8	525 dead
2011	Christchurch, New Zealand	6.3	185 dead
2011	Japan (Tohoku) earthquake and tsunami	9.0	15 854 dead; 3155 people missing; 129 225 buildings totally destroyed, with a further 947 000 buildings partially damaged
2014	Ludian, China	7.0	617 dead; 2400 injured
2016	Kaitoura, New Zealand	7.8	2 deaths

* Richter scale

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, as the world's coastal plains are the most densely settled areas of the Earth's surface.

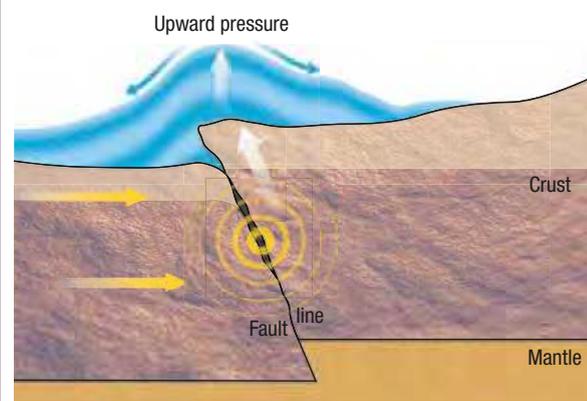


Figure 2.1.3e Tsunami wave formation

Table 2.1.3b **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



Figure 2.1.3f Lushan earthquake, China, 2013

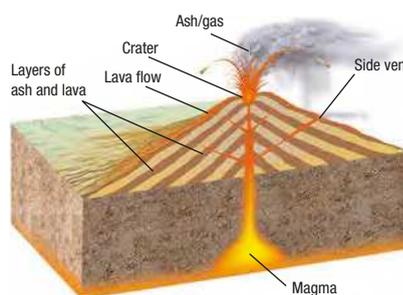


Figure 2.1.3g Features of a volcano



Figure 2.1.3h Active volcanic landscape, Bromo Tengger Semeru National Park, Indonesia

Table 2.1.3d **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 Sunda 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
2010	Mt Merapi, Indonesia	353 people were killed and 350 000 people were evacuated

ACTIVITIES

- Study Figures 2.1.3a and 2.1.3c. Describe the relationship between the distribution of earthquakes and volcanic eruptions.
- Study Figure 2.1.3b. Distinguish between divergent, convergent and transform tectonic plate margins.
- Study Figure 2.1.3d. Explain the difference between an earthquake's focus and its epicentre.
- Study Table 2.1.3a. Select a recent earthquake event and note its magnitude. State the likely effects of an earthquake of that magnitude.
- Study Table 2.1.3b. 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?
- Study Figure 2.1.3e. Write a paragraph explaining the origins of a tsunami.
- Study Table 2.1.3c. Construct a column graph showing the death toll of the 10 most deadly earthquakes since 1976.
- Study Figures 2.1.3g and 2.1.3h. Construct a photo sketch of the Bromo Tengger Semeru National Park's volcanic landscape. Annotate your sketch with the names of the prominent landform features shown.
- Study Table 2.1.3d. Construct a column graph showing the death toll of the volcanic eruptions listed.

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 healthcare 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; healthcare; 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 2016 liveability report ranked cities in Australia, Austria, Canada, Germany, Finland and New Zealand as the most liveable cities in the world. For the most part, people living in these countries' 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.

Table 2.2.1a Economist Intelligence Unit Global Liveability Ranking, 2016

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

The Mercer survey compares 221 cities on 39 measures, which include criteria related to personal safety, education, hygiene, healthcare, 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 safety/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 2.2.1b Mercer Quality of Living Survey, 2016

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

Table 2.2.1c Monocle's Most Liveable Cities Index, 2016

Rank	City	Country
1	Tokyo	Japan
2	Berlin	Germany
3	Vienna	Austria
4	Copenhagen	Denmark
5	Munich	Germany
6	Melbourne	Australia
7	Fukuoka	Japan
8	Sydney	Australia
9	Kyoto	Japan
10	Stockholm	Sweden

Planning more liveable cities

Liveability, connectivity and affordability are the top three qualities people now demand in urban living. Better connections to all elements of a city – public transport, open spaces, parks, work, entertainment, shops, cafes and restaurants – are seen as the key elements of a better living environment.

People crave connectivity. People want to live in neighbourhoods close to where they work and entertain themselves. They want to live in places with excellent infrastructure, quality public spaces and efficient transport links.

The growing demand for such urban places has initiated a boom in the

construction of medium- and high-density housing on sites close to public transport nodes, especially railway stations.

Geographers refer to this process as urban renewal and urban consolidation.

Urban renewal (the redevelopment of an urban area) is most frequently considered a response to the process of urban decay – the process by which a previously functioning part of a city falls into disuse and disrepair. The transformation of such areas into high-density residential precincts is an example of urban consolidation. Urban consolidation (or densification as it is often called) involves increasing population densities in an urban area in order to make more efficient use of existing infrastructure, and to limit

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 healthcare	1 2 3 4 5
• Quality of public healthcare	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 2.2.1a Liveability survey sheet

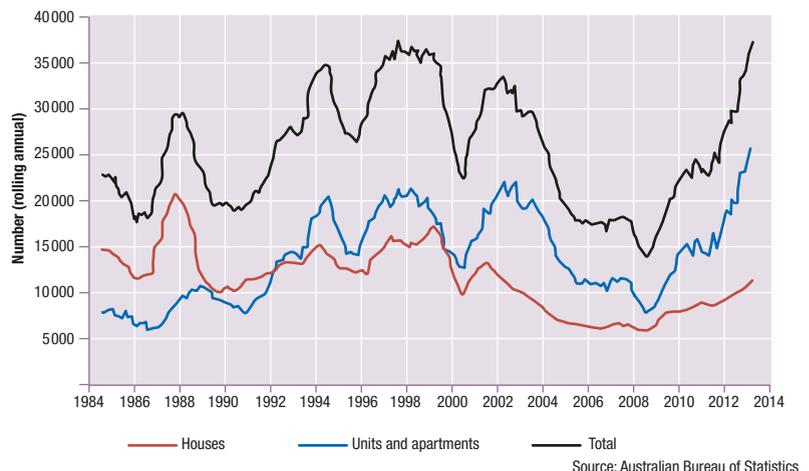


Figure 2.2.1b Sydney dwelling approvals by type, 1984–2014

the spread of urban land uses into surrounding rural areas (urban sprawl).

The need for urban consolidation in Sydney is becoming increasingly apparent. The New South Wales (NSW) State Government anticipates that the population of the city will increase to 8 million by the middle of this century (up from the current population of 5 million). The housing target for the Sydney region is an additional 664 000 dwellings. It is not feasible to accommodate this growth on the periphery of the metropolitan region. The cost of providing the necessary infrastructure would be prohibitive. Infilling is the only feasible option. Higher density living, especially in areas close to public transport nodes, is inevitable.

Darling Square is an example of urban renewal and consolidation. It is Sydney's newest residential and commercial inner-city neighbourhood in Darling Harbour. When complete, Darling Square will be home to 4200 residents and the workplace of a further 2500 people. There will be over 1500 apartments and accommodation for 1000 students in buildings of varying heights. At ground level more than 60 shops, bars and restaurants will line new streets and laneways. Commercial office space will also be included in the expectation that the area will become a new centre for firms engaged in technical innovation. Twenty-five per cent of the area will be open space.

Liveability in Sydney

In 2016, *The Sydney Morning Herald* commissioned a survey of liveability in Sydney (see Figure 2.2.1c). The study used a range of indicators to identify the most (and least) liveable suburbs in the city. The indicators included: access to employment; proximity to train, bus, light rail or ferry services; whether there are cultural facilities nearby, such as libraries, museums and art galleries; the level of traffic congestion; and closeness to schools, shopping, cafes and restaurants. Other factors used were the amount of public open space, tree cover, topographic variations, crime levels, mobile and broadband coverage and harbour and ocean views.

The most liveable suburbs were those lining the harbour and the coast. Perhaps surprisingly, some of the most liveable suburbs are also the most densely populated parts of the city. An increasing number of people are embracing high-density, inner-city housing and many apartment-dominated suburbs rated well. The high-rise, inner-city neighbourhoods of Elizabeth Bay, Potts Point, Pyrmont and Darlinghurst were all ranked in the top 50 for liveability.

Elsewhere in the city, areas once dominated by industry (known as *brownfield*) have been transformed into high-quality, high-density residential areas. The suburb of Rhodes, for example, occupies a site once dominated by a Union Carbide factory. The factory's toxic legacy had to be remediated before construction could commence. The suburb now ranks in the top 100 (out of a total of 555).

The transformation of other accessible brownfield sites into thriving medium- and high-density residential areas will continue to play an important role in accommodating the city's rapidly growing population. The string of suburbs, stretching from Central Station to Sydney's main airport, is currently being transformed into vibrant new urban precincts.

Suburbs at the bottom of the liveability ranking are those newly developed neighbourhoods on the edge of the metropolitan area. The liveability rankings of these suburbs will increase as transport services and other urban amenities improve.

There is also evidence of a multi-centre pattern of liveability developing in Sydney. Suburban precincts, located adjacent to commercial and employment hubs such as Parramatta, Penrith, Macquarie Park, Hornsby and Liverpool, now score well in terms of liveability. While such precincts have the advantages associated with access to employment, transport and services nearby, they also benefit from more open space and less congestion than suburbs closer to the city centre.

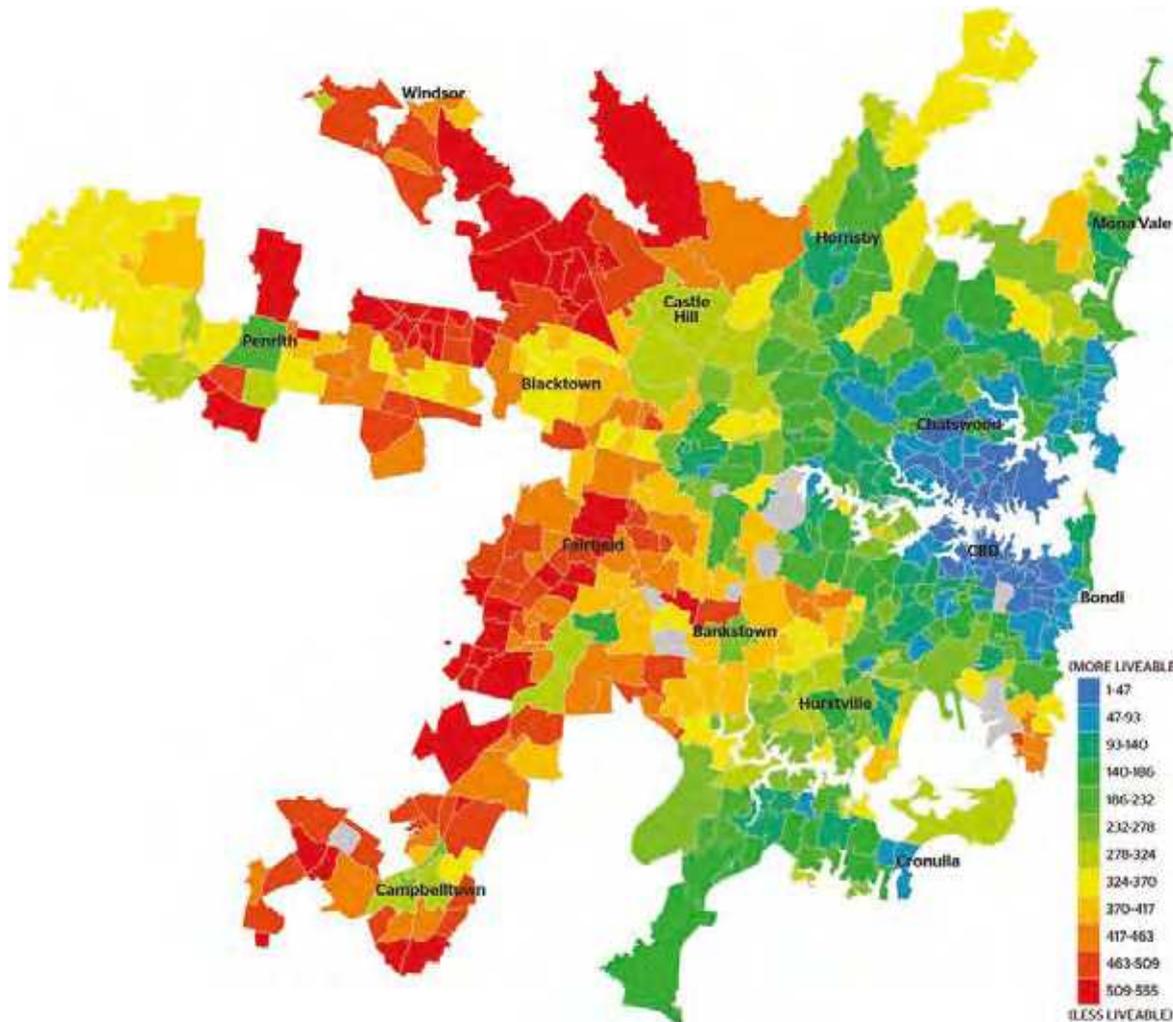


Figure 2.2.1c Suburban Sydney, liveability index, 2016

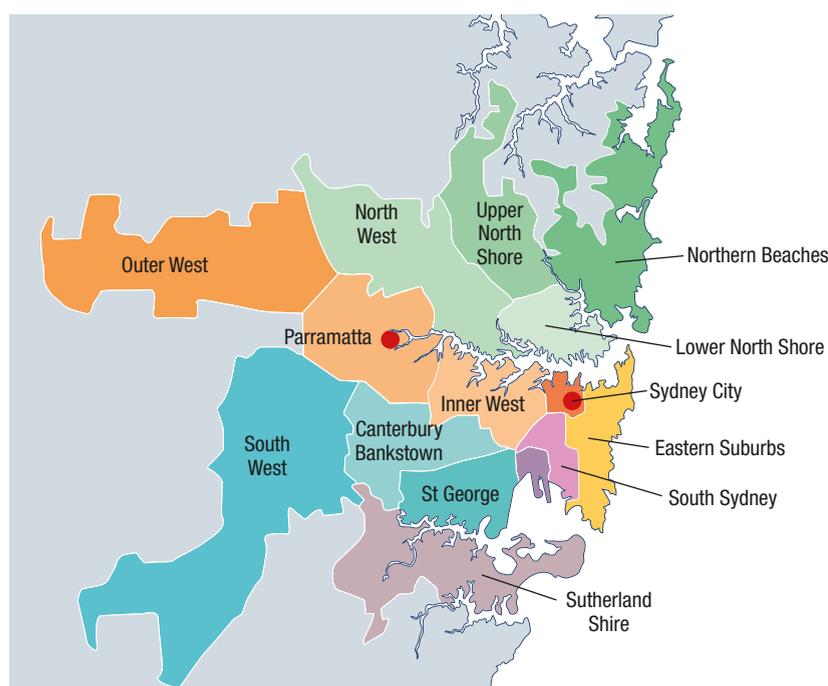


Figure 2.2.1d Sydney's geographic regions

ACTIVITIES

- 1 Study Tables 2.2.1a–c. Identify the cities common to all three liveability ranking surveys.
- 2 Study Figures 2.2.1c and Figure 2.2.1d. Describe and account for the pattern of liveability in Sydney.
- 3 Individually, rank your local neighbourhood, ranking the criteria outlined in Figure 2.2.1a on the scale 1 to 5. Tally the score.
- 4 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?
- 5 Repeat the ranking in nearby neighbourhoods. Rank the neighbourhoods assessed.



**Barangaroo:
enhancing
liveability**

The cities in which many of us live are dynamic places. They change over time. Advances in technology, the nature of economic activity, and the changing demographic and social characteristics of a population are the drivers of change. If managed carefully these changes can enhance the liveability of cities.

Over time, parts of cities experience periods of growth and decline. The latter involves deterioration in the quality of

the constructed (or built) environment. Urban infrastructure falls into a state of disrepair and buildings are left empty for long periods of time. This process is known as *urban decay*. Such areas are sometimes the focus of *urban renewal* (or redevelopment) initiatives. These aim to breathe new life into an area, once again making it relevant to the economic, political and social needs of the city and its residents.

Also relevant here is the process of urban consolidation. *Urban consolidation* is the term applied to policies designed to increase population densities in existing urban areas in order to make more

efficient use of urban infrastructure, and to limit the spread of urban land uses into surrounding rural areas (*urban sprawl*). It involves construction of medium- to high-density housing in already built-up areas, often on former industrial sites. Urban consolidation widens the range of housing types available to urban residents.

Barangaroo

Barangaroo, just to the west of Sydney's CBD, is an example of an urban precinct undergoing change. The port facilities that once lined the foreshore of Millers Point gradually fell into disuse and disrepair as

the technologies of shipping and cargo handling changed. In 2003, the NSW Government announced that the site would be transformed into a spectacular new waterfront precinct.

Today, Barangaroo is Australia's largest urban renewal project. When complete, more than \$6 billion will have been spent on the transformation of the site. More than 23 000 people will work in the precinct and thousands will call it home. Millions of Sydneysiders and tourists will visit the area to be entertained and it will become a focal point for many of Sydney's great celebrations.



Figure 2.2.2a The loading and unloading of ships in the 1920s highlights the labour-intensive nature of cargo handling before the introduction of containerisation in the 1950s.



Figure 2.2.2c In 1937 the area that is now Barangaroo was dominated by a series of finger wharves. These readily accommodated the size of ships built at the time and the methods used to handle cargo.



Figure 2.2.2b Aerial view of Millers Point finger wharves, 1950



Figure 2.2.2d The finger wharves that once dominated the site now occupied by Barangaroo can be seen in this 1951 aerial photograph of central Sydney.



Figure 2.2.2e The partially reclaimed waterfront of Millers Point (Barangaroo) in 1968. The redevelopment of the waterfront is now well advanced.

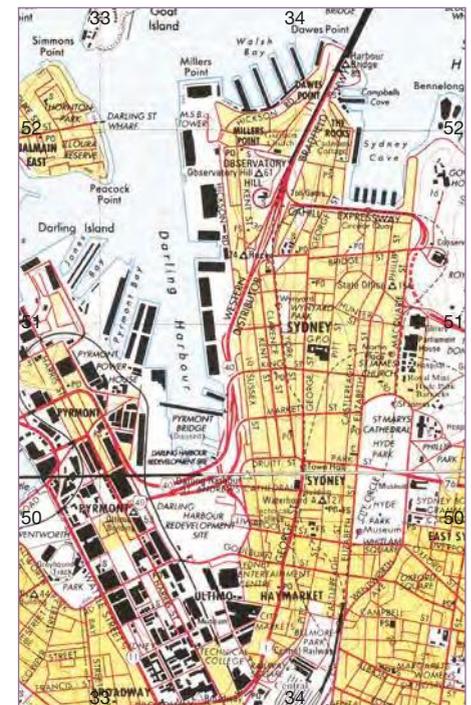


Figure 2.2.2f Topographic map of Darling Harbour and surrounds, 1972



Figure 2.2.2g Barangaroo and Darling Harbour, 2012



Figure 2.2.2h Computer-generated vertical image of the completed Barangaroo precinct

Change over time

The area now occupied by Barangaroo has been transformed a number of times. By the early 1900s the area was dominated by a series of finger wharfs that best accommodated the ships and cargo handling methods of the time. However, the technology of cargo handling was about to change. Containerisation was introduced in the 1950s. Before the introduction of containers, goods were mostly carried as general cargo. Goods were delivered to the dock by horse-drawn dray, rail or later motorised lorry in advance of the arrival of the ship and stored in warehouses. When the vessel arrived, the cargo was taken from the warehouse to the wharf and then loaded on board using either the ship's cranes or those installed dockside. The unloading of vessels was the reverse of the loading operation. This process can be seen in Figure 2.2.2a. The nature of the constructed environment that developed to accommodate this method of cargo handling can be seen in Figures 2.2.2b and 2.2.2c.

By the 1960s, the increasing size of ships, together with containerisation, brought about the most dramatic transformation in the site's maritime history. The reclamation of the foreshore zone and the construction of a large concrete apron eventually replaced the previous built environment. For a time the apron was used as a container terminal. However, the site's limitations soon

became apparent. The lack of a heavy rail link meant that containers had to be trucked through the congested streets of the Sydney CBD. As container ships became bigger this problem only worsened. The ultimate demise of commercial shipping in Darling Harbour, and Sydney Harbour as a working port, was the construction of Port Botany in 1979. In 2003, it was announced that the container terminal at Barangaroo would close.

Environmental sustainability

Barangaroo South will be Australia's first carbon-neutral urban precinct. A range of technologies will be used to minimise energy consumption. These include the addition of an automated solar-shading system on the outside of the commercial office towers and an energy-efficient centralised cooling system. The development will also be water positive. Rainwater capture, water-saving fixtures and appliances, and on-site treatment of waste water will allow water to be exported from Barangaroo South to nearby neighbourhoods and the rest of Barangaroo where it will be used to water parklands. The energy consumed in Barangaroo South will be offset by on-site and off-site solar power generation and the purchase of carbon offsets.



Figure 2.2.2i Computer-generated oblique image of the completed Barangaroo precinct



Figure 2.2.2j Computer-generated image of Barangaroo South's office towers and waterfront apartments



Figure 2.2.2k Computer-generated image of the Barangaroo South waterfront



Figure 2.2.2l Computer-generated image of Barangaroo South's public spaces



Figure 2.2.2m Computer-generated image of Barangaroo South's waterfront restaurants and cafes



Figure 2.2.2n Computer-generated image of Barangaroo South's laneways



Figure 2.2.2o Computer-generated image of Barangaroo South's public realm



Figure 2.2.2p Computer-generated image of Barangaroo South's Hickson Road streetscape

ACTIVITIES

- 1 Read the introductory text and then answer the following questions:
 - a What are the principal drivers of change in large cities?
 - b Define the concepts of urban decay, urban renewal, urban sprawl and urban consolidation.
- 2 Study Figure 2.2.2a. Describe the nature of cargo handling shown in the photograph.
- 3 Study Figures 2.2.2b to 2.2.2d. Describe the nature of the constructed environment shown in the photographs.
- 4 Study Figures 2.2.2d and 2.2.2e. Describe how the shoreline of what is now Barangaroo changed in the period 1951 to 1968.
- 5 Study Figures 2.2.2e and 2.2.2f. Describe how the shoreline of what is now Barangaroo changed between 1968 and 1972.
- 6 Study Figure 2.2.2g. In which direction was the camera facing when this

- 7 photograph was taken? Describe the nature of the constructed environment before the redevelopment of Barangaroo. Study Figures 2.2.2h and 2.2.2i. Identify the key elements of the Barangaroo redevelopment. To what extent has there been an attempt to re-establish elements of the area's original biophysical environment?
- 8 Read the text above on environmental sustainability. Outline the features of the development that contribute to the claim that it will be Australia's first carbon-neutral urban precinct.
- 9 Study Figures 2.2.2j to 2.2.2p. Using the Liveability Survey Sheet in Unit 2.1 assess the liveability of the completed Barangaroo development. Compare your findings with others in the class. To what degree is there agreement? Are there any differences in the assessments made?



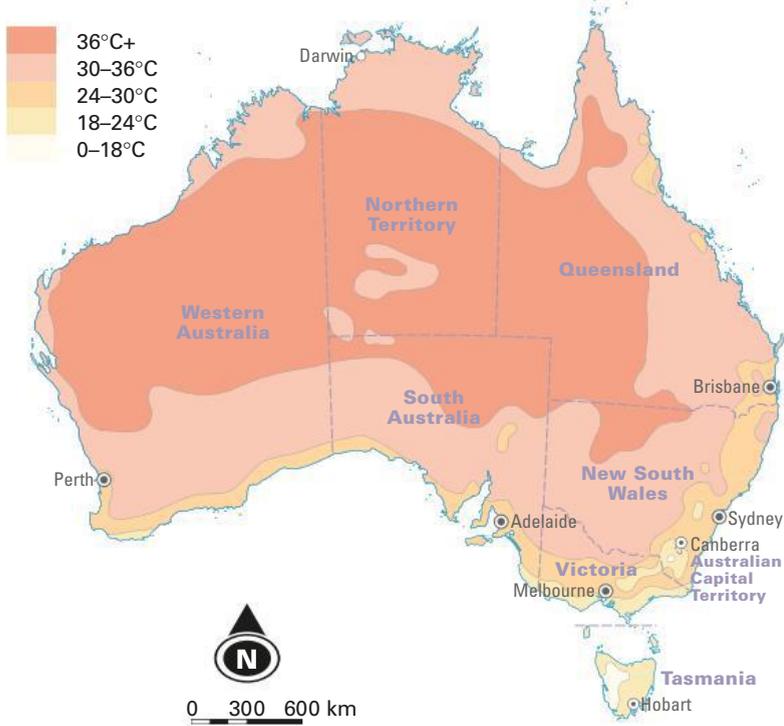


Figure 2.3.1b January maximum temperatures in Australia

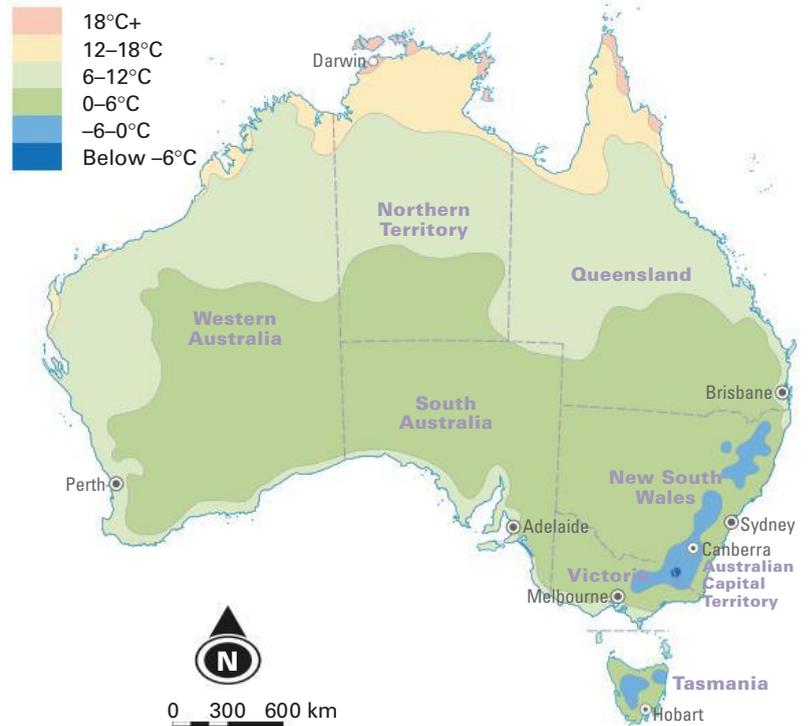


Figure 2.3.1c July minimum temperatures in Australia

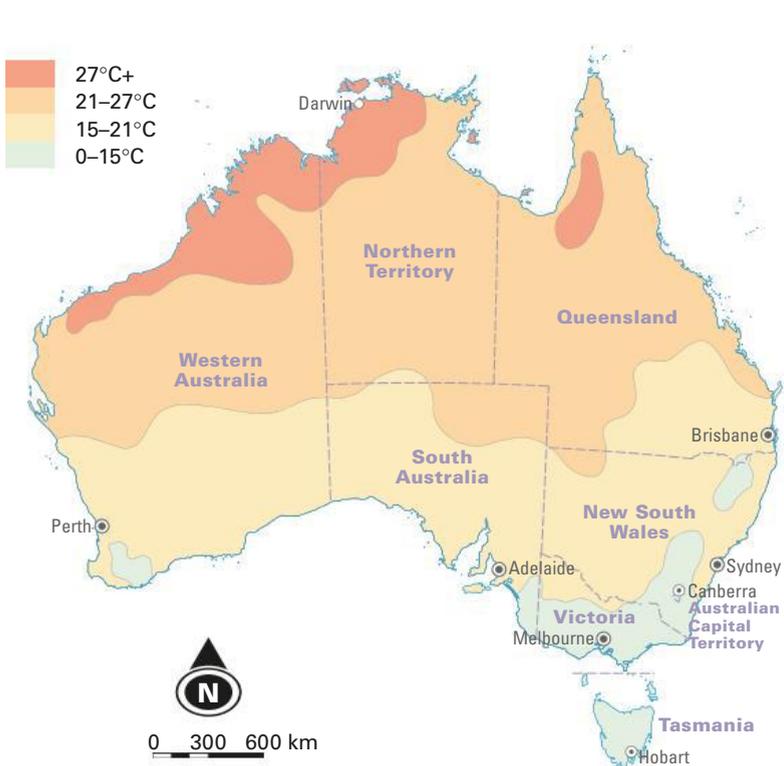


Figure 2.3.1d Mean temperatures in Australia

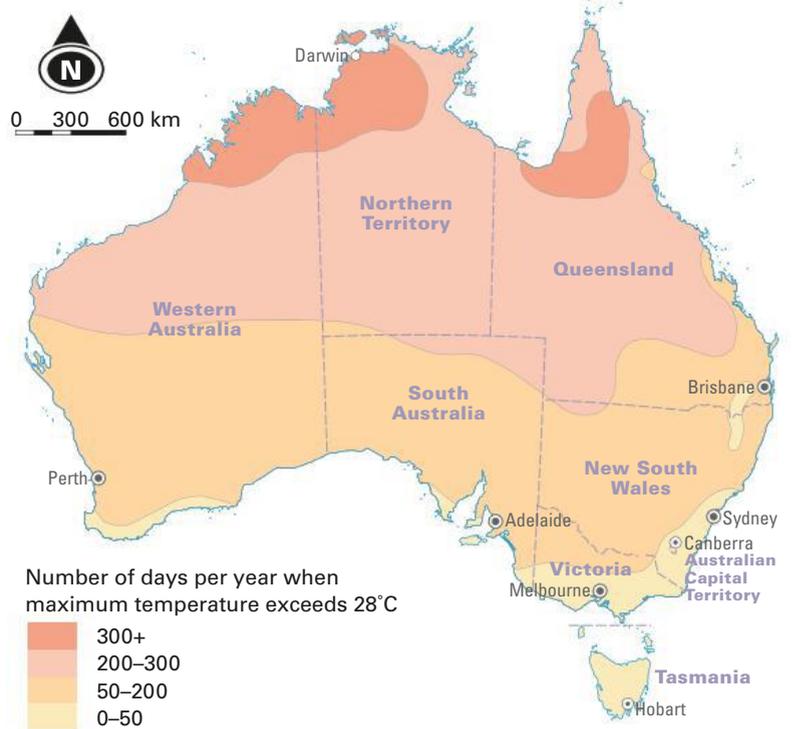


Figure 2.3.1e Hot days in Australia

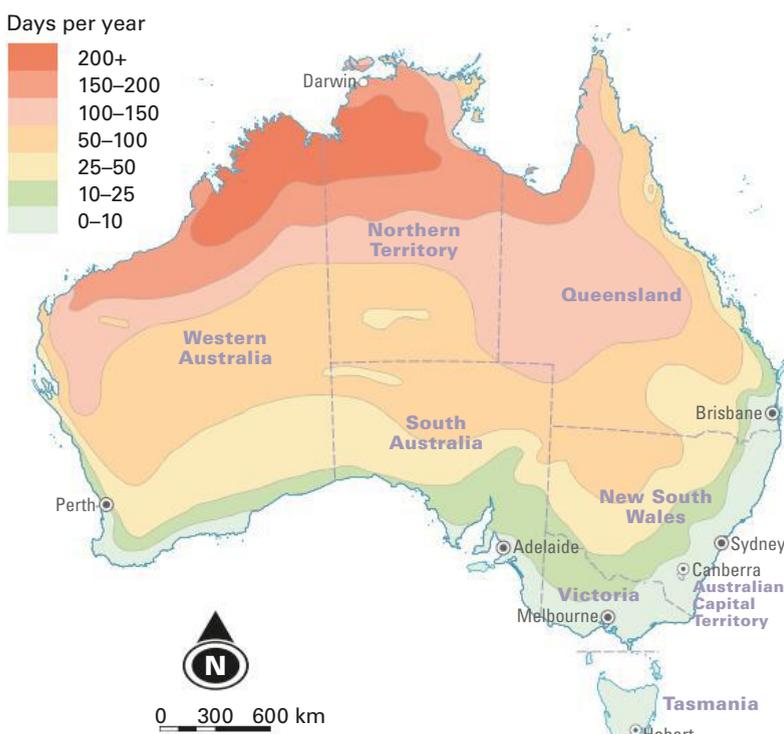


Figure 2.3.1f Heat discomfort in Australia

ACTIVITIES

- Study Figure 2.3.1a and complete the following tasks:
 - 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.
 - With the aid of Figure 2.3.1a, describe the distribution of the following climatic zones:
 - hot, humid summers
 - warm, humid summers
 - hot, dry summers and mild winters
 - hot, dry summers and cold winters
 - warm summers and cool winters
 - mild/warm summers and cold winters.
- Study Figures 2.3.1a, 2.3.1d and 2.3.1i (page 40). Describe the different climates you would experience on a road journey from Darwin to Adelaide.
- Study the climate graphs in Figure 2.3.1a and complete the following tasks:
 - Which location has the highest daily maximum temperature?
 - Which location has the lowest daily minimum temperature?
 - Which location has the largest range of mean daily maximum temperatures?
 - Which location has the smallest range of mean daily maximum temperatures?
 - Which location has the highest mean annual rainfall?
 - Which location has the lowest mean annual rainfall?
 - Estimate the average July temperature experienced by Darwin, Alice Springs, Adelaide and Hobart. Comment on the pattern evident.
 - Describe the seasonal distribution of rainfall in Cairns and Darwin.
 - Describe the seasonal distribution of rainfall in Perth and Adelaide.

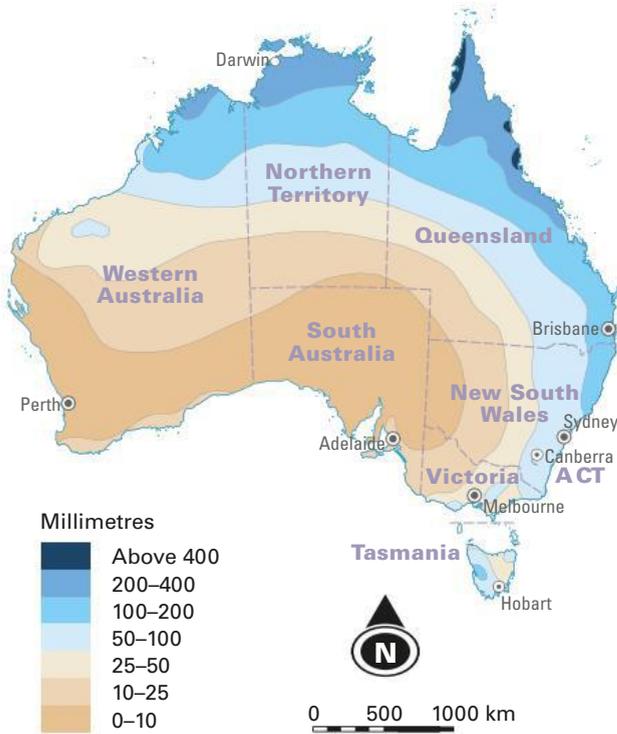


Figure 2.3.1g January rainfall in Australia

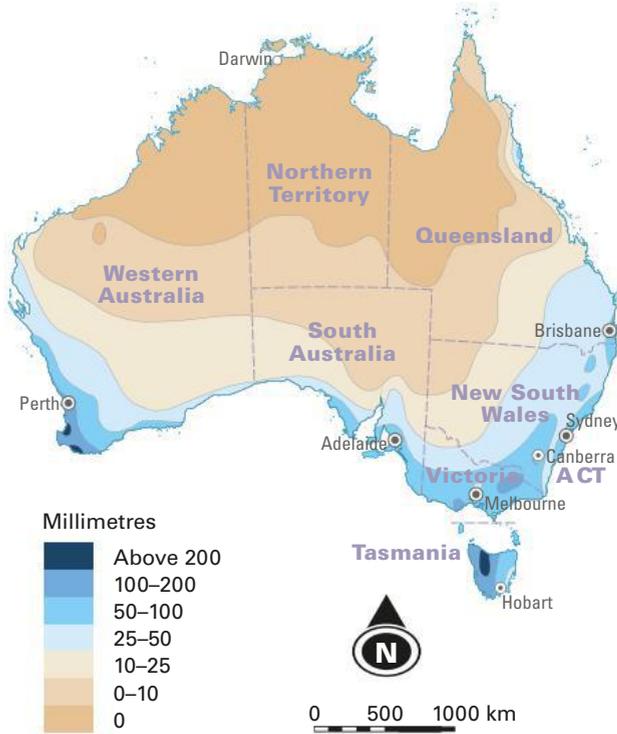


Figure 2.3.1h July rainfall in Australia

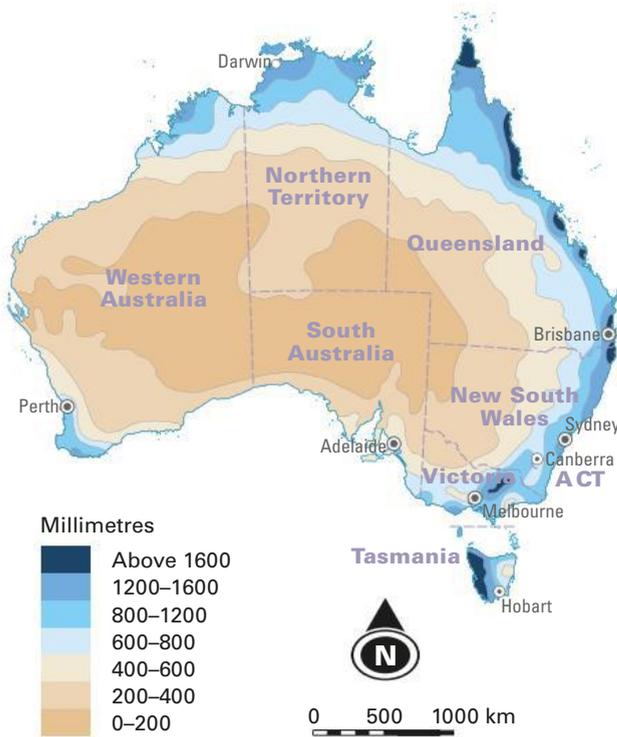


Figure 2.3.1i Median annual rainfall in Australia

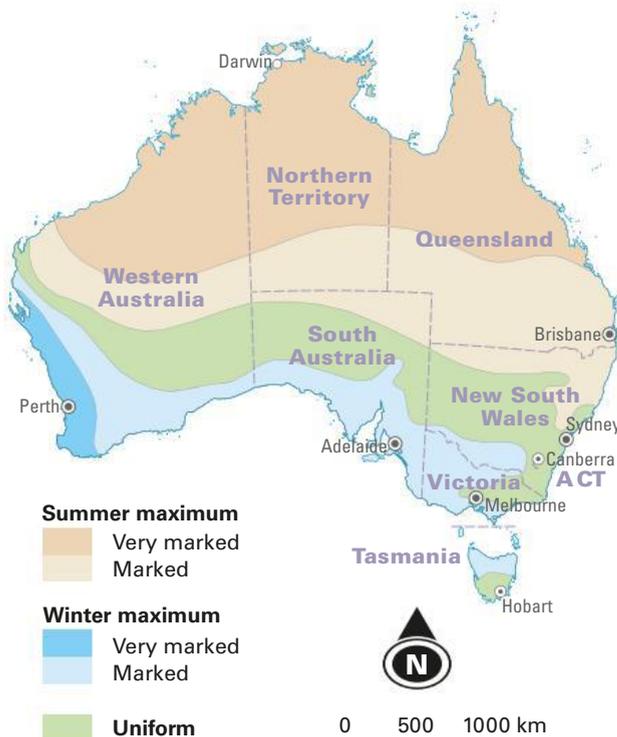


Figure 2.3.1j Seasonal rainfall in Australia

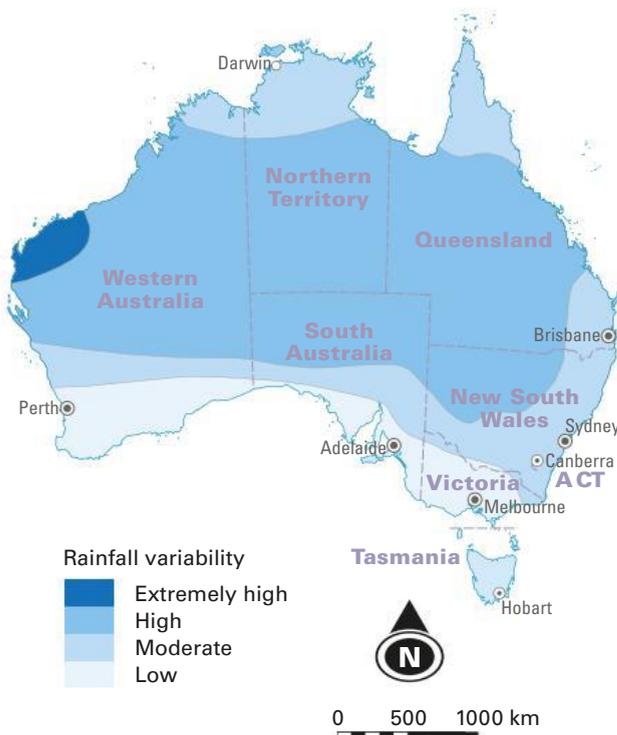


Figure 2.3.1k Rainfall variability in Australia

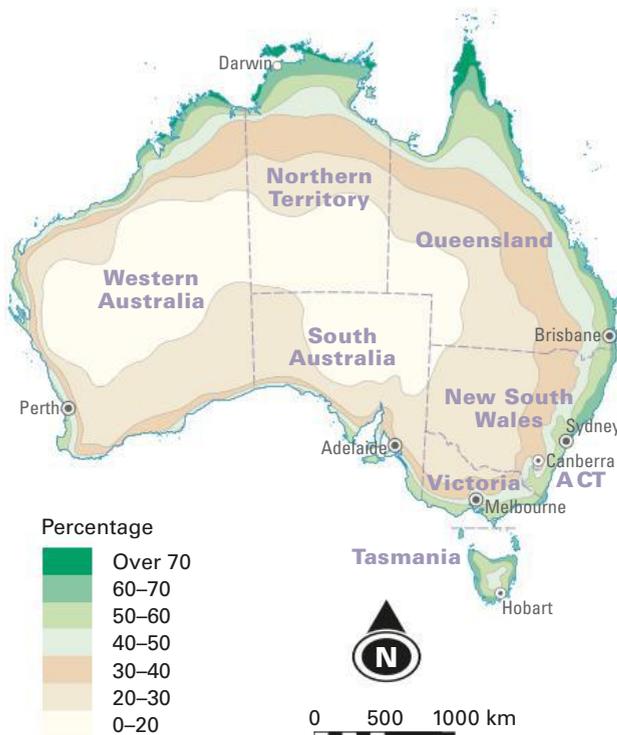


Figure 2.3.1l Relative humidity in Australia

- 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 2.3.1b (page 39) 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 2.3.1c (page 39) 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 2.3.1d (page 39) and describe the pattern of mean temperatures.
- 7 Study Figure 2.3.1e (page 39) 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 2.3.1f (page 39) 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 2.3.1g 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 2.3.1b, 2.3.1f (page 39) and 2.3.1g. What factors contribute to the high levels of heat discomfort in north-west Australia?
- 11 Study Figures 2.3.1i and 2.3.1j. Describe the seasonal distribution of rainfall in northern Australia.
- 12 Study Figure 2.3.1h. Describe the general pattern of July rainfall.
- 13 Study Figure 2.3.1i. Describe the pattern of median annual rainfall.
- 14 Study Figure 2.3.1j 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 2.3.1k 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 2.3.1l. What locational factor appears to be the most important influence on relative humidity?

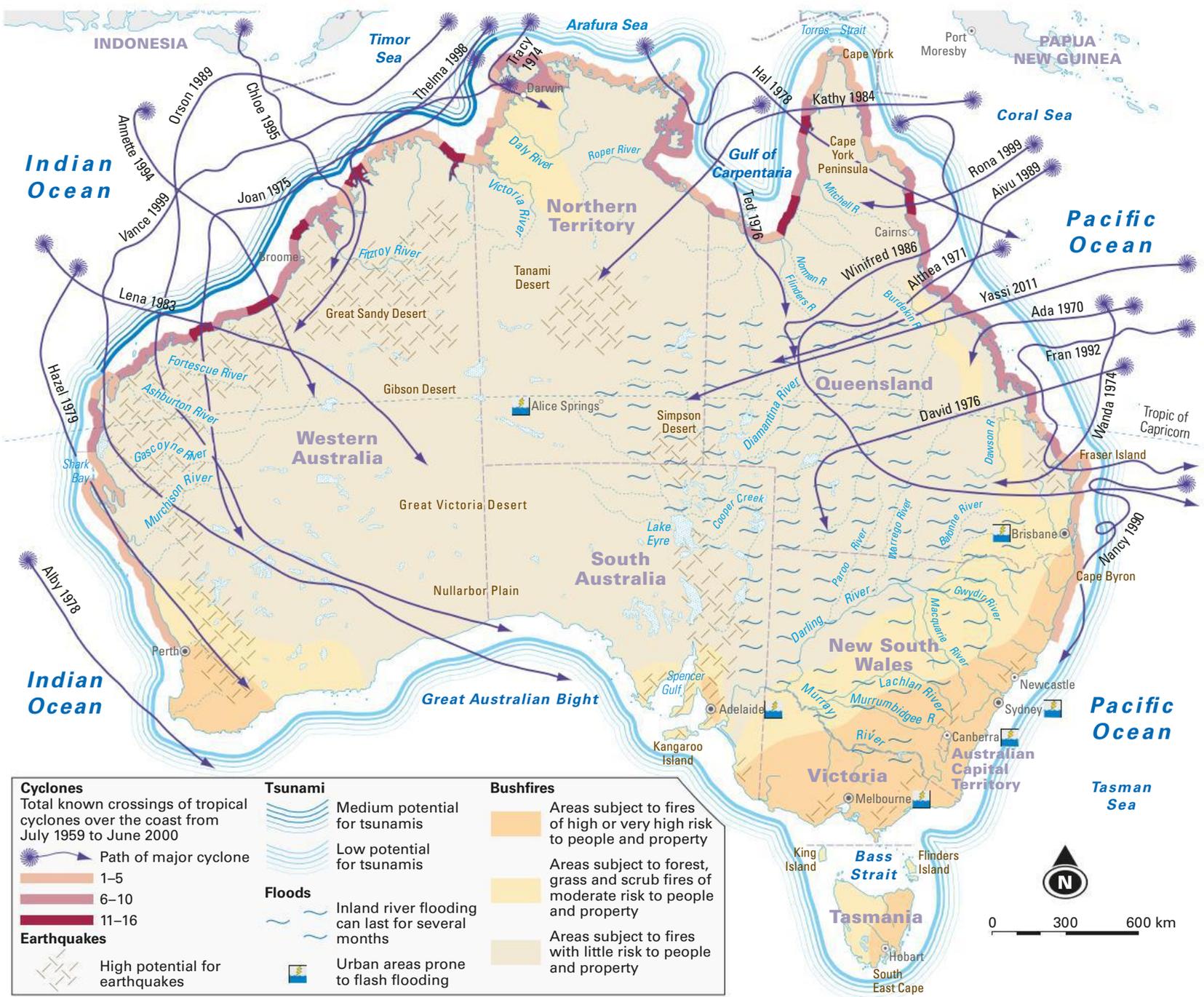


Figure 2.3.2a Natural hazards in Australia

ACTIVITIES

Study Figure 2.3.2a 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 2.1.2a (page 30), 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 2.3.2b Storm damage



Figure 2.3.2c Bushfire





Figure 2.3.3a A summer storm rolls across Sydney

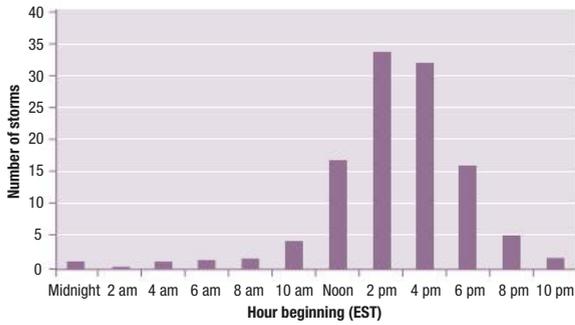


Figure 2.3.3c Average distribution of severe thunderstorms in NSW and the ACT by time of day

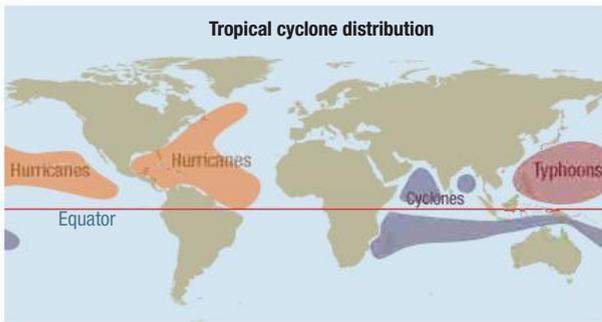


Figure 2.3.3e Getting the name correct! Tropical cyclones, hurricanes and typhoons

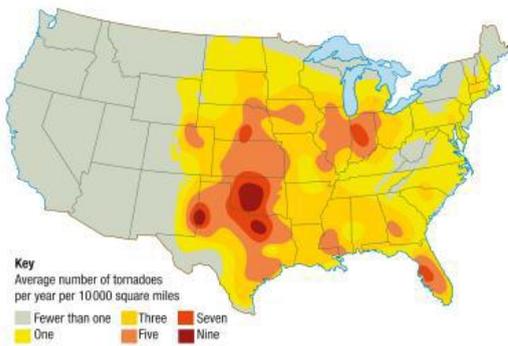


Figure 2.3.3g Average number of tornadoes per year, United States

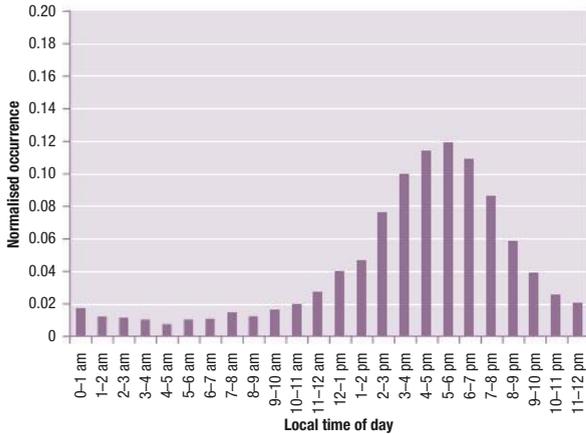


Figure 2.3.3i Average number of tornadoes per hour of day, United States



Figure 2.3.3j Flash flooding in suburban Melbourne

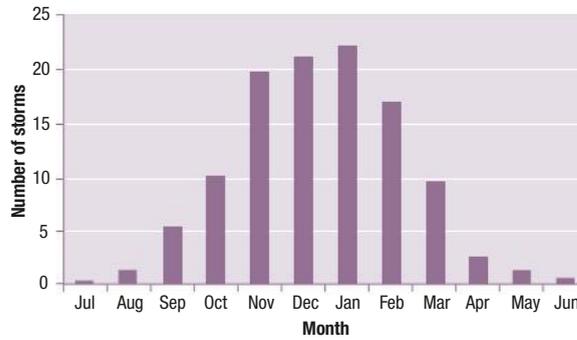


Figure 2.3.3b Average monthly distribution of severe thunderstorms in NSW and the ACT

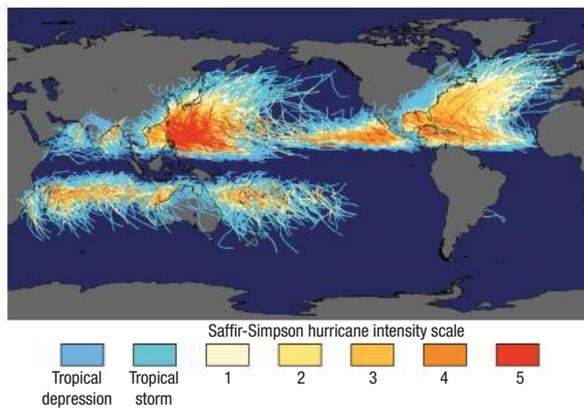


Figure 2.3.3d Distribution and intensity of tropical cyclones, hurricanes and typhoons



Figure 2.3.3f Three tornadoes on the ground at the same time near Dodge City, Kansas, 24 May 2016

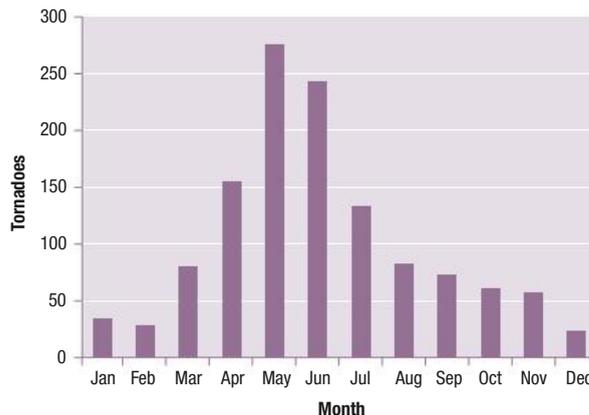


Figure 2.3.3h Average number of tornadoes per month, United States, 1991-2010



Figure 2.3.3k Couple awaiting rescue during flooding in southern Queensland

Weather-related hazards and disasters include severe storm systems, tornadoes, flooding, heatwaves and drought. They are all classified as natural hazards and disasters. Natural hazards are extreme and unusual natural events. When natural hazards impact on people, they are referred to as natural disasters.

Severe storms

Severe storms are the most common of all the atmospheric hazards. They are a local disturbance in the atmosphere and are accompanied by thunder, lightning, rain, hail and, in some cases, snow. They can occur anywhere and are responsible for more damage than any other natural hazard. (See Figures 2.3.3a, 2.3.3b and 2.3.3c.)

Tropical cyclones

Tropical cyclones (also known as hurricanes and typhoons in other parts of the world) are intense low-pressure systems (or severe storms) that form over warm tropical waters. Tropical cyclones are typically accompanied by damaging, gale-force winds and torrential rainfall. (See Figures 2.3.3d and 2.3.3e.)

Tornadoes

A tornado is a violently rotating column of air extending from the base of a thunderstorm to the ground. The most violent tornadoes carve a path of destruction across the landscape. (See Figures 2.3.3f, 2.3.3g, 2.3.3h and 2.3.3i.)

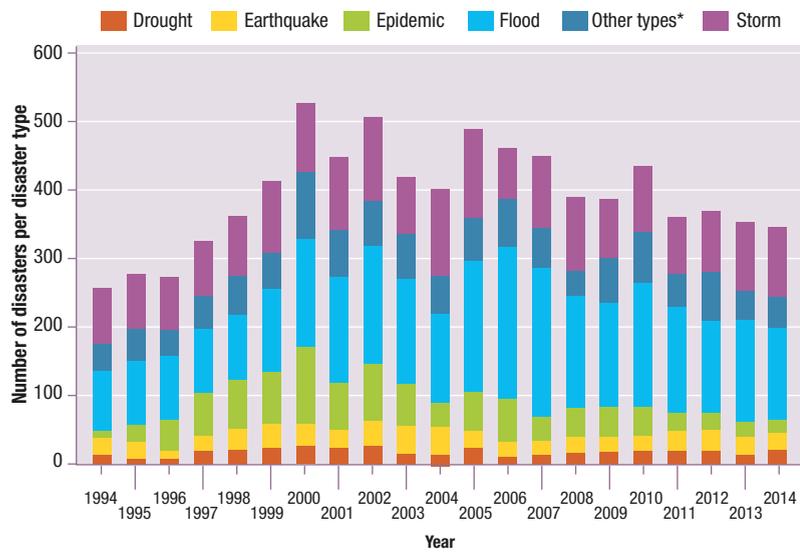
Flooding

Floods occur when a waterway overflows its natural banks onto normally dry land. Floods can result from prolonged periods of rain, rapid winter snowmelt or sudden, heavy downpours. (See Figure 2.3.3j.)

There are three types of floods:

- *Slow-onset floods* build up over time and may last for weeks, even months. They are often the result of a long period of above-average rainfall.
- *Rapid-onset floods* occur more quickly, and are more common in mountain areas of larger river systems and in rivers draining to the coast. These floods often only last a day or two.
- *Flash floods* occur when intense storms bring large amounts of rainfall within a brief period of time. Flash floods can be extremely dangerous. Sometimes they are caused by heavy rainfall many kilometres away. The resulting floodwaters surge down waterways, sweeping away all in their path: they can move boulders, tear out trees and destroy buildings and bridges.

Other types of atmospheric and hydrological hazards include heatwaves and drought.



* Figures include disasters such as insect infestation, extreme temperature, landslide, volcanic activity and wildfire.

Figure 2.3.3l Recorded natural disasters worldwide, by type, 1994–2014

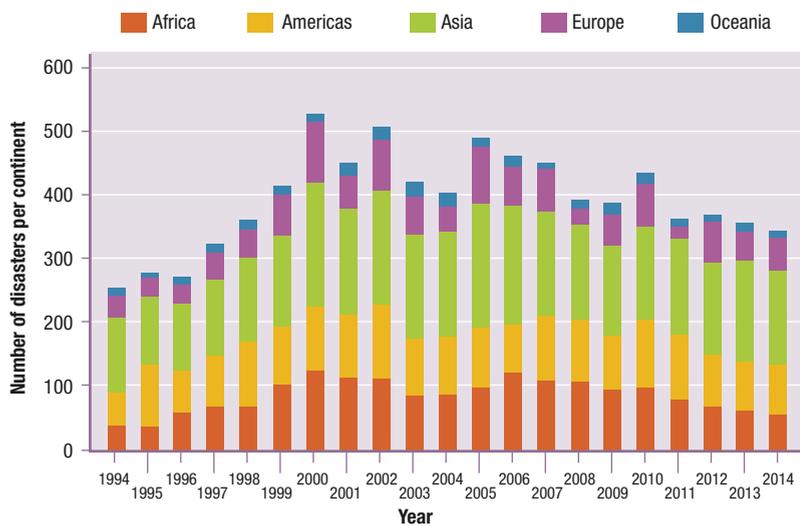
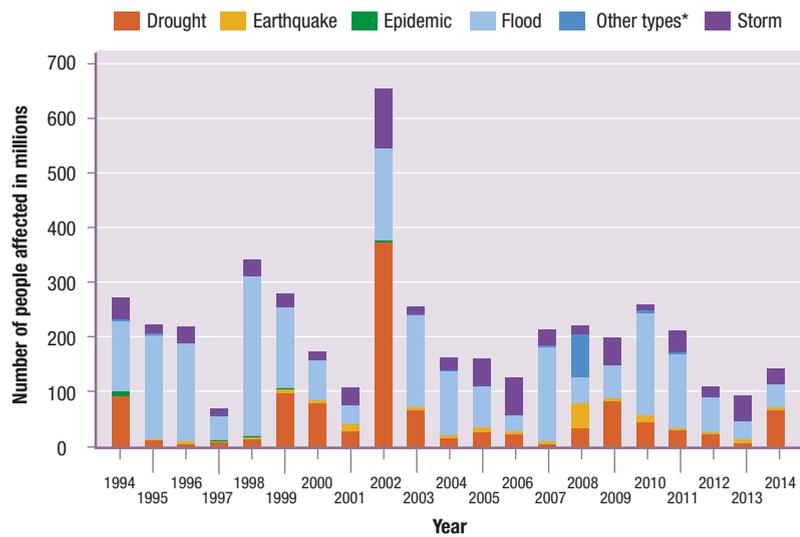


Figure 2.3.3m Recorded natural disasters worldwide, by region, 1994–2014



* Figures include disasters such as insect infestation, extreme temperature, landslide, volcanic activity and wildfire.

Figure 2.3.3n Estimated number of people affected by natural disasters, by type, 1994–2014

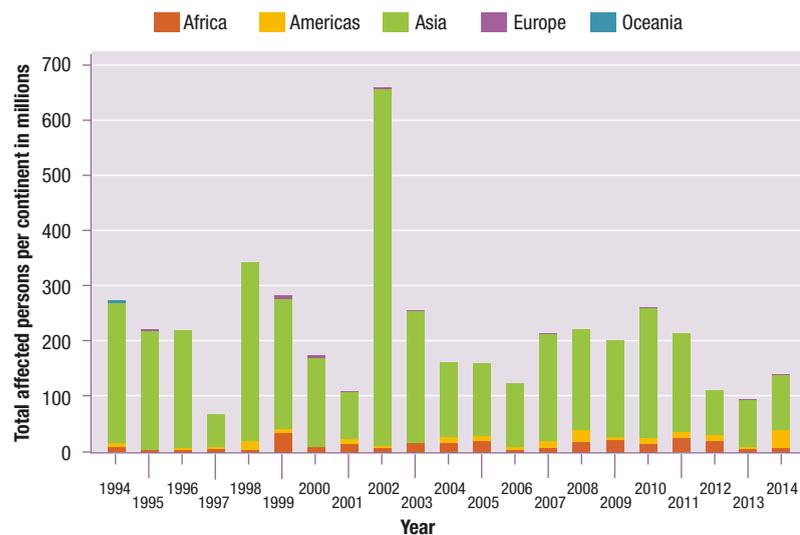


Figure 2.3.3o Estimated number of people affected by natural disasters, by region, 1994–2014



Figure 2.3.3p Rainfall is the most important factor in the onset of flooding, but there are many other contributing factors. When rain falls in a catchment, the amount of rainwater that reaches its rivers and streams depends on the characteristics of the catchment, particularly its size, shape and the land uses present. Some rainfall is captured by soil and vegetation, and the remainder enters waterways as flow. River characteristics such as size and shape, the vegetation in and around the river, and the presence of structures in and adjacent to the waterway all affect the level of water in the waterway.

ACTIVITIES

- Read the introductory text and answer the following questions:
 - List the types of weather-related hazards and disasters.
 - Name the atmospheric hazard responsible for more damage than any other natural hazard.
 - State the names given to tropical storm systems in various parts of the world.
 - Distinguish between slow-onset, rapid-onset and flash flooding.
- Study Figures 2.3.3b and 2.3.3c and answer the following questions:
 - In which month of the year does the number of severe storms peak in NSW and the ACT?
 - In which season do most storms occur?
 - At what time of day are severe storms likely to occur?
- Study Figures 2.3.3d and 2.3.3e and answer the following questions:
 - In which region of the world do hurricanes occur?
 - In which region of the world do typhoons occur?
 - Locate the region that experiences the most intense (Category 5) hurricanes/typhoons.
- Study Figures 2.3.3g to 2.3.3i and answer the following questions:
 - With the aid of an atlas identify where the average number of tornadoes a year exceeds nine.
 - In which months of the year does tornado activity peak?
 - At what time of day are tornadoes most likely to occur?
- Study Figures 2.3.3l to 2.3.3o and answer the following questions:
 - Which year was the worst for recorded natural disasters by type?
 - In a typical year what is the most common form of recorded natural disaster?
 - Which was the worst year for flooding?
 - In a typical year which region experiences the greatest number of natural disasters?
 - Which region is least likely to experience a natural disaster?
 - In which year did drought affect the greatest number of people?
 - In which year did flooding have the greatest impact on the world's population?
 - In which year was the largest number of people affected by natural disasters? In which years were the fewest number of people affected?
 - How many people living in Asia were affected by natural disasters in 2002?
- Study Figure 2.3.3p. Write a paragraph or two outlining the factors that contribute to flooding in the catchment illustrated.

2.4

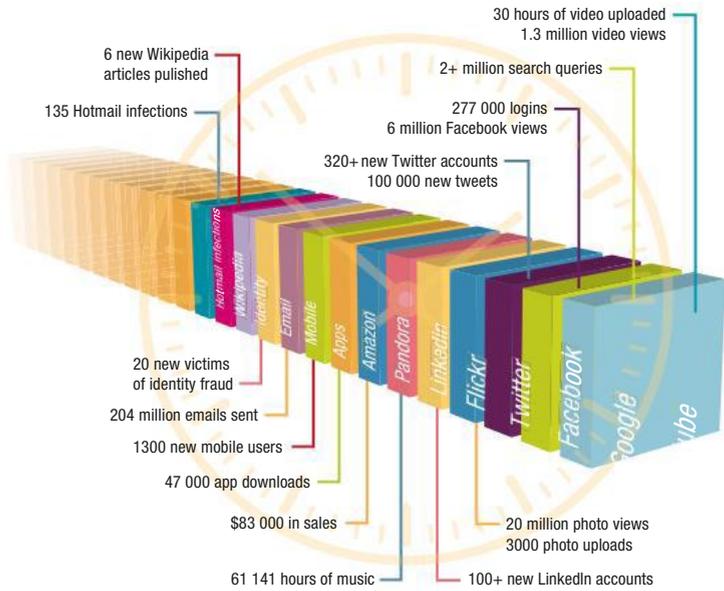
2.4.1

Interconnections

Connecting with people and places

The use of technologies such as the internet and smartphones means that 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.

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.



And future growth is staggering

Today, the number of networked devices = the global population

In 2015, the number of networked devices = 2 x the global population

It would take you 5 years to view all video crossing IP networks each second.

Figure 2.4.1a What happens in an internet minute?

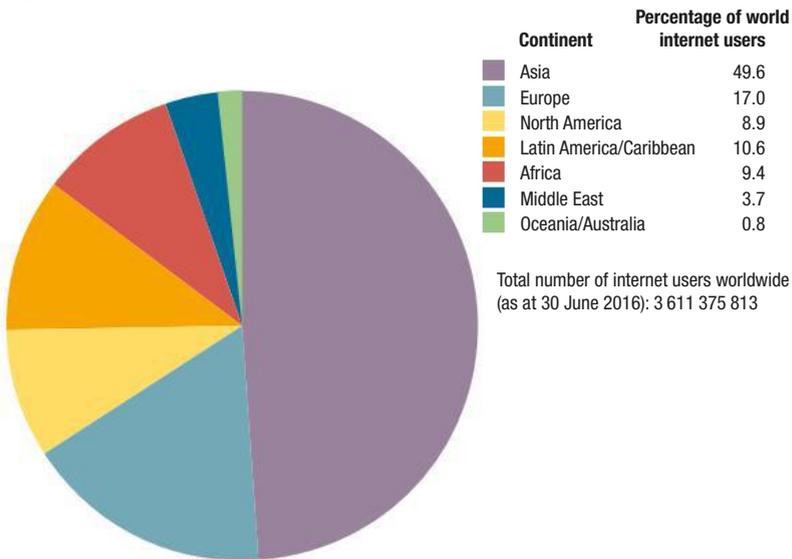


Figure 2.4.1c Internet users, distribution by region, June 2016

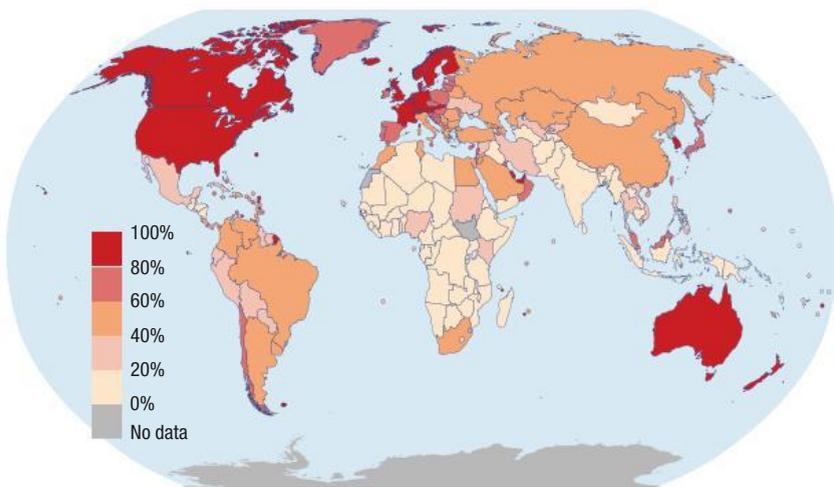


Figure 2.4.1e Percentage of population using the internet, by country, 2014

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 3.6 billion in 2016.

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.

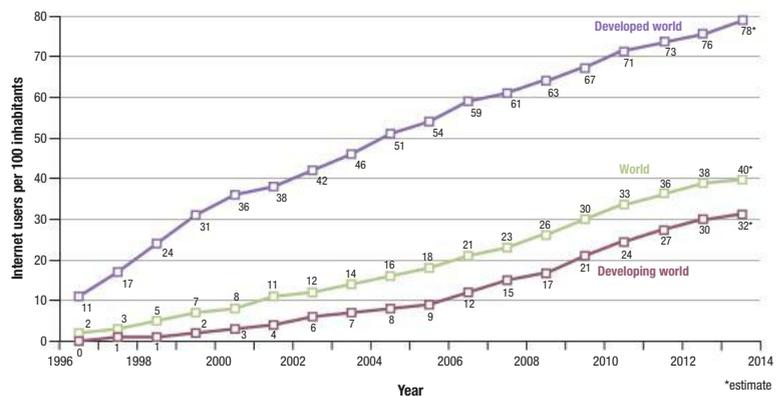


Figure 2.4.1b Internet users, percentage of population, 1997 to June 2014

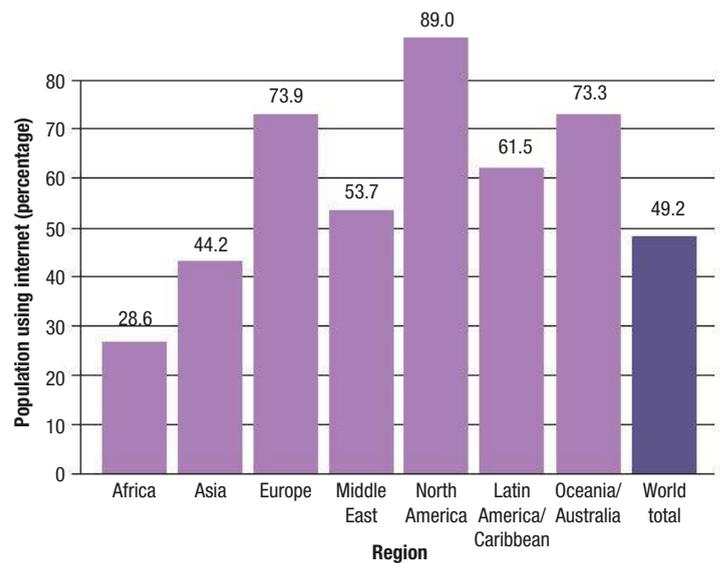


Figure 2.4.1d Percentage of population using the internet, by region, 2016

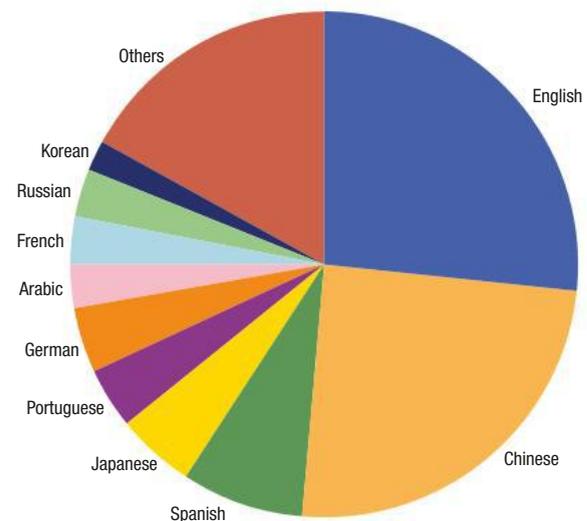


Figure 2.4.1f Internet users by language, 2014

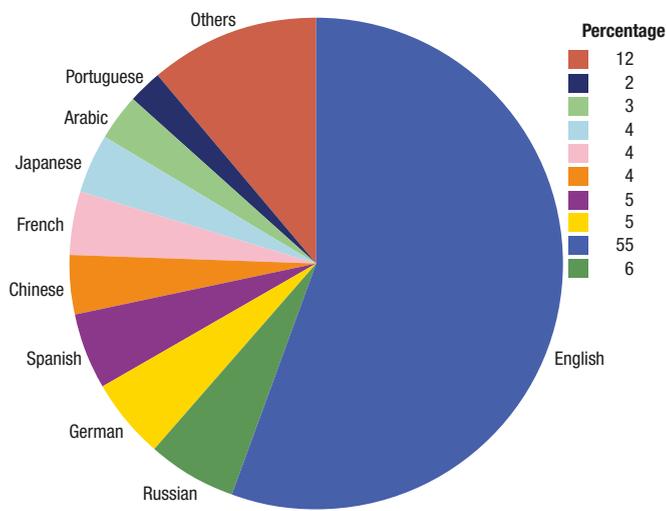


Figure 2.4.1g Websites by language, 2014

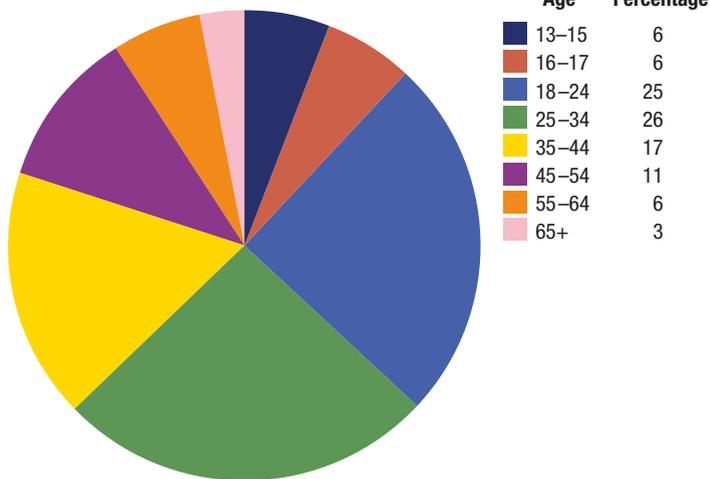


Figure 2.4.1i Age distribution of Australian Facebook users

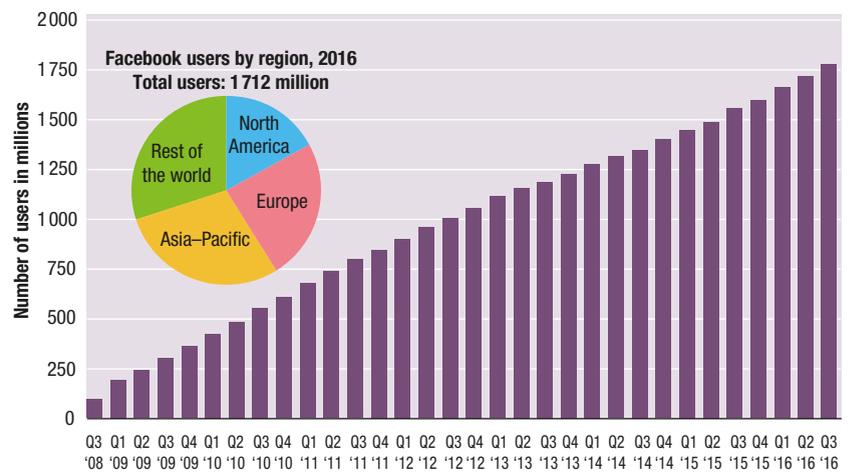


Figure 2.4.1h Number and distribution of monthly active Facebook users worldwide, third quarter 2008 to third quarter 2016 (in millions)

FACEBOOK

Facebook is the world's most popular social networking site. Mark Zuckerberg, and fellow Harvard College students and roommates, launched the site in February 2004. As of the end of January 2016, there were 1.59 billion users active on the website every month. The company had a share market value of US\$350 billion in mid-2016.

After registering to use the Facebook site, users can create a personal profile and add other users as 'friends'. They can also exchange messages, post status updates and photos, share videos and receive notifications when others update their profiles.



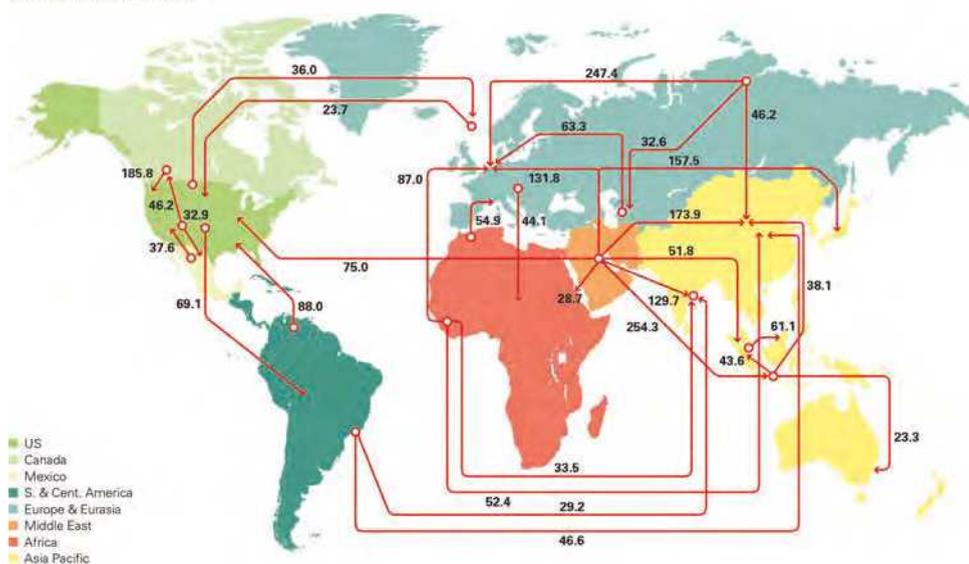
Figure 2.4.1j Map of world airline routes. The map shows 59036 airline routes between 3209 airports by 531 airlines.

AIR TRANSPORT

Developments in aviation technology, especially the introduction of the Boeing 747 and 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.

Major trade movements 2015



Oil trade in 2014 and 2015

Figure 2.4.1k Major international movements of oil, 2015

WORLD OIL TRADE

The global oil industry includes the exploration, extraction, refining, transporting and marketing of oil-based products, especially petroleum. The principal products of the industry are fuel oil and petrol. Oil is also the raw material for many chemical products, including pharmaceuticals, solvents, fertilisers, pesticides and plastics.

The global pattern of production and consumption features significant differences between areas of production and consumption. To address this, a vast global distribution system has been developed using tankers and pipelines.

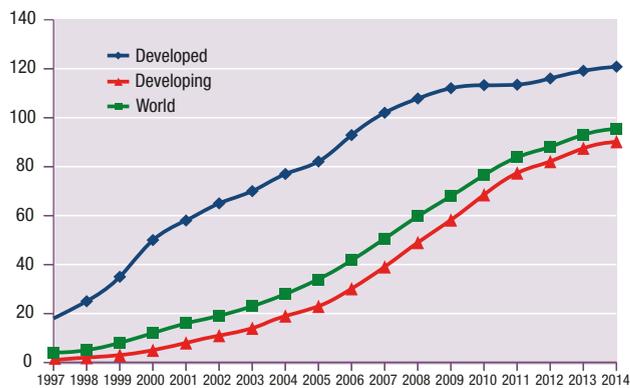


Figure 2.4.1l Mobile phone subscribers per 100 inhabitants, 1997–2014

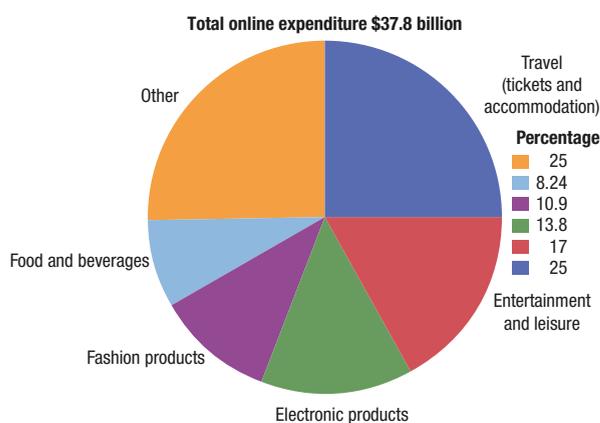


Figure 2.4.1n Online expenditure by category, 2015

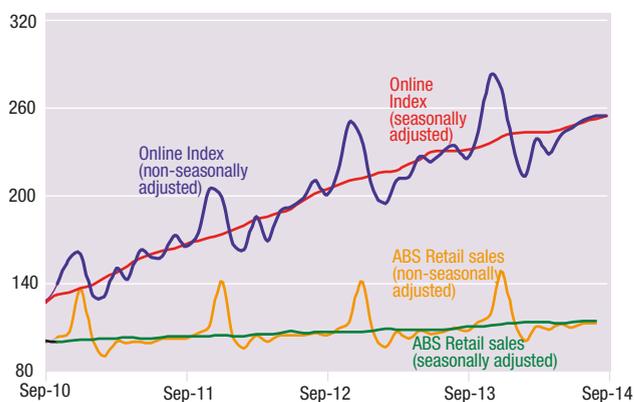


Figure 2.4.1m Growth in online retailing compared to traditional retailing, 2010–2014

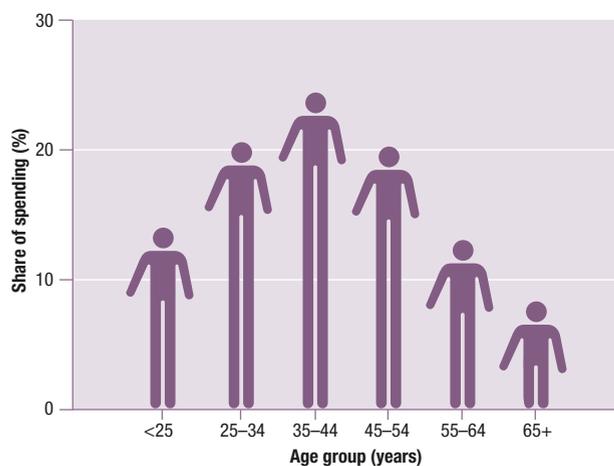


Figure 2.4.1o Share of online spending by age group

Table 2.4.1a Australia's major trading partners, 2014

Country	Exports (A\$ million)	Imports (A\$ million)	Total trade (A\$ million)
China	98 210	54 258	152 468
Germany	2 867	13 858	16 725
Japan	50 247	19 971	70 218
Malaysia	7 923	12 659	20 582
New Zealand	12 125	11 343	23 467
Republic of Korea	22 017	12 609	34 626
Singapore	12 085	18 102	30 187
Thailand	6 105	12 873	18 978
United Kingdom	8 319	12 469	20 788
United States	18 510	41 932	60 442

Source: <http://dfat.gov.au/trade/resources/trade-at-a-glance/pages/default.aspx>

STAYING CONNECTED

In 2014 there were 84 mobile phone subscriptions per 100 people in the developing world. In the developed world there were 120 subscriptions per 100 – meaning that every fifth person has two phones! By mid-2015 there were 21 million mobile phone subscribers in Australia.

ONLINE RETAILING

In 2015, the value of e-commerce exceeded US\$2.05 trillion in a single year for the first time. Australia's share of this was US\$36.2 billion. More than 12 million Australians, or half the population, bought something online in 2015, spending an average of \$4106 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, which came in at number one.

AUSTRALIA'S MAJOR TRADING PARTNERS

International trade involves the transfer of goods and services from one country to another in exchange for money, goods or services. Australia's two-way trade in goods and services was worth nearly \$670 billion in 2015 – a vital component of Australia's economic prosperity. Australia's 10 largest trading partners are listed in Table 2.4.1a.

ACTIVITIES

- Study Figure 2.4.1a (page 44). 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?
- Study Figure 2.4.1b (page 44) and then answer the following questions:
 - When did the internet reach 50 per cent of the inhabitants in the developed world?
 - What rate was achieved in the developing world in that year?
 - What was the gap in internet users per 100 inhabitants between the developed and developing world in 2014?
- Study Figure 2.4.1c (page 44) and then answer the following questions:
 - Which region has the largest number of internet users?
 - How many internet users were there in Europe in 2016?
- Study Figure 2.4.1d (page 44). Which region had the highest internet penetration rate in 2016? Which had the lowest?
- Study Figure 2.4.1e (page 44) and then answer the following questions:
 - Which countries/regions had an internet use rate greater than 80 per cent in 2014?
 - In which regions were the rate of internet usage lowest?
- Study Figure 2.4.1f (page 44) and then answer the following questions:
 - Which are the two content languages most commonly found on the internet?
 - What percentage of internet users speak:
 - English
 - Chinese?
- Study Figure 2.4.1g (page 45). State the percentage of the world's websites that are English based. What is the most distinctive difference between the language of internet users shown in Figure 2.4.1f (page 44) and the website languages shown in Figure 2.4.1g?
- Study Figure 2.4.1h (page 45) and complete the following tasks:
 - Calculate the percentage by which the number of Facebook users increased between the 4th quarter 2011 and the 2nd quarter of 2016.
 - Calculate the number of Facebook users in the Asia-Pacific region.
- Study Figure 2.4.1i (page 45). Estimate the percentage of Facebook users in the 18–34 age groups. What percentage of users are over the age of 55?
- Study Figure 2.4.1j (page 45). With the aid of an atlas, identify the world's main concentrations of airline activity.
- Study Figure 2.4.1k (page 45). With the aid of an atlas, identify the four most important markets for oil sourced from the Middle East.
- Study Figure 2.4.1l. Using data from the graph outline the trends in mobile phone use 1997–2014.
- Study Figure 2.4.1m. Compare the trend in online retailing (seasonally adjusted) to traditional retailing as measured by the Australian Bureau of Statistics (ABS).
- Study Figure 2.4.1n. Calculate the amount spent in entertainment and leisure in 2015.
- Study Table 2.4.1a and then complete the following tasks:
 - Identify Australia's three largest trading partners in 2014.
 - Identify Australia's most important export destination.
 - Identify Australia's largest source of imports.
 - Construct two column graphs, one showing the distribution of exports, the other showing the source of imports.



According to the Australian Bureau of Statistics (ABS), tourism comprises the activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited. International tourist movements surpassed 1 billion people for first time in 2012. The

income generated by tourism exceeded US\$7.2 trillion in 2015 (9.8 percent of the world's GDP). Chinese people are now the world's biggest tourism spenders. In 2015, 120 million Chinese tourists spent \$104.5 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 2.4.2a Why tourism matters, 2015

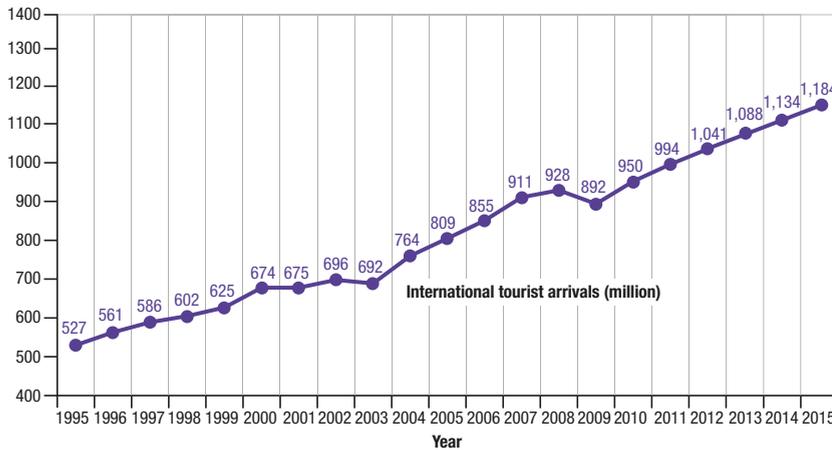


Figure 2.4.2b Growth in world inbound tourism, 1995-2015

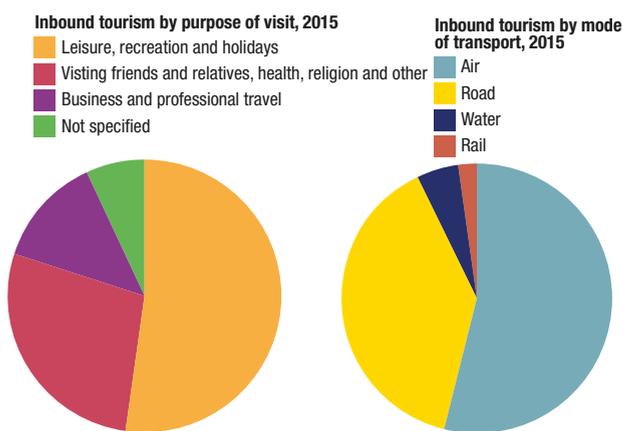
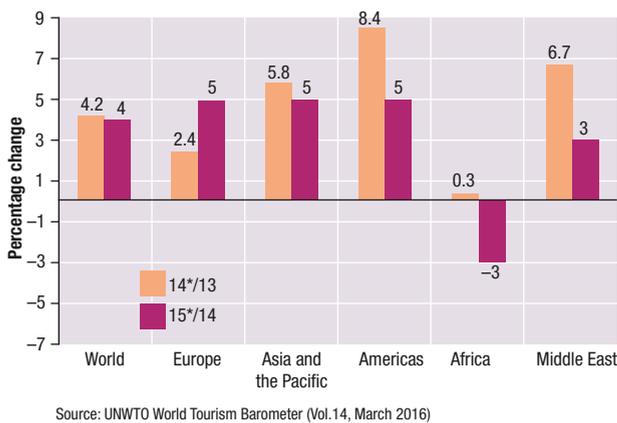


Figure 2.4.2d International tourist arrivals, percentage change 2014/13, 2015/14, by region

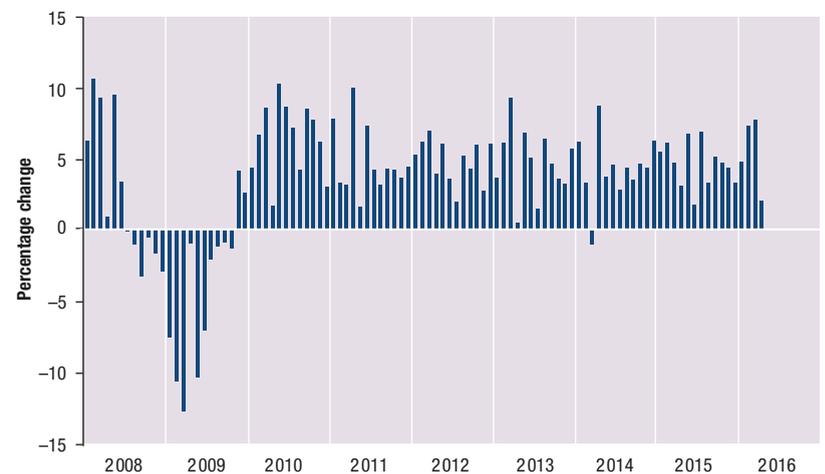


Figure 2.4.2c International tourist arrivals, monthly movements (% change), 2008-2015

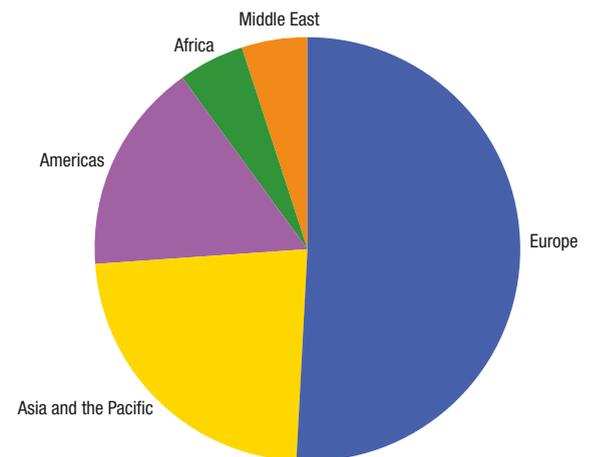


Figure 2.4.2e International tourist arrivals, by region, 2014-2015

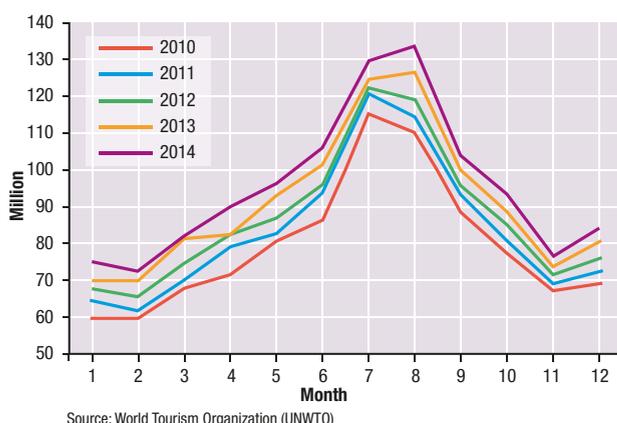


Figure 2.4.2g International tourist arrivals, by month, 2010-2014

Figure 2.4.2f Purpose and mode of travel, 2015

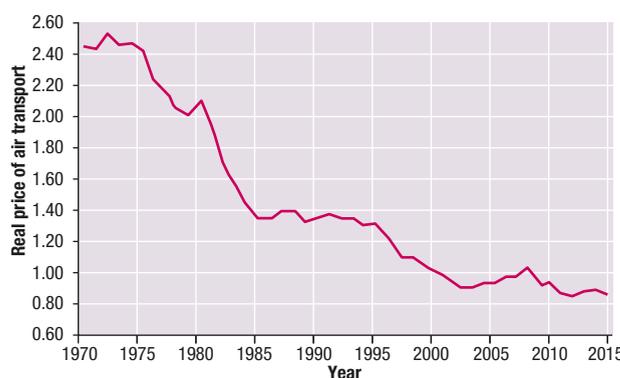


Figure 2.4.2h The real price of air travel, 1970-2015

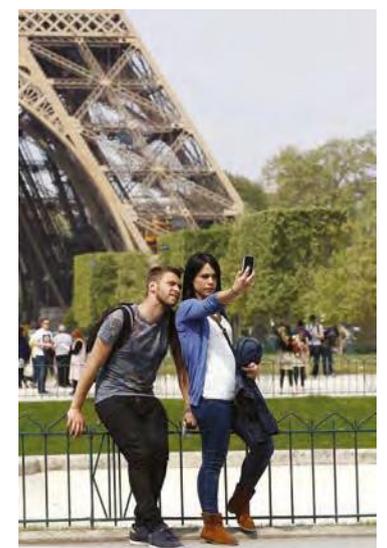


Figure 2.4.2i Paris is the world's most popular tourist destination.



Figure 2.4.2j Tourism is one of Australia's most important industries.

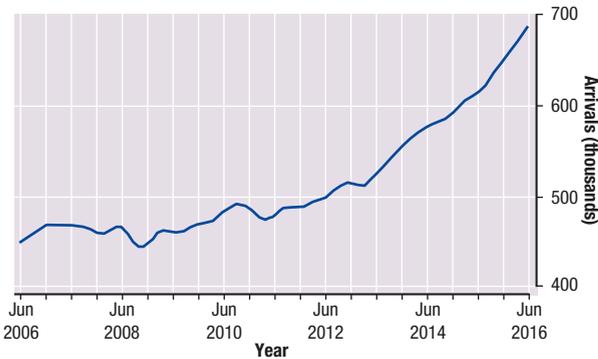


Figure 2.4.2k Short-term visitor arrivals, Australia, 2006–16

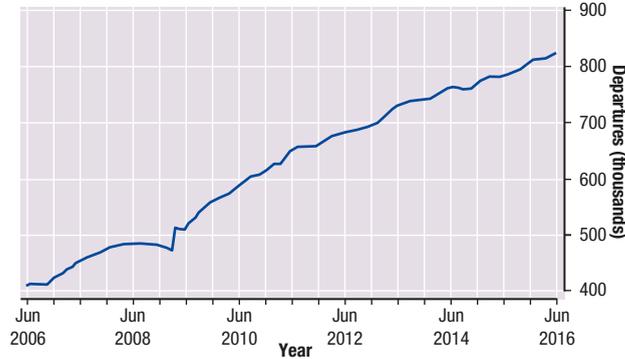


Figure 2.4.2l Short-term visitor departures, Australia, 2006–16

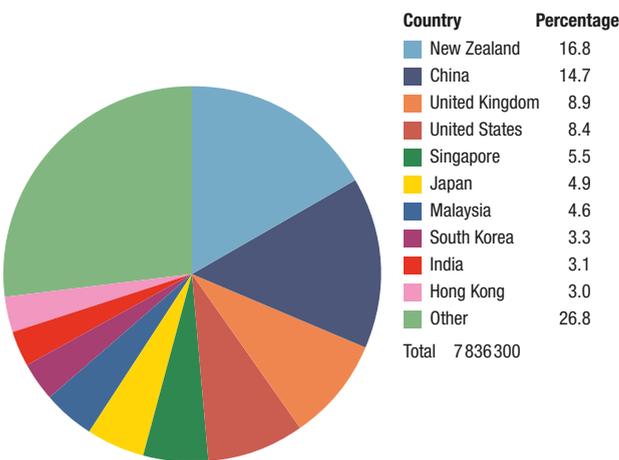


Figure 2.4.2m Where are they coming from? Country of origin, short-term visitors to Australia, 2014–15

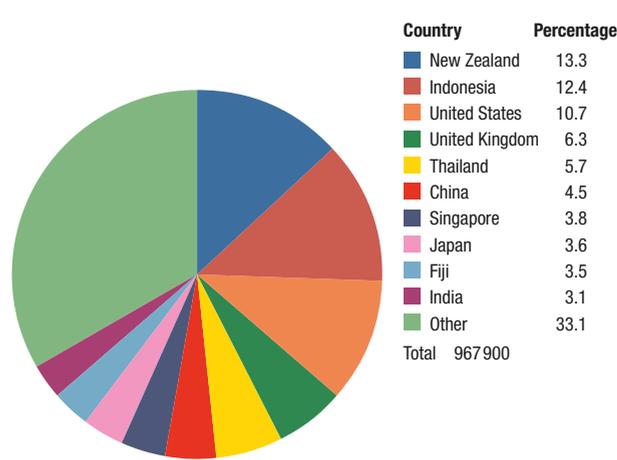


Figure 2.4.2n Where are we going to? Destination of short-term departures, 2014–15

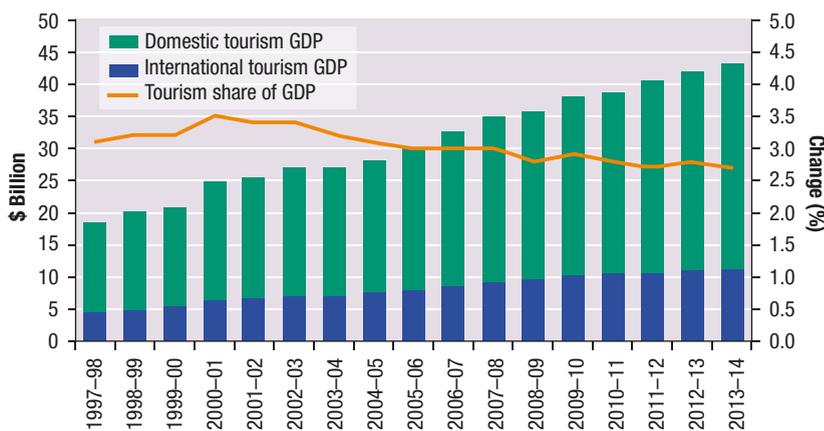


Figure 2.4.2o Tourism's contribution to Australia's GDP, 1997–98 to 2013–14

Australian tourism

Tourism is an important Australian industry. It accounts for 2.7 per cent of Australia's gross domestic product (GDP) and is worth around \$47.5 billion a year to the national economy. Domestic tourism accounts for approximately 73 per cent of all tourism-related GDP. International tourism accounts for the rest. The industry employed 534 000 (5 per cent of the workforce) in 2014–15, of which 45 per cent were employed casually or part-time.

In 2015, more than 7.4 million international visitors came to Australia. The selling of the tourist experience contributed approximately 11 per cent of Australia's total export earnings in 2014–15. 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.

ACTIVITIES

- Study Figure 2.4.2e (page 47) and then answer the following questions:
 - What proportion of international in-bound tourists did Europe account for in 2014–15?
 - How many international in-bound tourists did the Americas account for in 2014–15?
- Study Figure 2.4.2f (page 47) and then answer the following questions:
 - What is the principal reason for travel?
 - What percentage of travel is for the purpose of business?
 - What is the principal mode of travel?
 - What percentage of travel is by road?
- Study Figure 2.4.2g (page 47). State the months of the year in which international tourist arrivals peak. Can you think of a reason why this may be the case?
- Study Figure 2.4.2h (page 47). Describe the trends in the real cost of air travel. What might the implication of this trend be?
- Study Figure 2.4.2k. Using data from the graph, describe the trend in short-term visitor arrivals to Australia.
- Study Figure 2.4.2l. Using data from the graph, describe the trend in short-term departures from Australia.
- Study Figures 2.4.2m and 2.4.2n and then answer the following questions:
 - What is the largest source of in-bound short-term visitor arrivals in 2014–15?
 - What percentage of short-term arrivals came from China?
 - How many tourists came from the United States?
 - What are the three most popular destinations for Australians travelling overseas?
 - What percentage of departing Australians went to the United States?
 - How many departing Australians travelled to New Zealand?
- Study Figure 2.4.2o and then answer the following questions:
 - In what year did tourism's contribution to Australia's GDP peak?
 - Which type of tourism (domestic or international) has shown the greatest proportional increase between 1997–98 and 2013–14?
 - What was the value of domestic tourism to the Australian economy in 2013–14?

ACTIVITIES

- Study Figure 2.4.2a (page 47). Write a paragraph outlining the global significance of the tourism industry.
- Study Figure 2.4.2b (page 47) and then answer the following questions:
 - What was the percentage increase in international tourist arrivals between 1995 and 2015?
 - What was the absolute growth in international tourist movements between 1995 and 2015?
- Study Figure 2.4.2c (page 47). Describe the trend in international tourist arrivals since 2008 using data from the graph.
- Study Figure 2.4.2d (page 47) and then answer the following questions:
 - Identify the regions that experienced a decline in the rate of growth in international tourist arrivals in 2015/14 when the rate is compared with that achieved in 2014/13.
 - Identify the region whose growth rate in 2015/14 was twice as great as in 2014/13.

The cruise industry is one of the fastest-growing sectors of the global tourism industry. In 2015 the industry's economic worth was valued at \$119.9 billion and the growing fleet of cruise ships carried 23 million passengers. In 2015, the world's fleet of 298 ocean-going vessels had a total passenger capacity of 482 000.

The cruise industry has had an average annual passenger growth rate of 7 per cent since 1990. This growth has, at least in part, 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 have also increased demand for cruise-based holidays.

A total of seven new ships were added in 2015 with a total passenger capacity of 18 813. From 2016 to 2017, 15 more new cruise ships will come into service adding 39 637 to worldwide passenger capacity, or 8.1 per cent. The ships from 2015 to 2016 will add \$3.6 billion in annual revenue to 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).

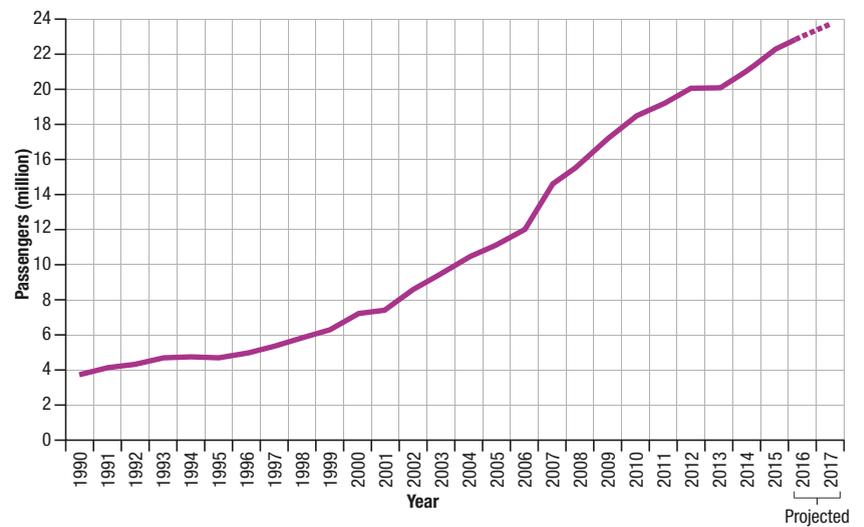


Figure 2.4.3a Growth in the global cruise industry, passengers carried, 1990–2016

Table 2.4.3a Cruise passengers by origin, 2015

Source region	(%)
North America	58.6
Europe	25.9
Asia	8.5
South America	2.5
Australia/New Zealand	4.3
Middle East/Asia	0.2

THE AUSTRALIAN CRUISE INDUSTRY

The Australian cruise industry has grown rapidly in recent years. In 2015–16 more than 1 million Australians (4.2 per cent of the country's population) took a cruise on one of the 46 vessels operating out of, or visiting, Australian ports. Australia is now the world's fastest-growing passenger market. Australians now account for 4.5 per cent of the world's 22.5 million cruise passengers, making the country the fourth-largest source market. The cruise industry contributed \$1.737 billion to the Australian economy in 2015–16.

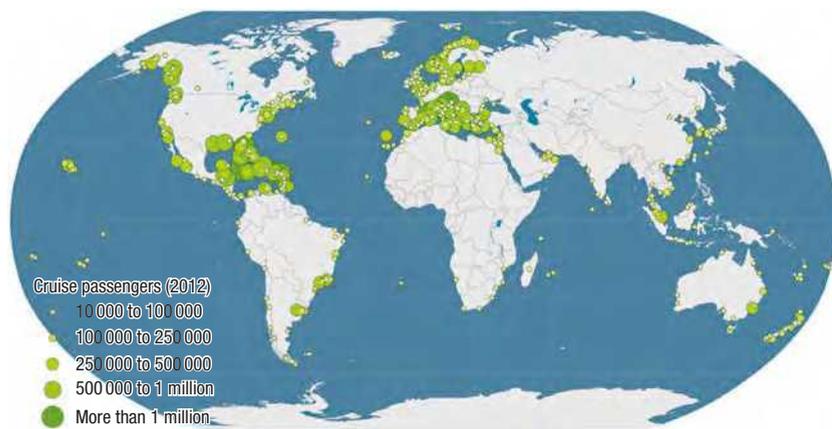


Figure 2.4.3b Cruise passenger port visits, 2012

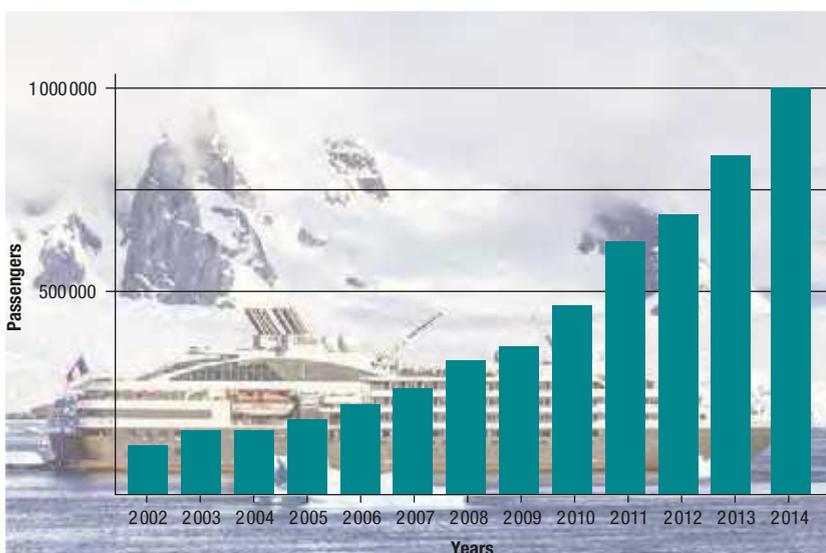


Figure 2.4.3c Australian cruise industry: growth in passenger numbers, 2002–14

ACTIVITIES

- Study Figure 2.4.3a and then answer the following questions:
 - By how much did the number of passengers carried by the world's cruise industry increase between 1990 and 2015?
 - In what year did the number of passengers carried exceed 12 million?
 - Which period experienced the greatest rate of increase in passenger numbers?
- Study Table 2.4.3a. Construct a pie graph showing cruise passengers by source in 2015.
- Study Figure 2.4.3b. With the aid of an atlas, identify the regions of the world most intensively visited by cruise ships.
- Study Figures 2.4.3c and 2.4.3d. Using data from the graphs write a paragraph outlining the growth of the Australian cruise industry since 2002.

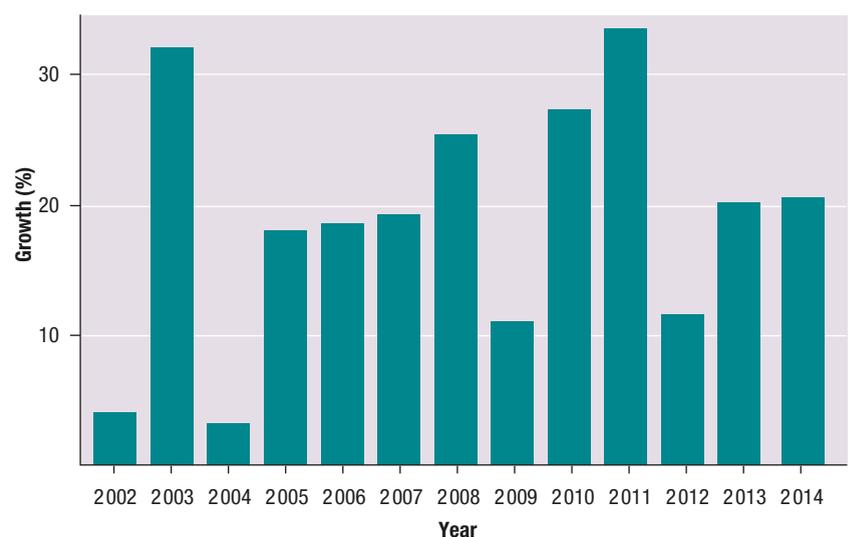


Figure 2.4.3d Australian cruise industry: annual percentage growth in passenger numbers, 2002–14

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 types of biomes are found there. The Earth's major biomes are shown in Figure 2.5.1a.

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 habitats, including 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 eco-system 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 2.5.1a **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

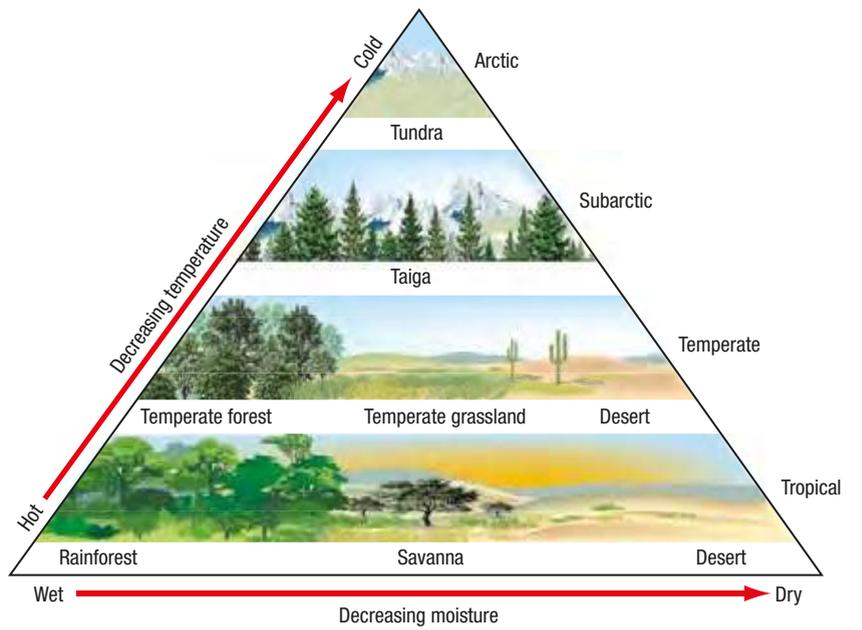


Figure 2.5.1b Land-based biomes are determined by climate (temperature and moisture).

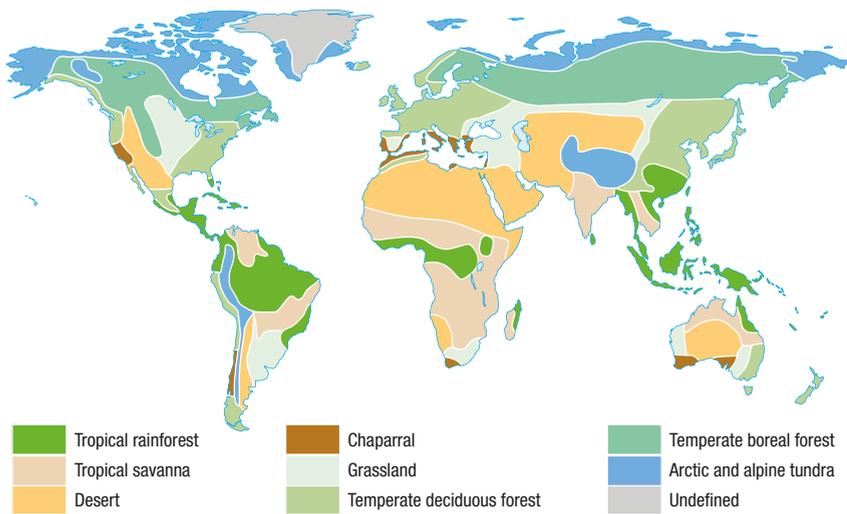


Figure 2.5.1a Biomes of the world

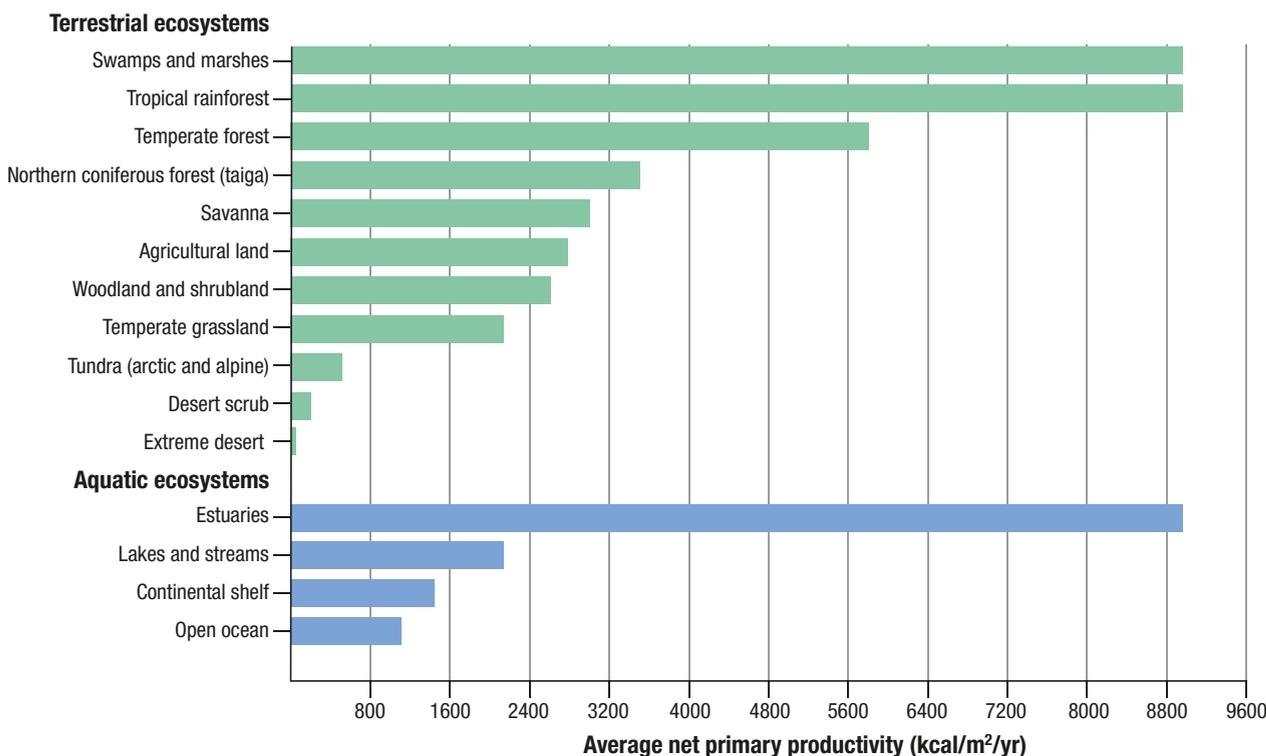


Figure 2.5.1c Average net primary productivity of ecosystems

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.

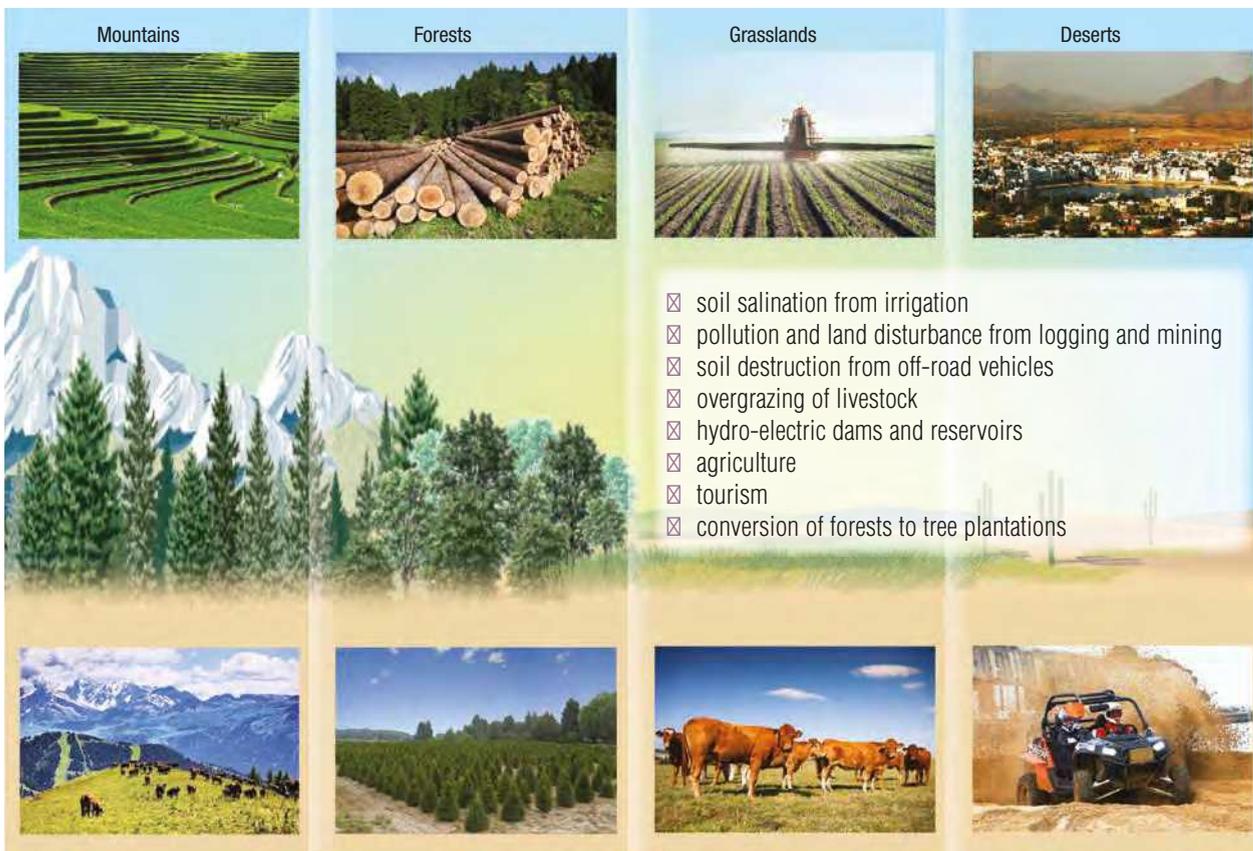


Figure 2.5.1d Major human effects on land-based (terrestrial) ecosystems



Figure 2.5.1e Major human effects on marine ecosystems and coral reefs (aquatic ecosystems)

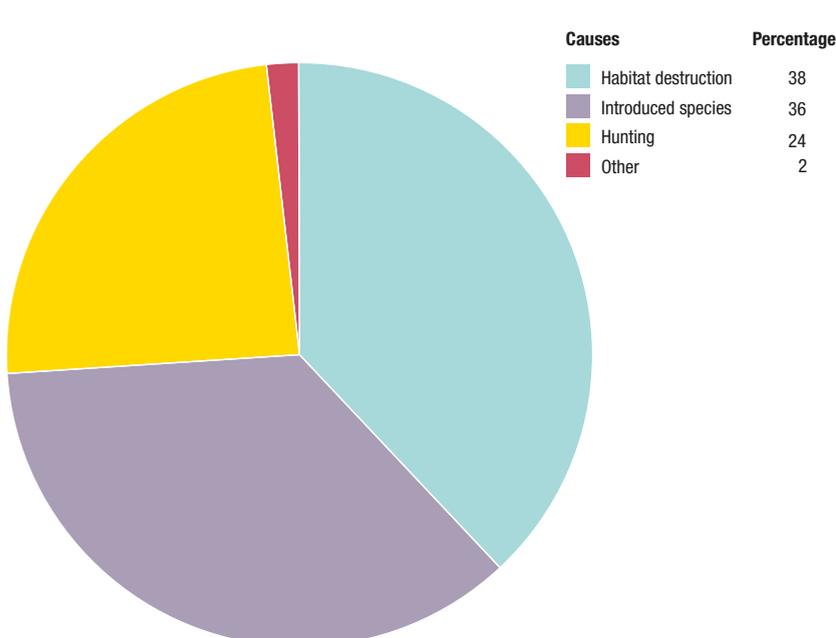


Figure 2.5.1f Causes of species loss

ACTIVITIES

- 1 Study Figures 2.5.1a, 2.5.1b and an atlas map showing the Earth's climate zones. Write a paragraph or two outlining the relationship between latitude, climate and the distribution of the Earth's major biomes.
- 2 Study Table 2.5.1a. Construct a pie graph showing the percentage of the Earth's surface occupied by each of the major terrestrial biomes.
- 3 Study Figure 2.5.1b. 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 2.5.1c. 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 2.5.1d and 2.5.1e. Use the information featured in the illustrations to construct your own mind map documenting human effects on terrestrial and aquatic environments.
- 7 Study Figure 2.5.1f. What is the principal cause of species loss? What percentage of species loss is a result of species introduction?

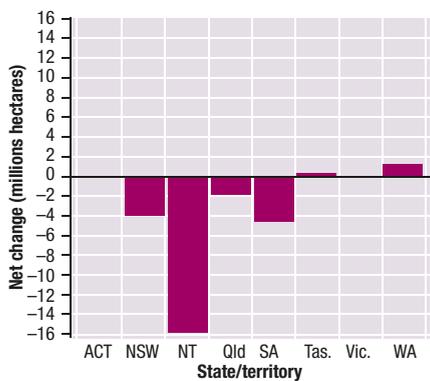


Figure 2.5.2j Australia: net change in forest cover, by state and territory, 2008–13

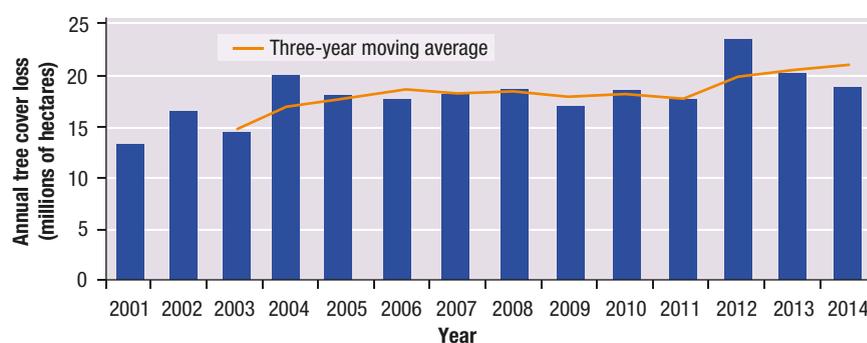


Figure 2.5.2k Global annual tree cover loss, 2001–14

ACTIVITIES

- 6 Study Figure 2.5.2h 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 22 000 ha of native forest?
- 7 Study Figures 2.5.2i and 2.6.3b (page 65). Comment on the relationship between land clearing and the distribution of Australia's population.
- 8 Refer to Figures 2.5.2a and 2.5.2i. Which vegetation types have been most affected by land clearing?
- 9 Study Figure 2.5.2j and complete the following tasks:
 - a Identify the state/territory that experienced the greatest loss of forest cover in the period 2008–13.
 - b State the state/territory that experienced the greatest increase in forest cover.
- 10 Study Figure 2.5.2k and complete the following tasks:
 - a State the years in which tree cover loss equalled or exceeded 20 million hectares per annum.
 - b Describe the general trend in tree cover loss since 2003.
- 11 Study Figure 2.5.2l and identify those countries experiencing a reduction in the amount of tropical forest loss in the 2010–20 period compared with the 2005–14 period.
- 12 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.
- 13 As a class, list the activities of people that contribute to land degradation.
- 14 Construct a photo sketch of Figure 2.5.2m.
- 15 Study Figure 2.5.2n. Explain the effects of land clearance on salinity.
- 16 Study Figure 2.5.2o. Explain how irrigation can affect the level of salinity in river systems.
- 17 Undertake library and/or internet-based research. Investigate alternative methods of irrigation that minimise the amount of water added to the water table.
- 18 Undertake library and/or internet-based research. Investigate strategies to manage rising water tables and protect water quality in local river systems.

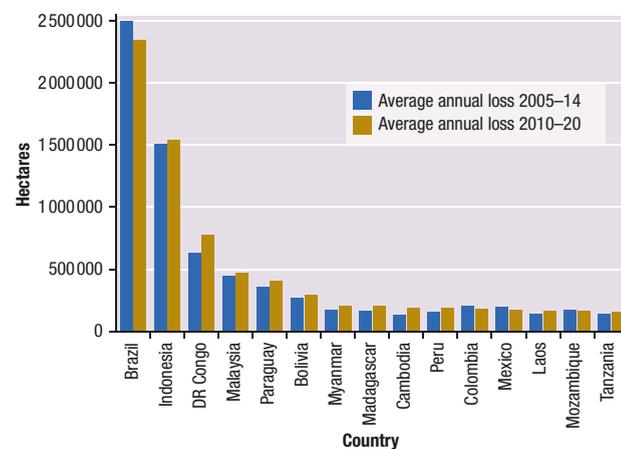
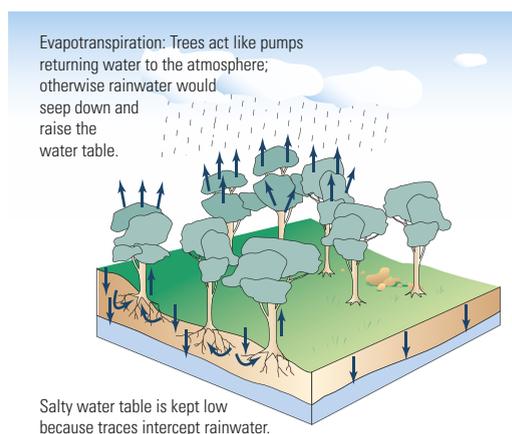


Figure 2.5.2l Annual tropical forest loss, 2005–14 and 2010–20, (top 15 countries) hectares

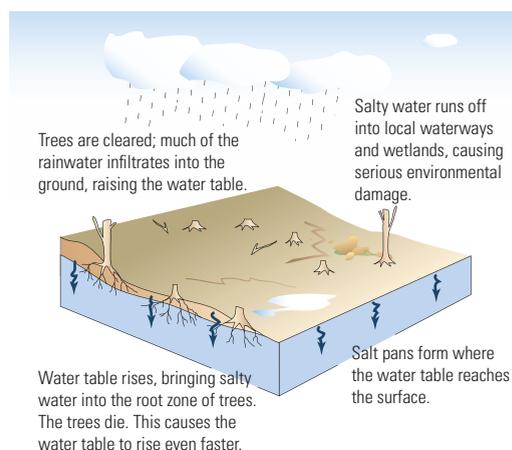


Figure 2.5.2m Land clearing in Tasmania

LAND CLEARING AND SALINITY



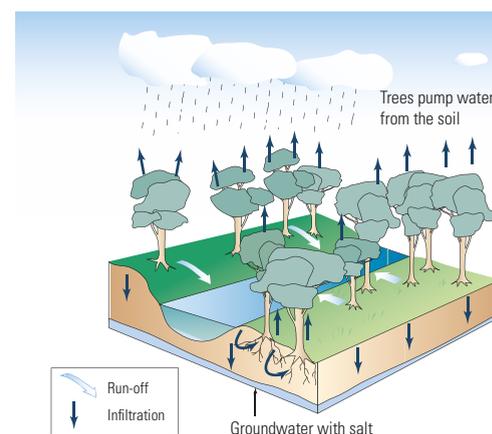
(i) Before land clearance



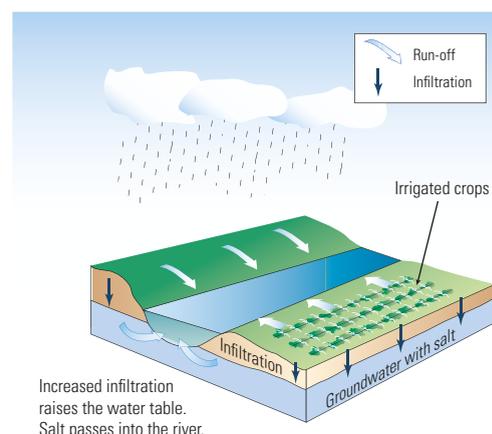
(ii) After land clearance

Figure 2.5.2n The effects of land clearance on salinity. The removal of deep-rooted native vegetation results in rising water tables and the salinisation of soils.

IRRIGATION SALINITY



(i) Before irrigation



(ii) After irrigation

Figure 2.5.2o The effects of irrigation on salinity. Irrigation water causes the water table to rise, bringing dissolved salts to the surface.



Figure 2.5.3a A Sudanese woman shows the only available food for her family, as they continue their daily struggle to survive in a refugee camp.

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 are outlined in Figure 2.5.3d.

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 take 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.

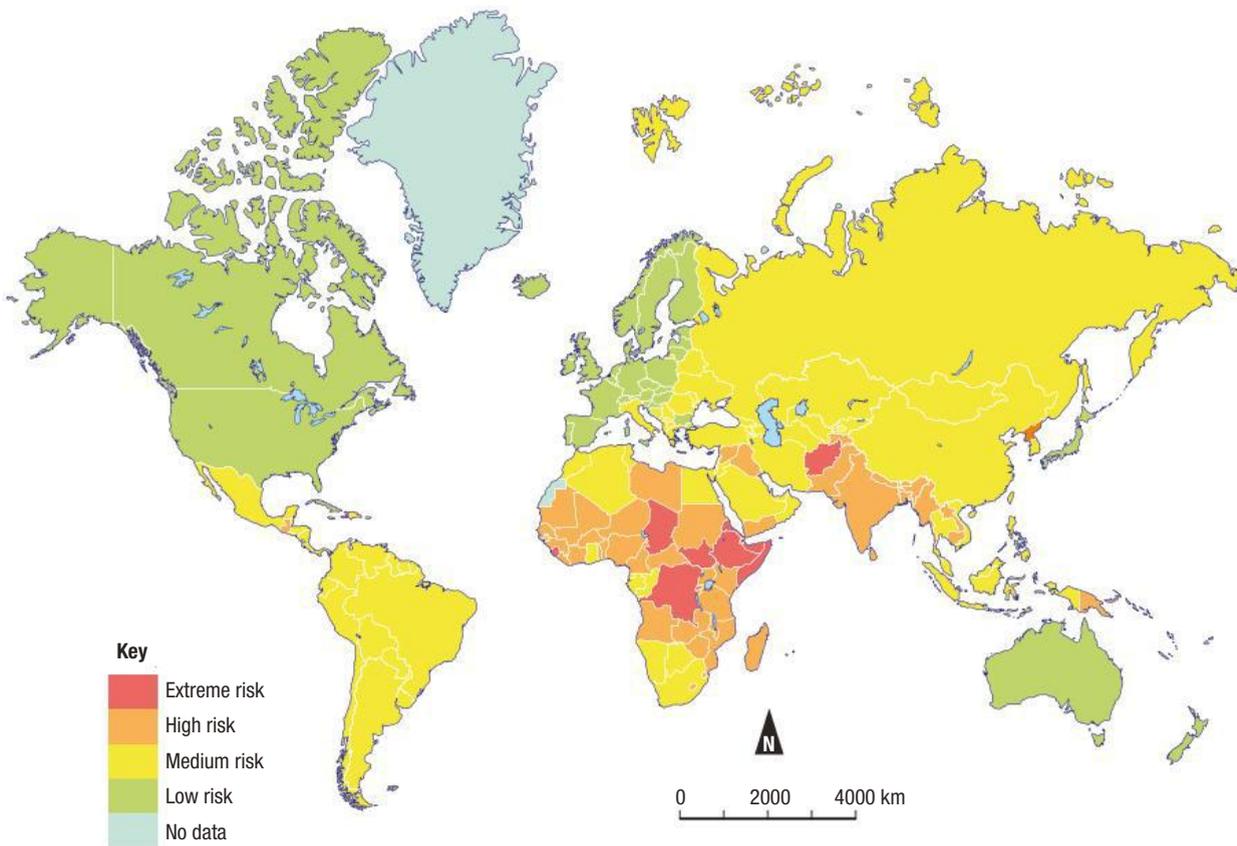


Figure 2.5.3b Food Security Index, 2015. The Global Food Security Index considers the core issues of affordability, availability and quality.

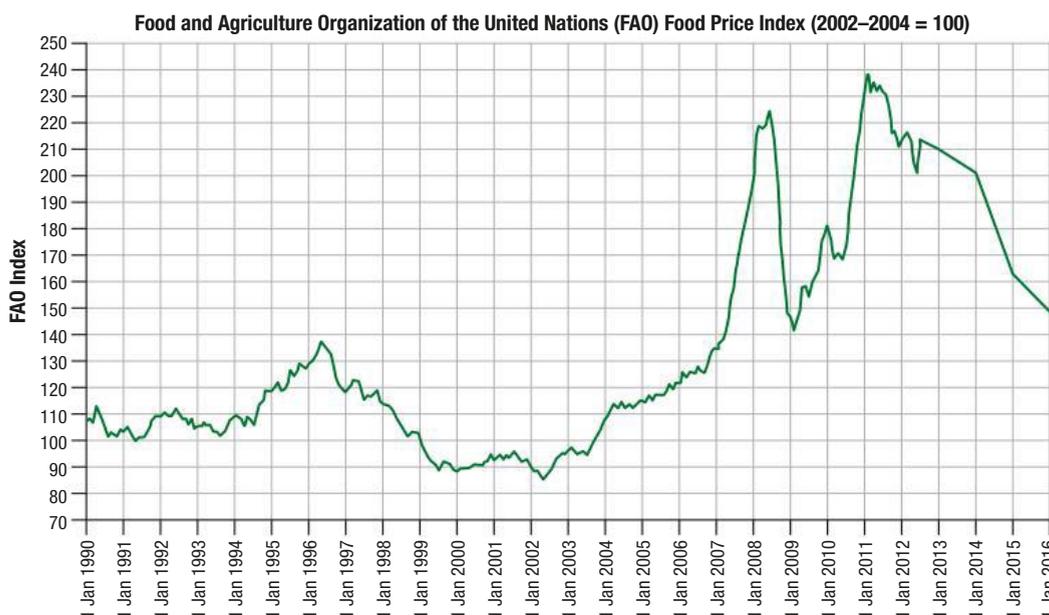


Figure 2.5.3c Trends in food prices, 1990–2016

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

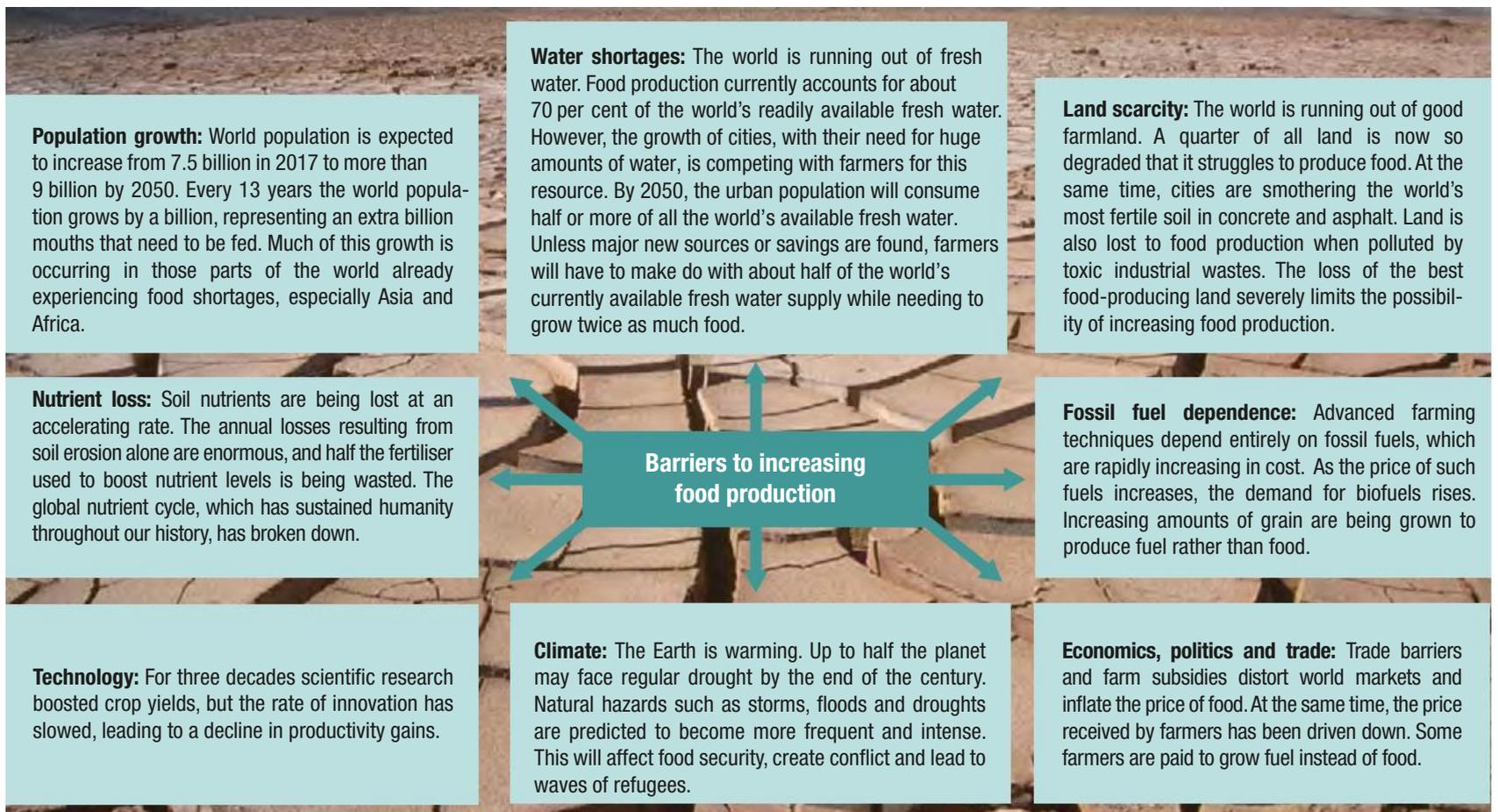


Figure 2.5.3d Barriers to increasing food production

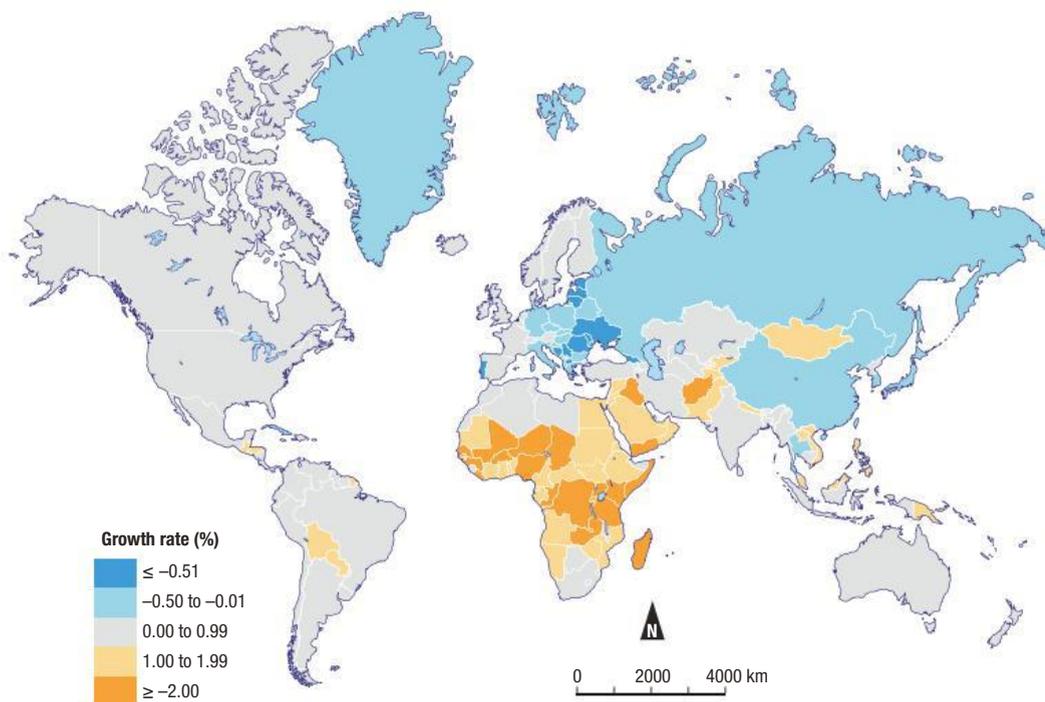


Figure 2.5.3e Projected annual growth rate of country populations, 2010–50

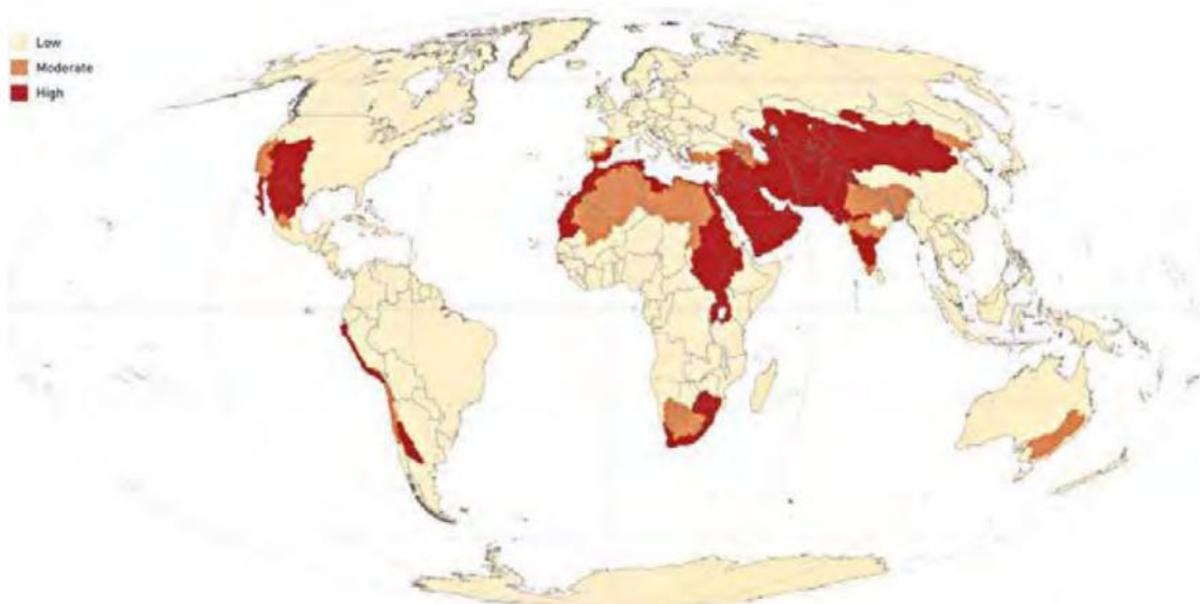


Figure 2.5.3f Distribution of physical water scarcity by major water basins



Figure 2.5.3g A malnourished Somali boy lies on his mother's hands. Millions of people in eastern Africa are affected by food shortage – a result of drought and famine.

Water scarcity

Water is essential for human wellbeing 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.

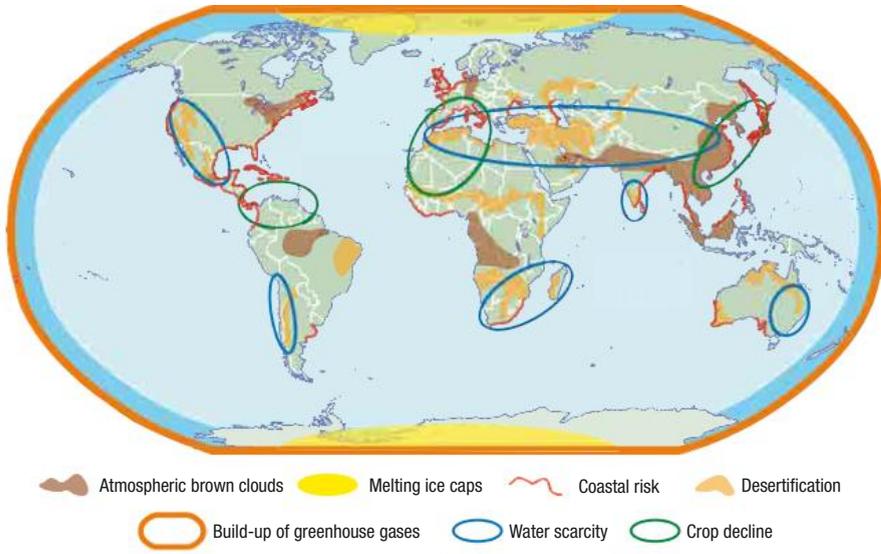


Figure 2.5.3h Environmental damages and risks from climate change

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.

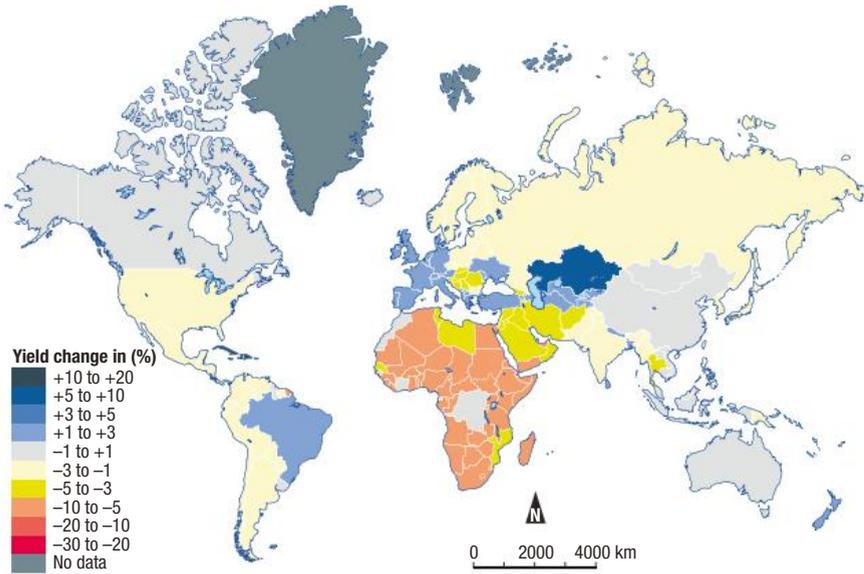


Figure 2.5.3i Effects of climate change on global food production (projected weighted average yield change in % for grain crops)

Land degradation

Land degradation is the process in which the biophysical environment is adversely affected by the activities of people. Land degradation consists of 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.

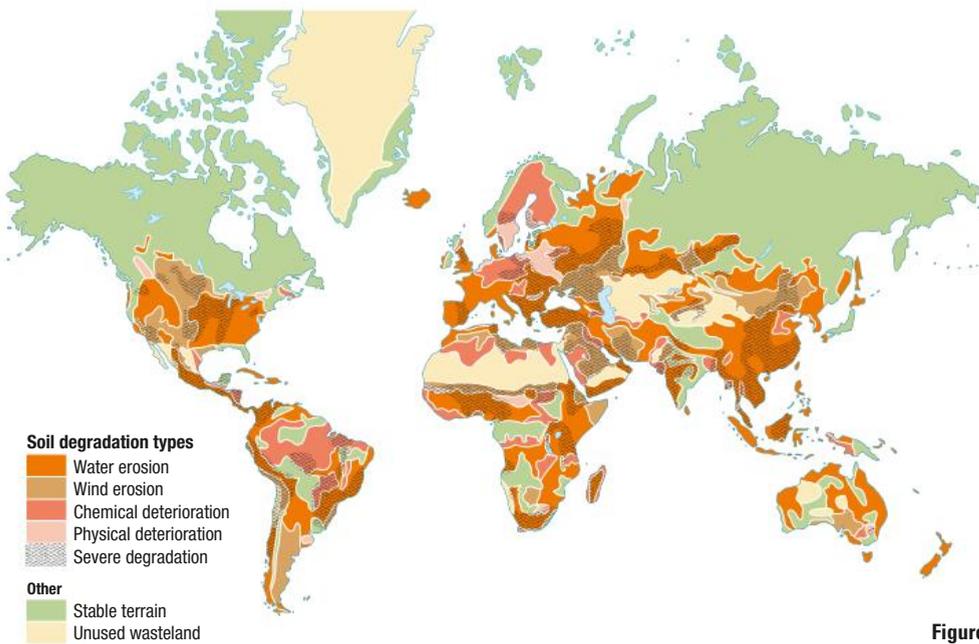


Figure 2.5.3j Land degradation by type

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 to 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.

World biofuels production trends

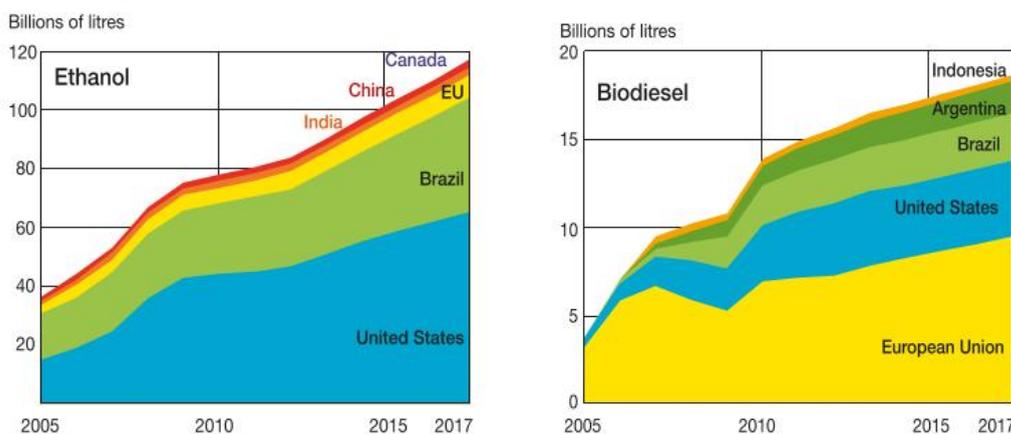


Figure 2.5.3k World biofuel production. Source GRID-Arendal

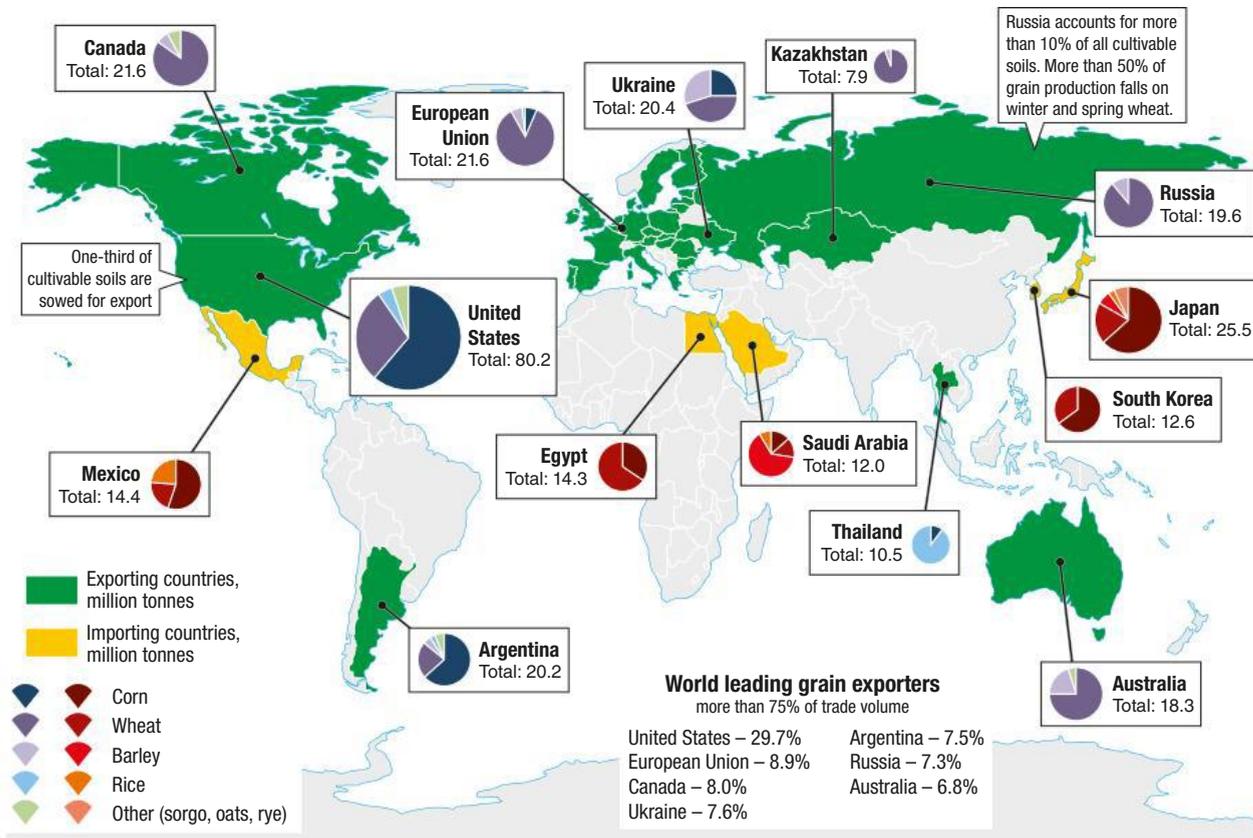


Figure 2.5.3l World grain exporters and importers

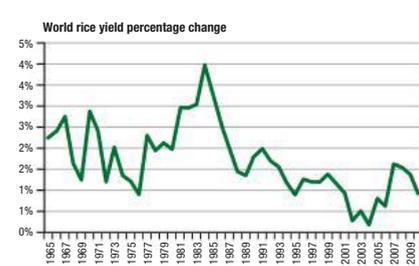
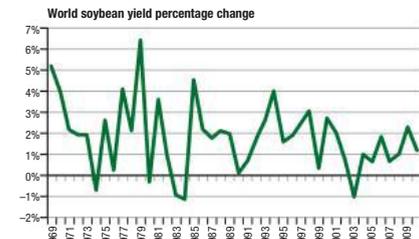
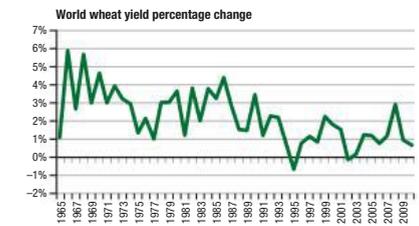
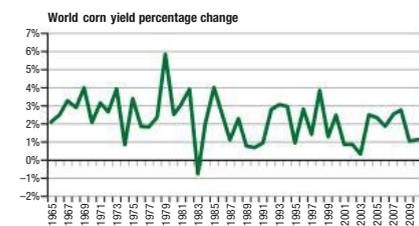


Figure 2.5.3n Trends in selected crop yields

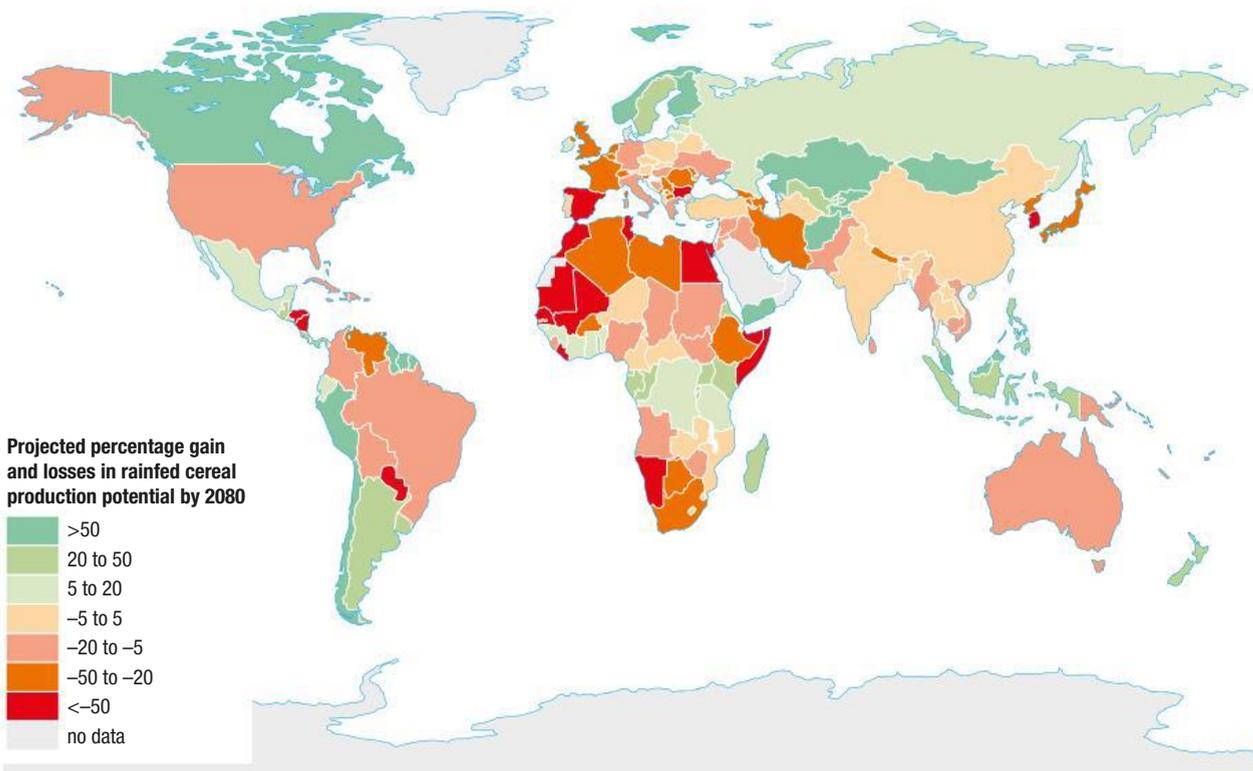


Figure 2.5.3m Projected global gains and losses in cereal production by 2080

ACTIVITIES

- Study Figure 2.5.3b (page 54). 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 2.5.3e (page 55)?
- Study Figure 2.5.3c (page 54). 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?
- Study Figure 2.5.3d (page 55). Write an extended response outlining the barriers to increasing world food production. Use data from this unit to illustrate your response.
- Study Table 2.5.3a (page 54). 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?
- Study Figure 2.5.3e (page 55). Identify the countries in which average annual population growth rates exceed 2.0 per cent. In which regions of the world are average annual growth rates greatest?
- Study Figure 2.5.3f (page 55). With the aid of an atlas, identify the regions of the world with high levels of water scarcity.
- Study Figure 2.5.3h. With the aid of an atlas, identify the regions of the world likely to experience desertification, water scarcity and crop decline as a result of climate change.
- Study Figure 2.5.3i. 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.
- Study Figure 2.5.3j. With the aid of an atlas, identify those regions of the world experiencing severe degradation.
- Study Figure 2.5.3k and then answer the following questions:
 - Which two countries produce the largest amounts of ethanol? How much ethanol is produced by the United States?
- Which are the three largest producers of biodiesel?
- How much biodiesel is produced by Germany?
- Study Figure 2.5.3l and then answer the following questions:
 - Identify the world's largest exporter of grain.
 - Name the country that is the world's largest grain importer.
 - Name the principal grain export from the United States.
 - Identify the country whose principal grain export is wheat.
 - Identify the principal grain import of Japan.
 - Name the principal grain export of Thailand.
- Study Figure 2.5.3m. Identify the countries in which gains in rainfed cereal production losses are projected to exceed 50 per cent by 2080.
- Study Figure 2.5.3n. Describe the trend in crop yields for corn, wheat, soybean and rice.

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

1 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, which are least able to cope.

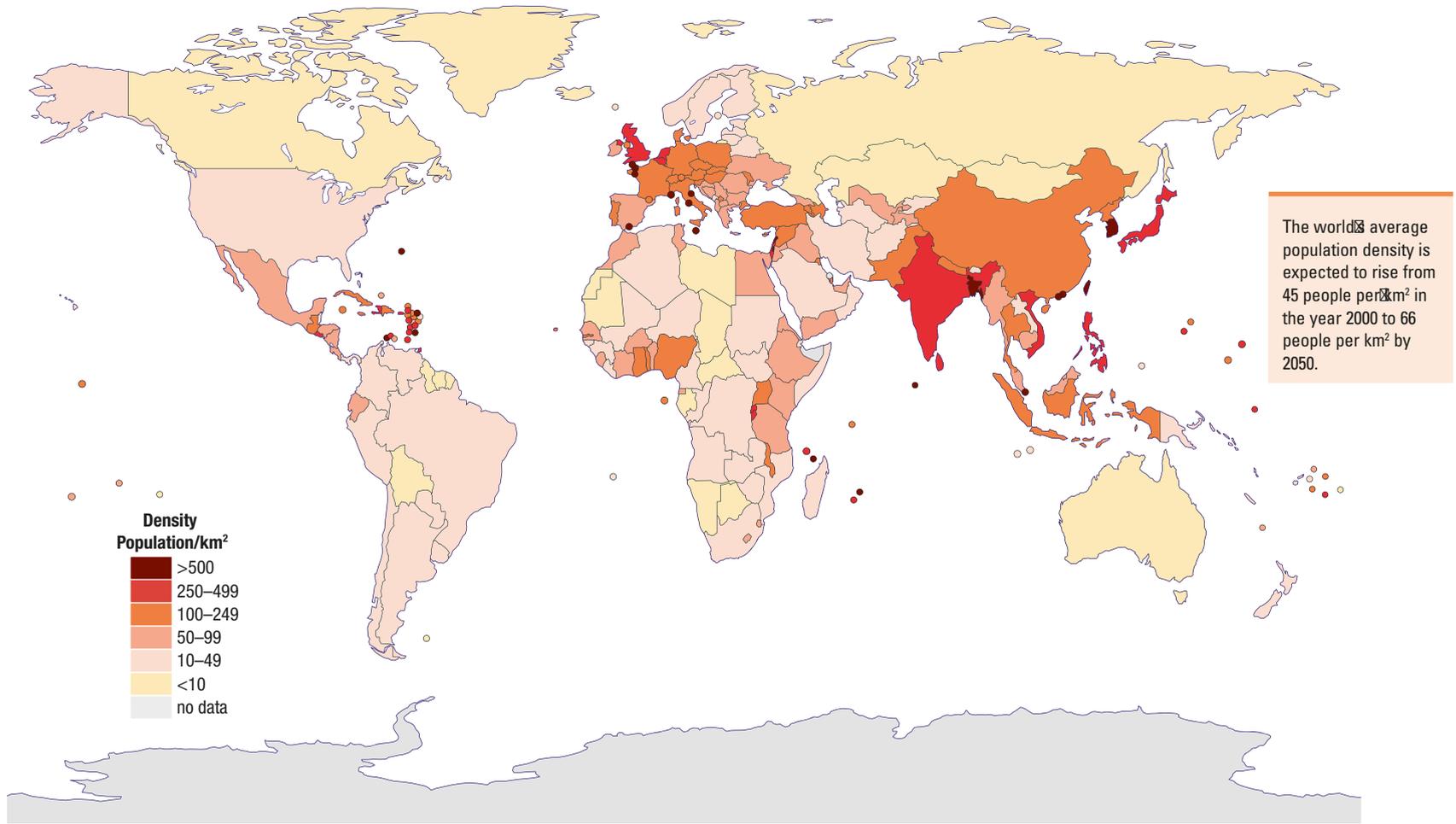


Figure 2.6.1a Population density, 2015

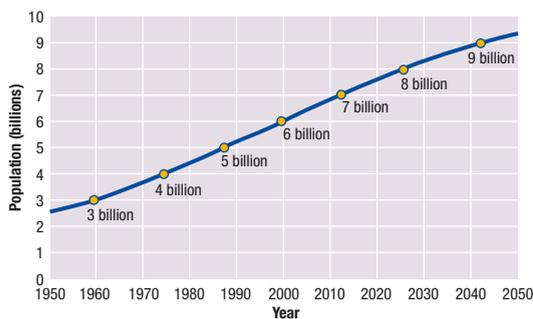


Figure 2.6.1b World population growth, 1950-2050



Figure 2.6.1c World population growth rates, 1950-2050



Figure 2.6.1d Annual world population change, 1950-2050

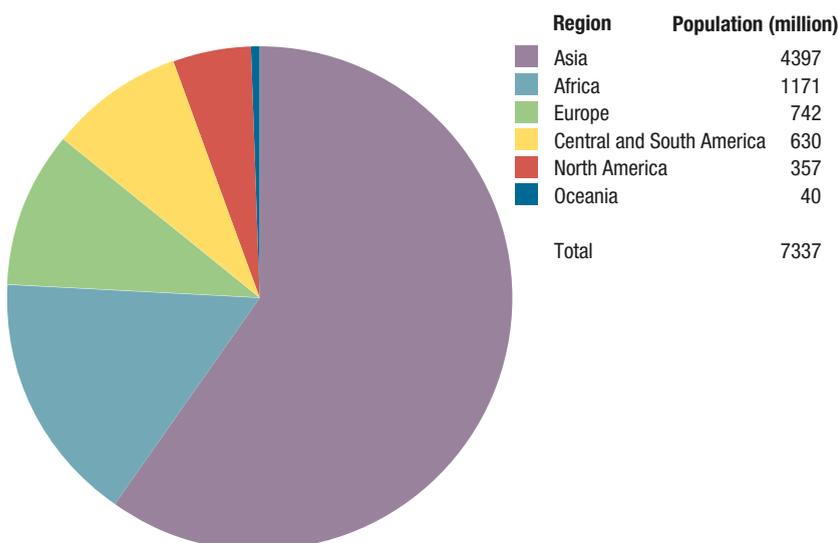


Figure 2.6.1e Distribution of the world's population, 2015

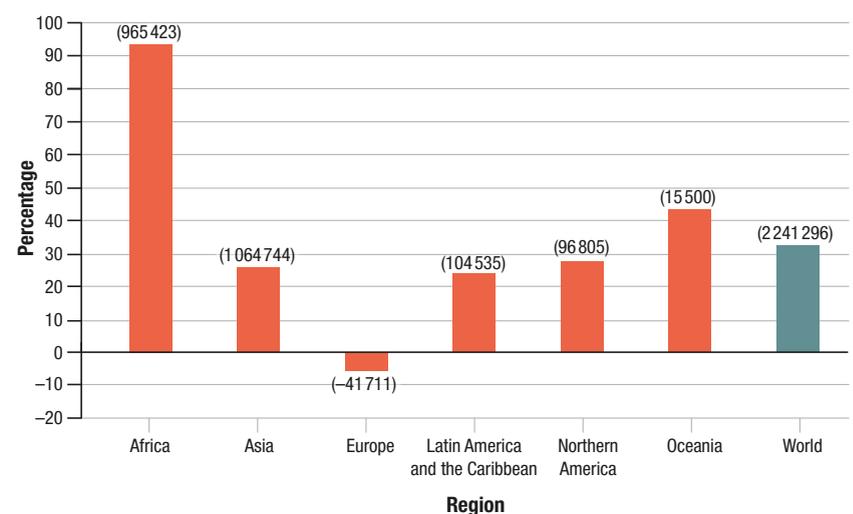


Figure 2.6.1f Projected population change by region, 2010-50 (millions)



Figure 2.6.1g Group of Nigerian children

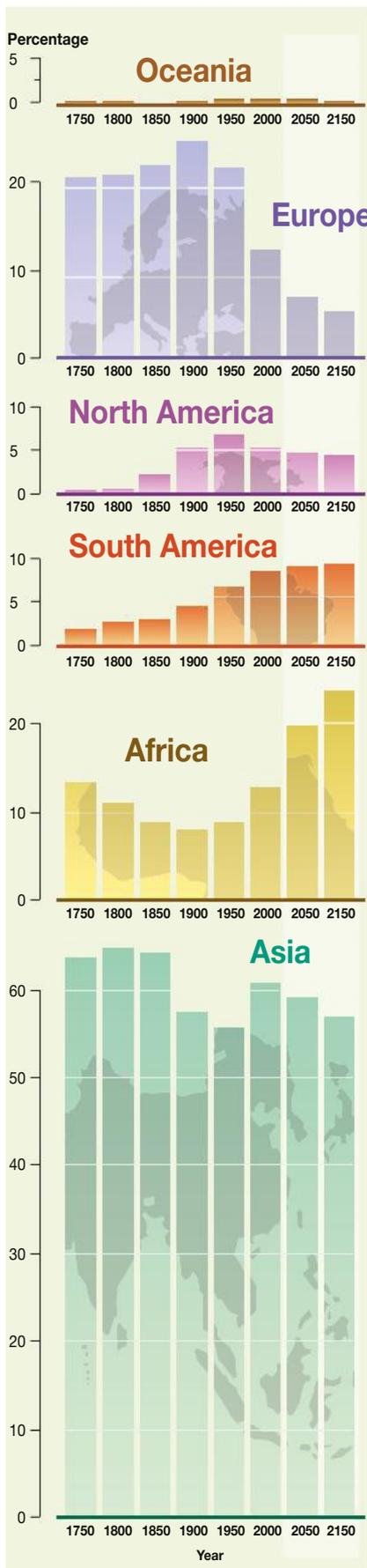


Figure 2.6.1h Global population distribution (percentage of world population by region), 1750-2150

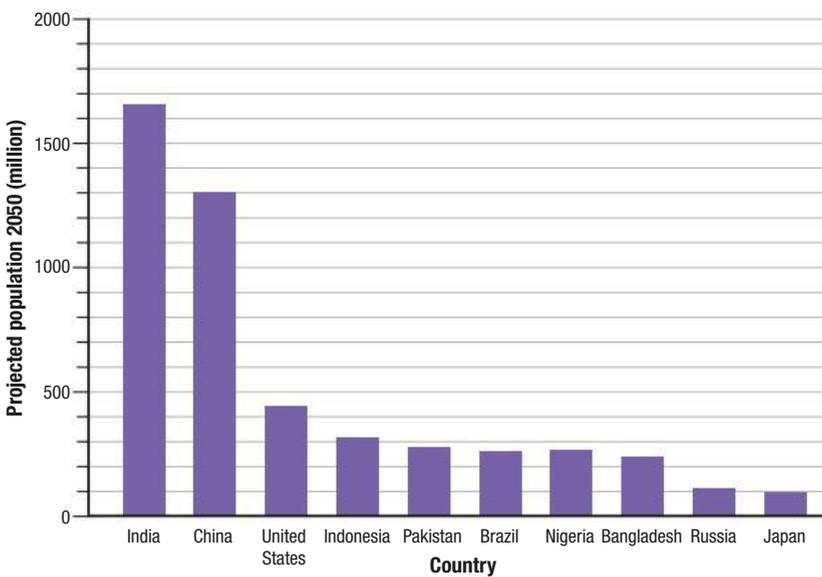
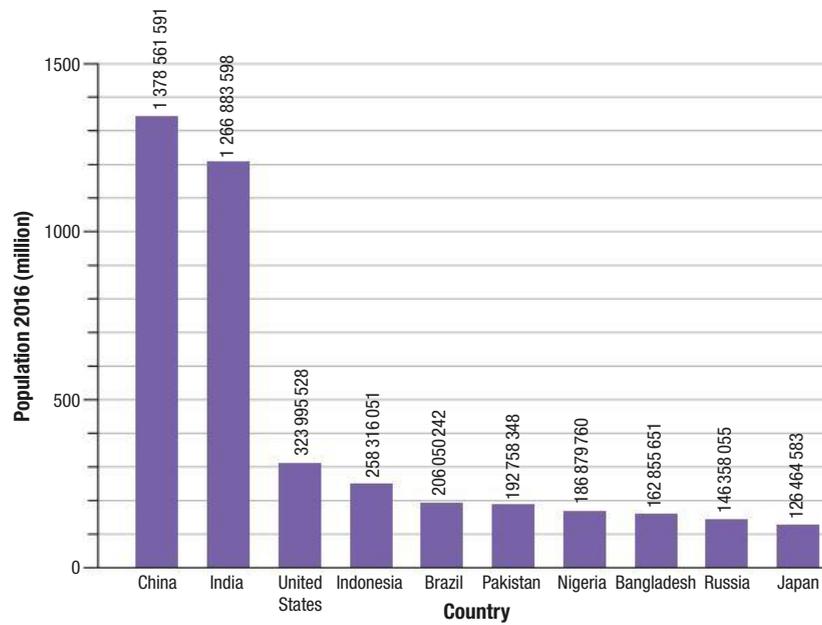


Figure 2.6.1i World's 10 most populous countries, 2016 and 2050 (projected)

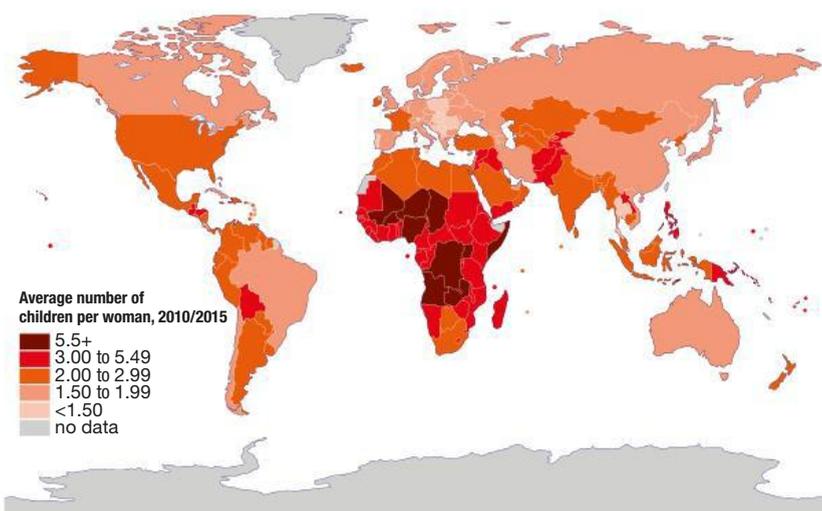


Figure 2.6.1j Total fertility rate, 2010/2015

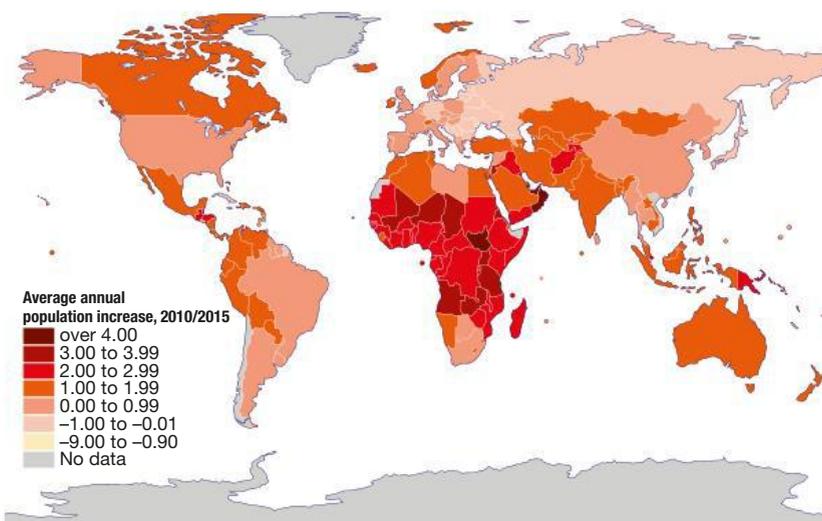


Figure 2.6.1k Average annual rate of population increase, 2010/2015



Figure 2.6.1l 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 2015 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.

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.

AGEING POPULATION

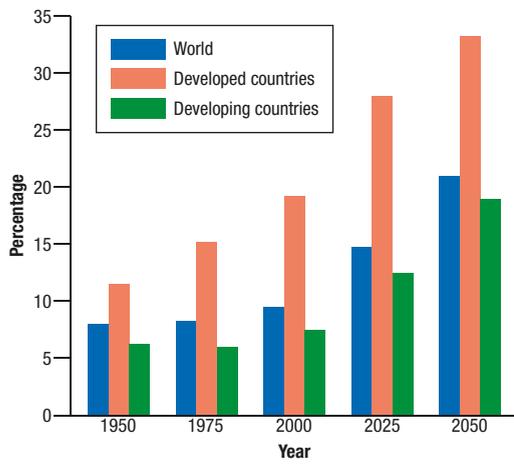


Figure 2.6.1m Proportion of the population aged 60 or over, 1950–2050

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.

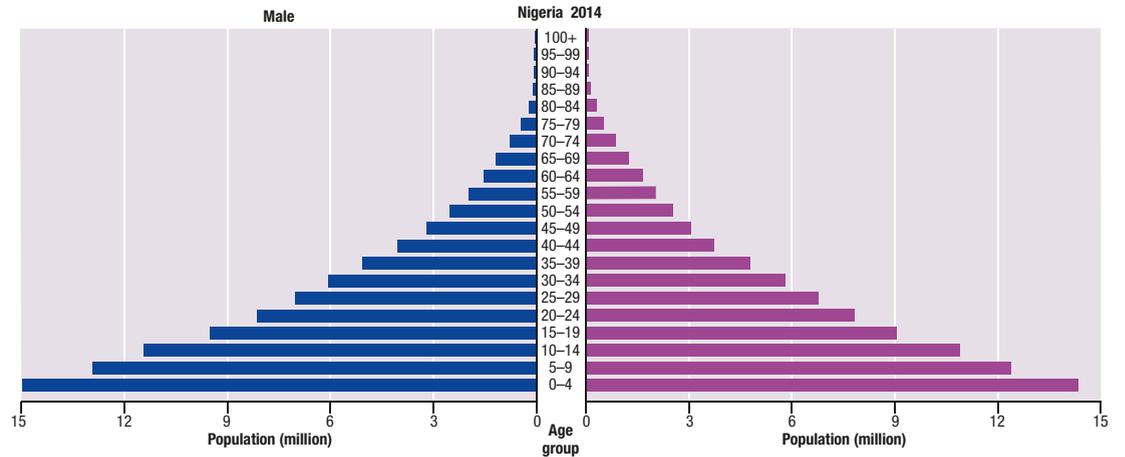
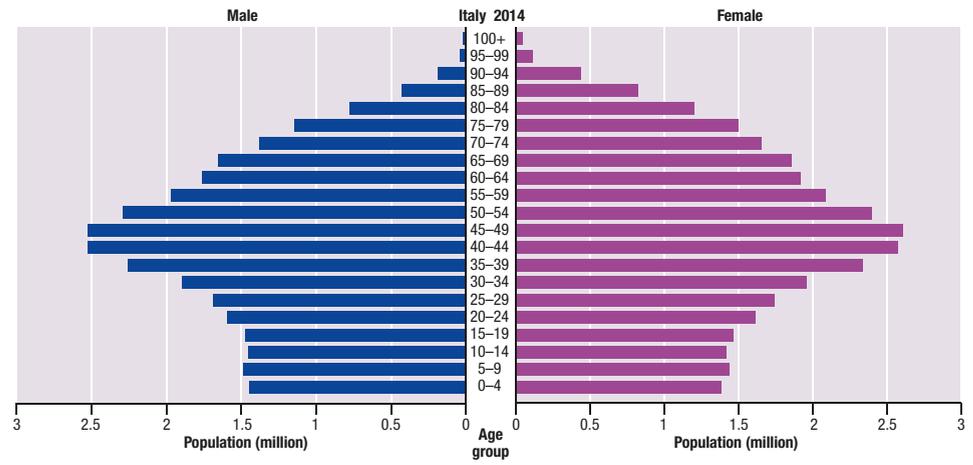


Figure 2.6.1n Population pyramids, Italy and Nigeria, 2014

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 2.6.10.

The majority of the world's urban population – in common with most of the world's total population – lives in developing countries. In 2015, developing countries had 2.9 billion urban dwellers, compared with only 980 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.

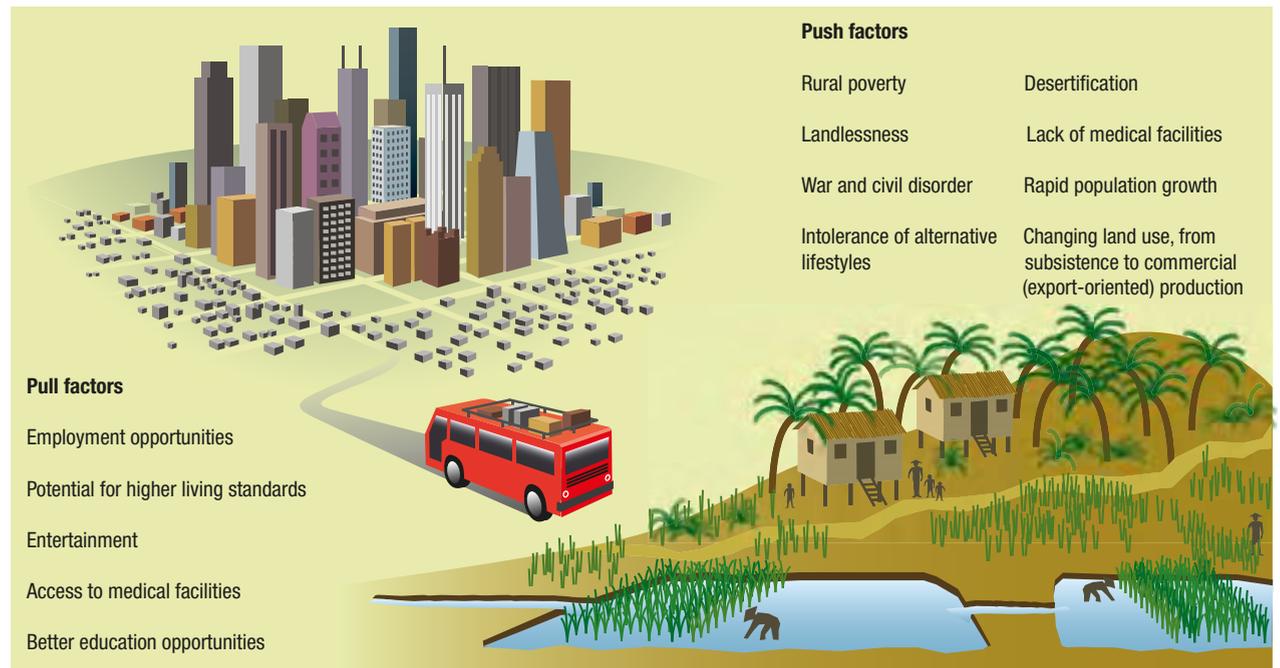


Figure 2.6.10 Factors in the process of urbanisation



Figure 2.6.1p Manhattan skyline, New York

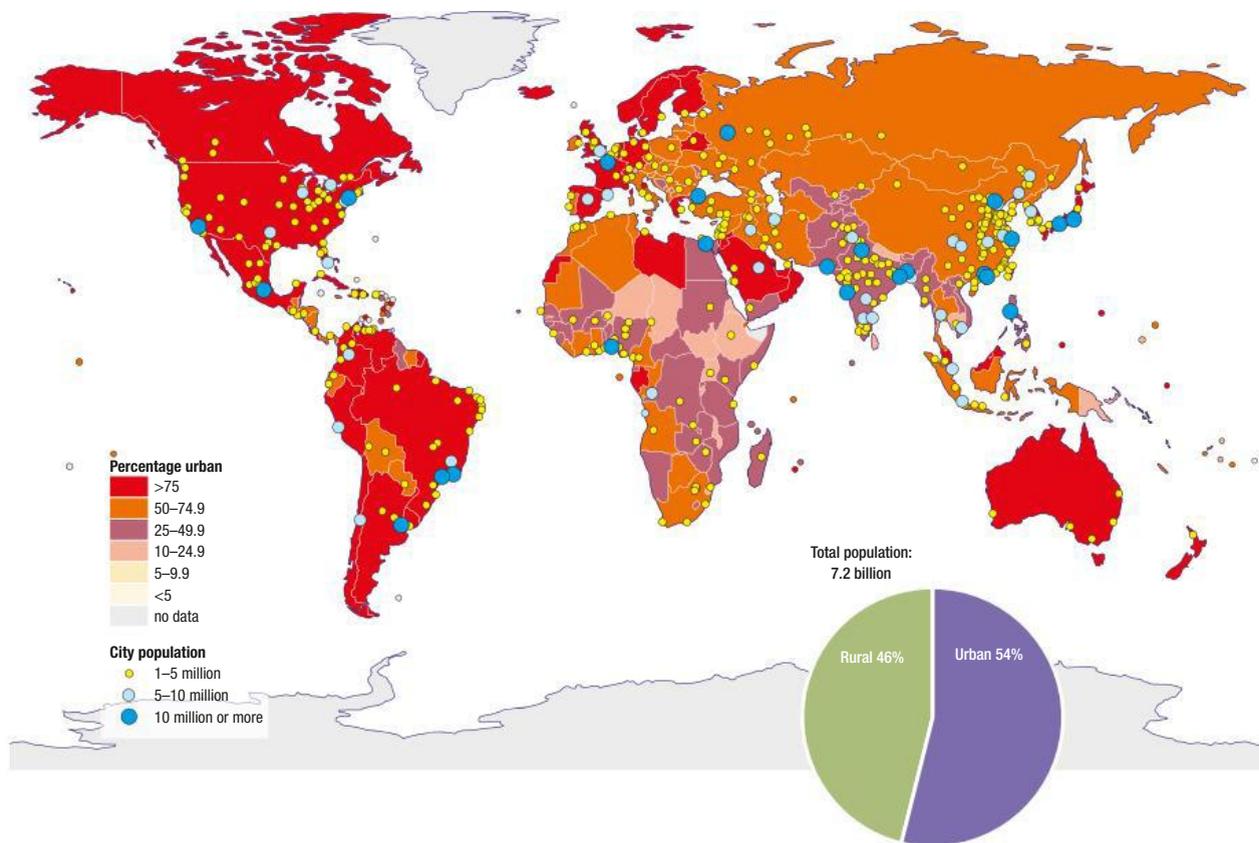


Figure 2.6.1q Urbanisation, 2016. The inset graph shows the percentages of urban and rural populations, 2015.

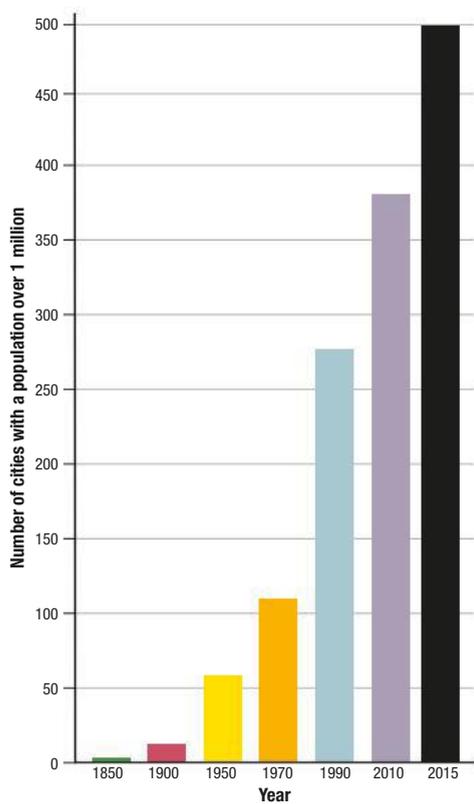


Figure 2.6.1r Number of cities with a population over 1 million, 1850–2015

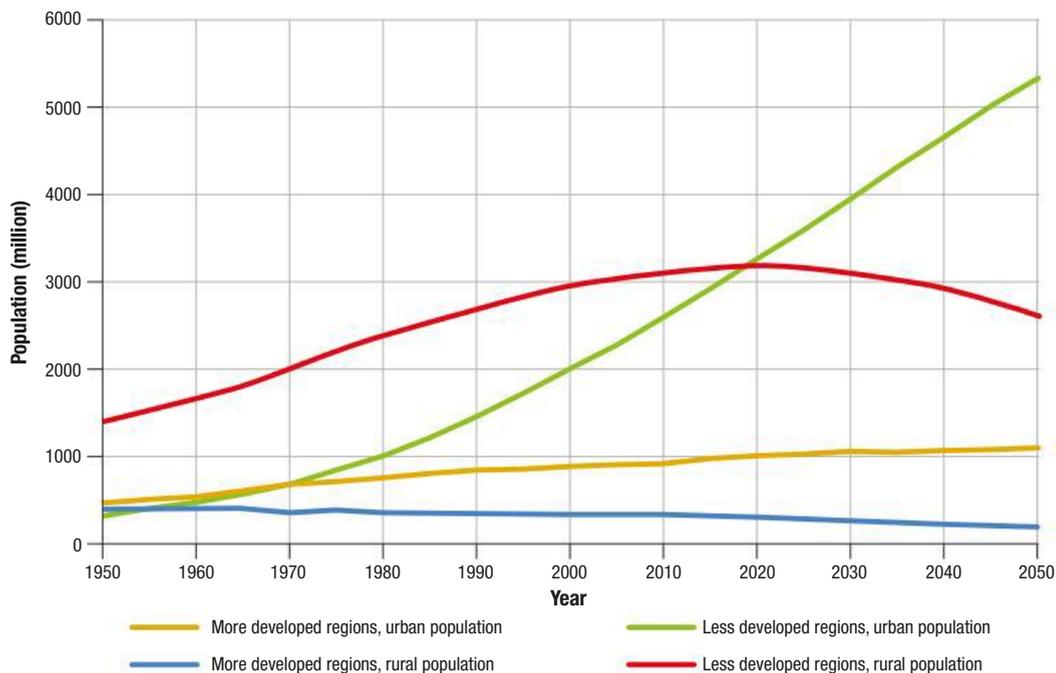


Figure 2.6.1s Urban and rural population by development group, 1950–2050

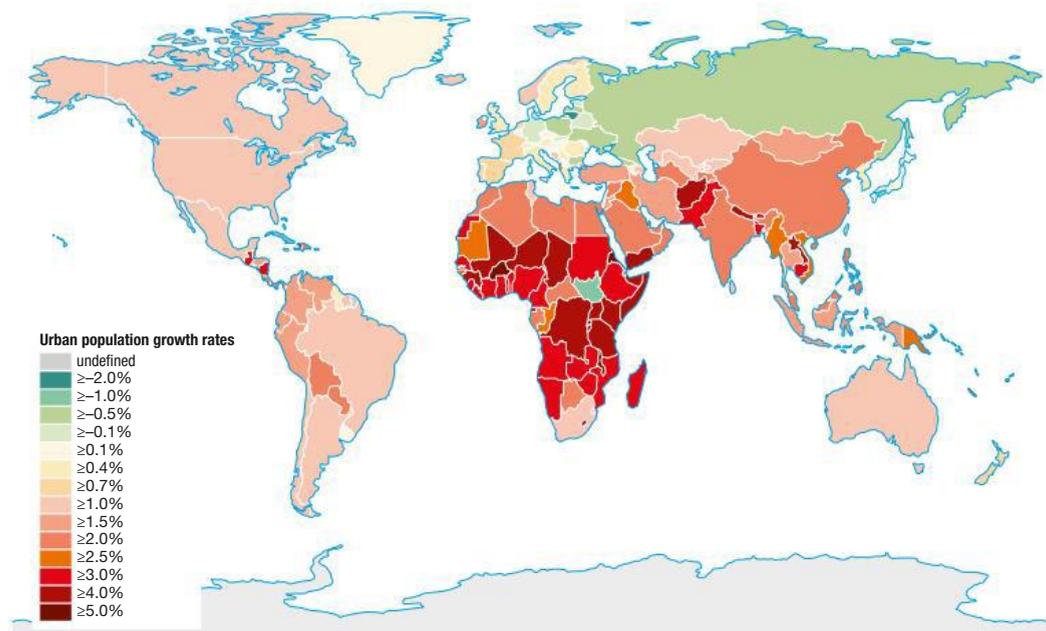


Figure 2.6.1t Urban population growth rates, 2010–2015



Figure 2.6.1u Polluted urban waterway, Delhi, India

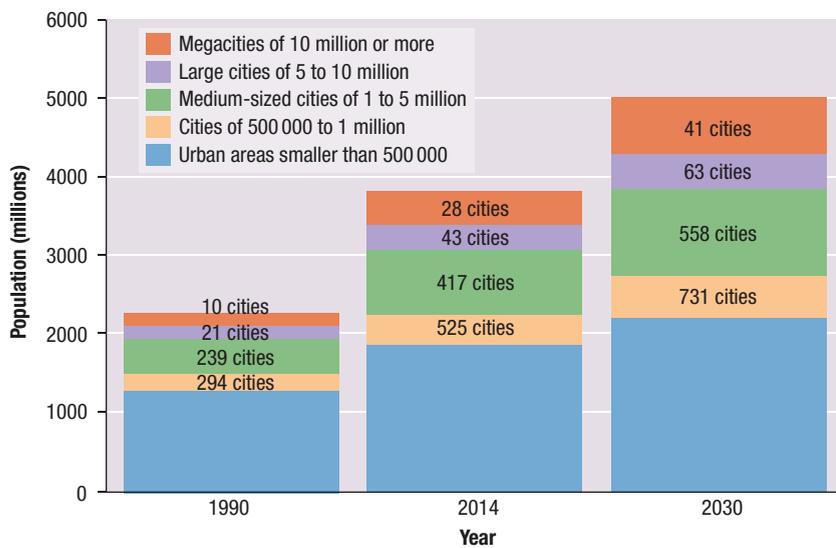


Figure 2.6.1v Distribution of the world's urban population by city size, 1990, 2014 and 2030

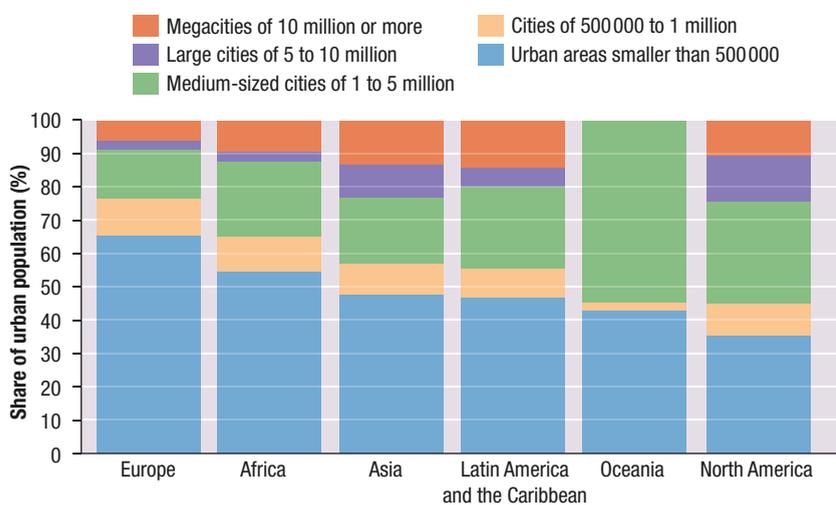


Figure 2.6.1w Population distribution by city size, 2014



Figure 2.6.1x Squatter settlement in the Philippines

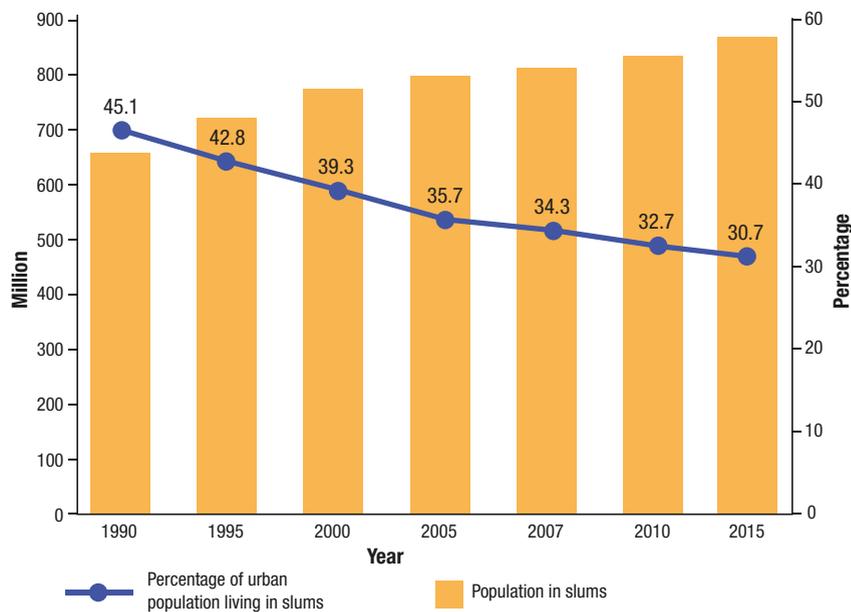
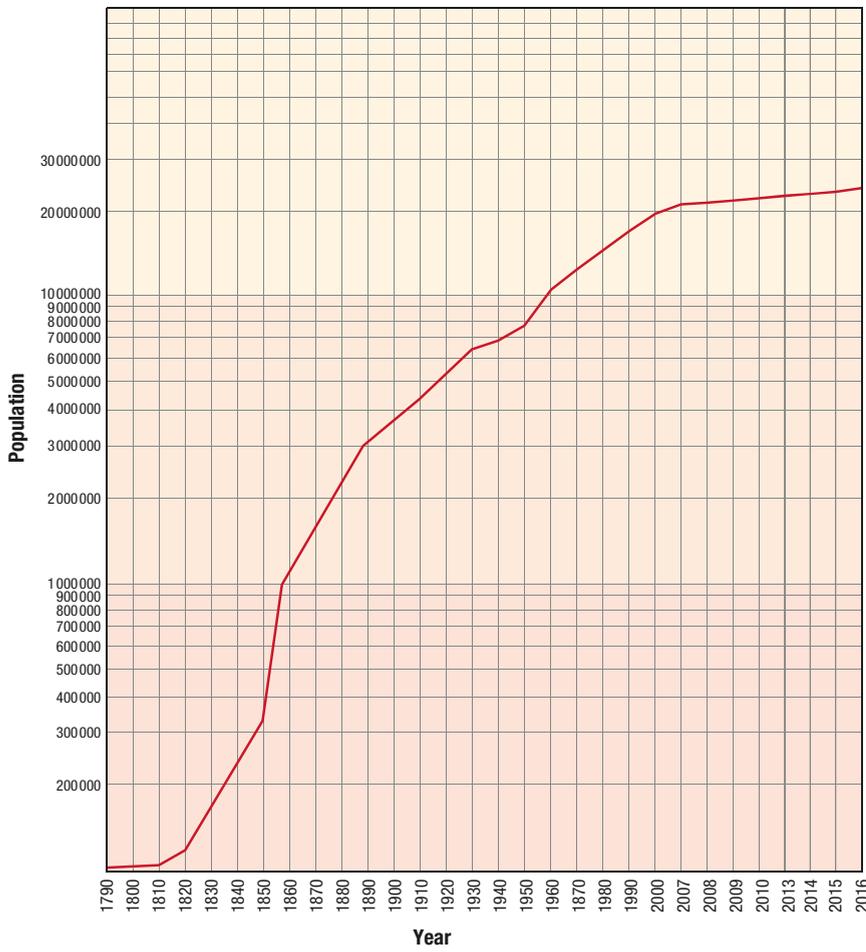


Figure 2.6.1y Population living in slums and proportion of the urban population living in slums, developing regions, 1990–2015

ACTIVITIES

- Study Figure 2.6.1a (page 58) and then, with the aid of an atlas, identify those parts of the world that have the highest and lowest population densities.
- Study Figure 2.6.1b (page 58) and then answer the following questions:
 - In what year did the world's population exceed 6 billion?
 - In what year is the world's population expected to exceed 9 billion?
 - How many years did it take for the population of the world to double from 3 billion to 6 billion people?
- Study Figure 2.6.1c (page 58) and then answer the following questions:
 - In what year did world population growth rates peak?
 - What has been the general trend in world population growth rates since the mid-1960s?
 - What was the world population growth rate in 2000?
- Study Figure 2.6.1d (page 58) and then answer the following questions:
 - In what year did the annual growth of world population peak? How many people were added to the world's population in that year?
 - In what year is the annual growth of the world's population expected to begin its long-term decline?
 - What is the level of annual world population growth expected to be in 2050?
- Study Figure 2.6.1e (page 58) and then answer the following questions:
 - On which continent is the greatest share of the world's population located?
 - How many people live in Asia?
 - What percentage of the world's population lives in Africa?
- Study Figure 2.6.1f (page 58). 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?
- Study Figure 2.6.1h (page 59). Identify the regions with an increasing share of the world's population and those with a declining share between 2000 and 2150. Which region's share of the world's population will increase most rapidly?
- Study Figure 2.6.1i (page 59). Which countries will increase their ranking between 2016 and 2050?
- Study Figure 2.6.1j (page 59). With the aid of an atlas, identify those parts of the world with the highest total fertility rate.
- Compare Figure 2.6.1k (page 59), which shows the pattern of population growth, with Figure 2.8.1a (page 75), which shows gross national income per capita. Describe the nature of the relationship.
- Study Figure 2.6.1m (page 60) and then answer the following questions:
 - What percentage of the world's population was aged 60 years and over in 2000?
 - What percentage of the world's population is projected to be over 60 years in 2050?
- In what part of the world is the rate of population ageing projected to be fastest in the period 2000–50?
- Study Figure 2.6.1n (page 60) and then answer the following questions, giving your answer as a whole number (no decimal places):
 - What percentage of Italy's population was under the age of 15 years in 2014?
 - What percentage of Italy's population was over the age of 65 years in 2014?
 - What percentage of Nigeria's population was under the age of 15 years in 2014?
 - What percentage of Nigeria's population was over the age of 65 years in 2014?
 - How many Italians are there under the age of 15 years?
 - How many Nigerians are there under the age of 15 years?
- Study Figure 2.6.1o (page 60). Write two to three paragraphs outlining the factors driving the process of urbanisation.
- Study Figure 2.6.1q (page 61) and, with the aid of an atlas, identify those regions of the world that have the highest and lowest rates of urbanisation.
- Study the inset graph in Figure 2.6.1q (page 61). What was the size of the world's urban population in 2015?
- Study Figure 2.6.1r (page 61). In which period did the number of 1 million-plus cities increase most rapidly?
- Study Figure 2.6.1s (page 61) and answer the following questions:
 - Which population is growing most rapidly?
 - In what year will the rural population of less developed regions start declining?
- Study Figure 2.6.1t (page 61). With the aid of an atlas, identify the regions with the highest and lowest urban population growth rate in 2010–15.
- Study Figure 2.6.1v. Which category of city will show the greatest proportional increase in the period 2014–30?
- Study Figure 2.6.1w and then answer the following questions:
 - Which region has the greatest proportion of its population living in urban areas smaller than 500 000?
 - Which region has the smallest proportion of its population living in urban areas smaller than 500 000?
 - Which region has more than 50 per cent of its population living in medium-sized cities of 1 million to 5 million?
 - Which region has the largest percentage of its population living in megacities of 10 million or more?
- Study Figures 2.6.1u (page 61) and 2.6.1x. 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.
- Study Figure 2.6.1y. Describe the trends in the world's slum population.



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

Figure 2.6.2a A semi-logarithmic graph showing the growth in the Australian population, 1790–2016

In June 2016, Australia's population reached 24.16 million. This is nearly three times the population in 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 2.6.2c Immigrant ship arriving at the Port of Fremantle, Western Australia

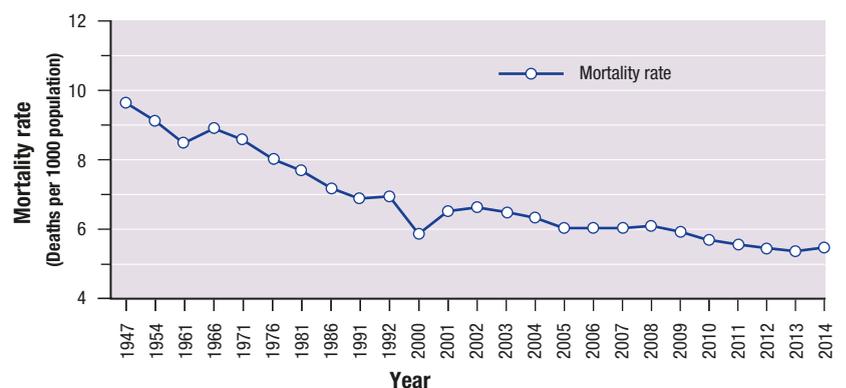
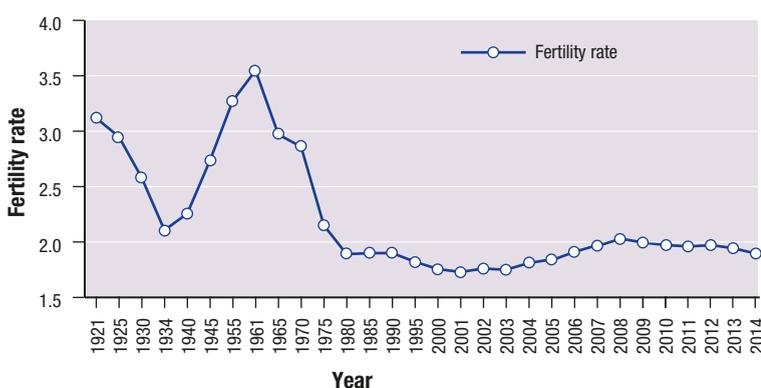
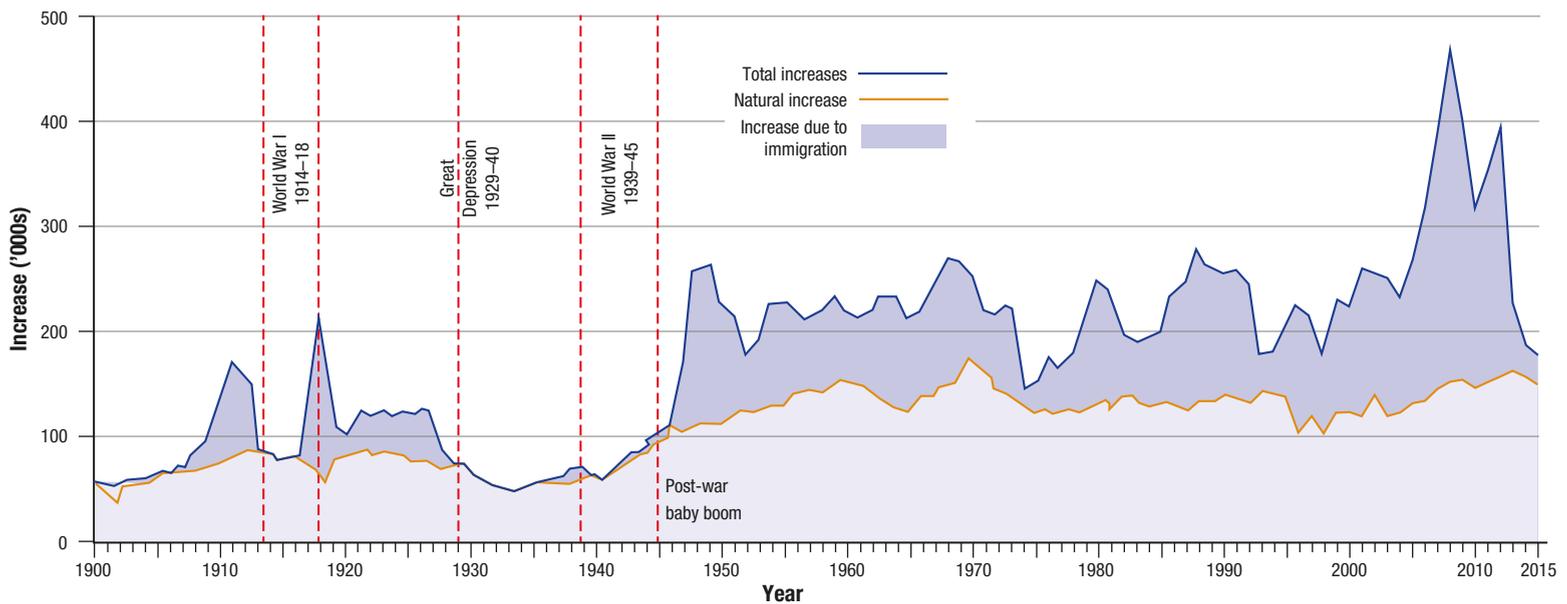


Figure 2.6.2b Components of Australia's population growth, 1900 to 2015: Australia's fertility rate, 1921 to 2014; Australia's mortality rate, 1947 to 2014



Figure 2.6.2d Australia celebrates its multicultural heritage.

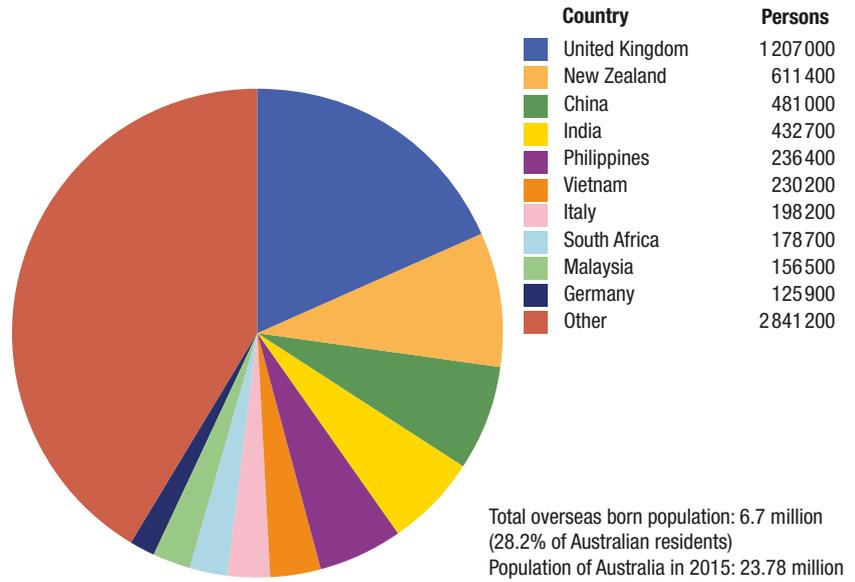


Figure 2.6.2e Top 10 countries of birth of Australian residents, 30 June 2015

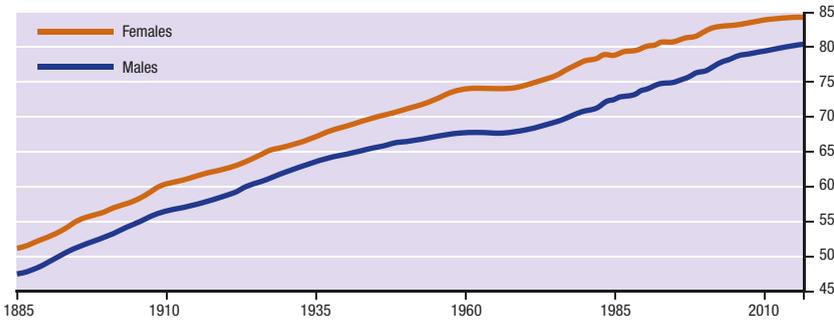


Figure 2.6.2f Life expectancy 1885–2014

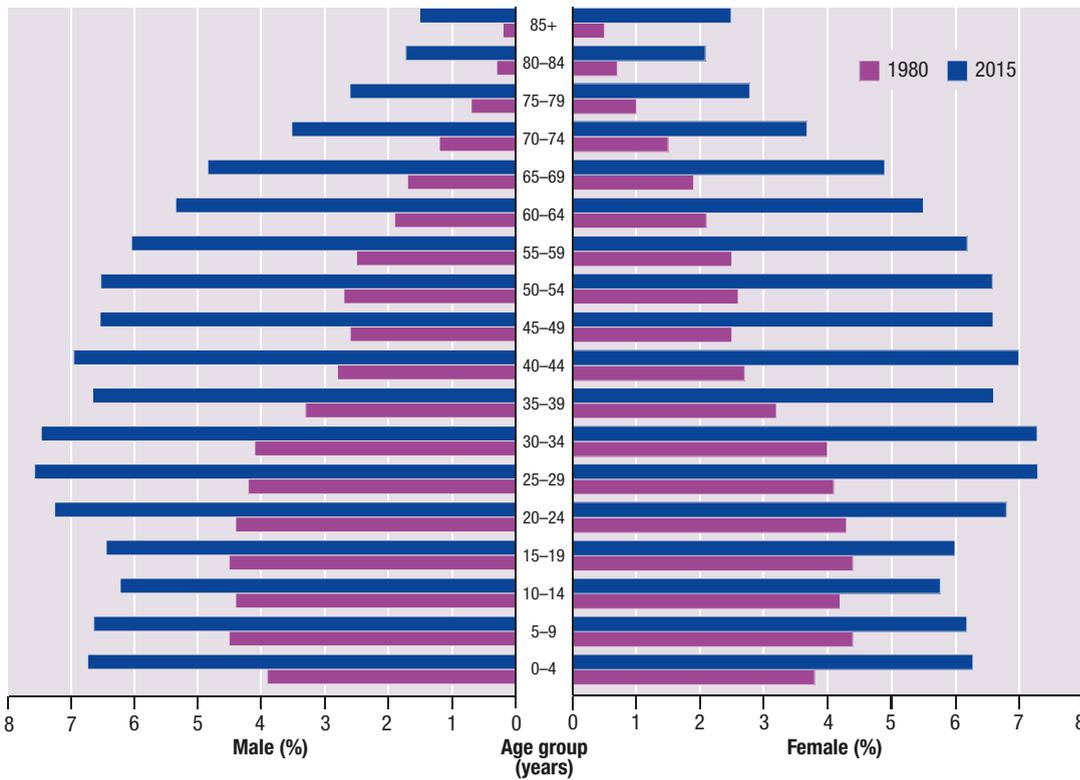


Figure 2.6.2g Population structure of Australia, by age and sex, 1980 and 2015

ACTIVITIES

- Study Figure 2.6.2a (page 63) and then answer the following questions:
 - What was the population of Australia in:
 - 1850
 - 1900
 - 1950?
 - Which decade experienced the most rapid population growth?
 - Which decade of the 20th century experienced the slowest rate of population growth?
- Study Figure 2.6.2b (page 63) and then answer the following questions:
 - In which year did the rate of natural increase peak?
 - What effect did the world wars and the Great Depression have on population growth? What was affected more: natural increase or immigration?
 - Explain why there was a significant increase in population growth in 1918 and 1946.
- Study Figure 2.6.2e and then answer the following questions:
 - What was the most common birthplace of overseas-born residents in Australia in 2015?
 - What percentage of Australian residents were born in New Zealand in 2015?
- Study 2.6.2f. By how much has life expectancy for Australian males and females increased since 1910?
 - Estimate the number of Australians under the age of 15 years in 1980.
 - Estimate the number of Australians under the age of 15 years in 2015.
 - Calculate the percentage of Australians under the age of 15 years in 1980.
- How many Chinese-born Australian residents were there living in Australia in 2015?
 - How many Australians were born in either China or India in 2015?
 - What percentage of all Australians were born in either China or India?
- Calculate the percentage of Australians under the age of 15 years in 2015.
 - Estimate the number of Australians over the age of 65 years in 1980.
 - Estimate the number of Australians over the age of 65 years in 2015.
 - Calculate the percentage of Australians over the age of 65 years in 1980.
 - Calculate the percentage of Australians over the age of 65 years in 2015.
 - What do the figures suggest about the changing structure of the Australian population?
 - What other evidence is there that Australia has an ageing population?

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 apartments). 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 2015 the population had grown to 624 918.

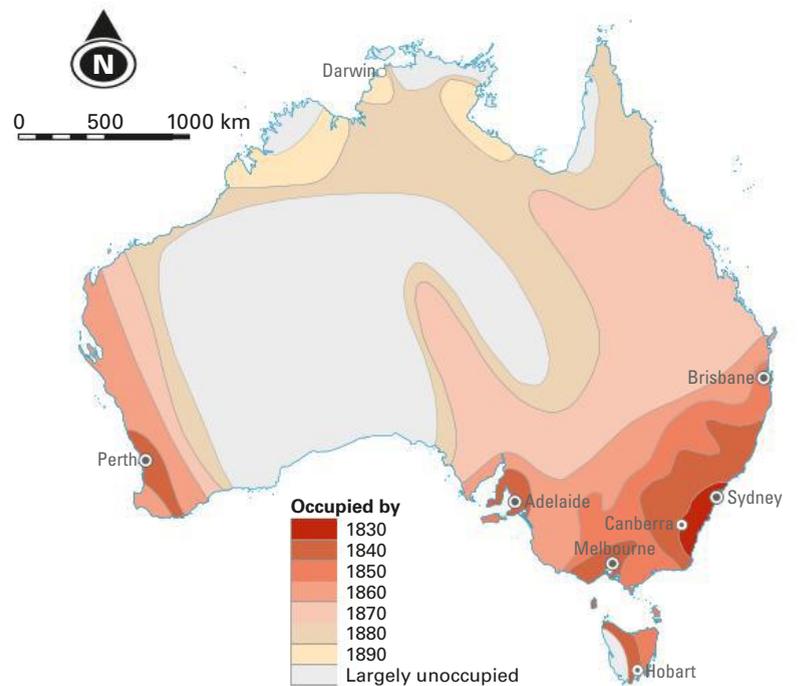
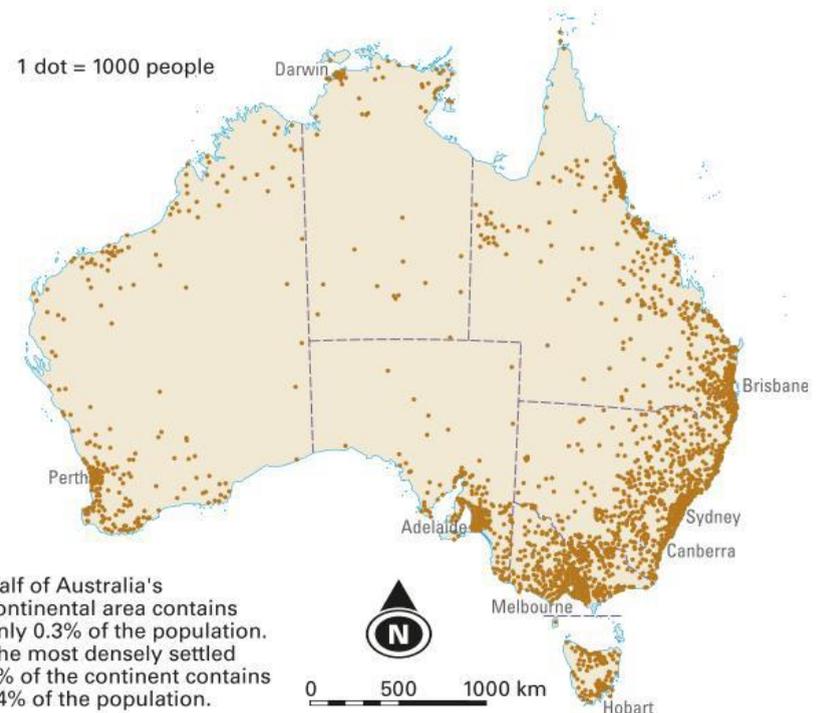


Figure 2.6.3a Spread of European settlement in Australia since 1788



Half of Australia's continental area contains only 0.3% of the population. The most densely settled 1% of the continent contains 84% of the population.

Figure 2.6.3b Dot map showing the distribution of the Australian population, 2015

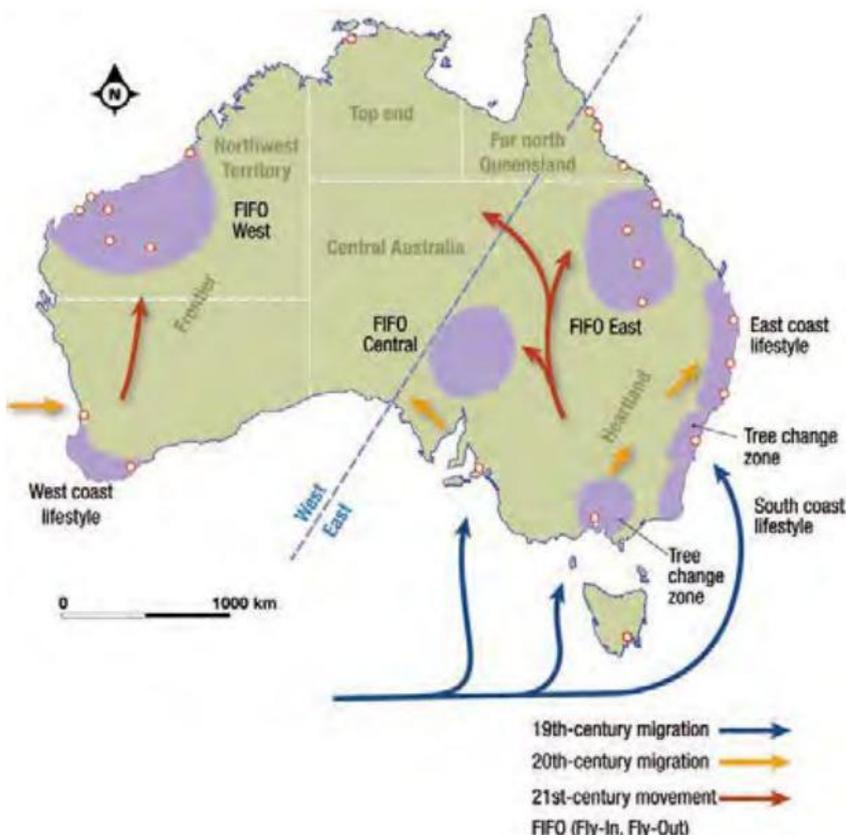


Figure 2.6.3c Population movements over time

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 2014–15, net overseas migration added 43 700 to the population of New South Wales, followed by Victoria (39 760) and Queensland (20 490). The Northern Territory received just 1250 persons. Sydney is using immigrants to replace departing residents.

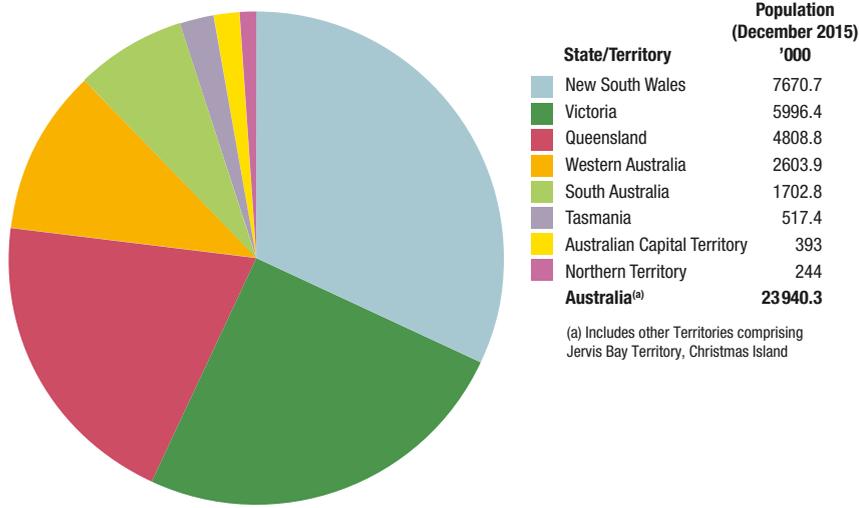


Figure 2.6.3d Distribution of Australia's population by state and territory, December 2015

INDIGENOUS AUSTRALIA

In 1788, Australia's population was thought to be about 315 000, 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 2.6.3a The distribution of the Australian population

	1901	2015
Rural	52%	18%
Inner city	25%	5%
Suburban	15%	58%
Coastal	8%	19%

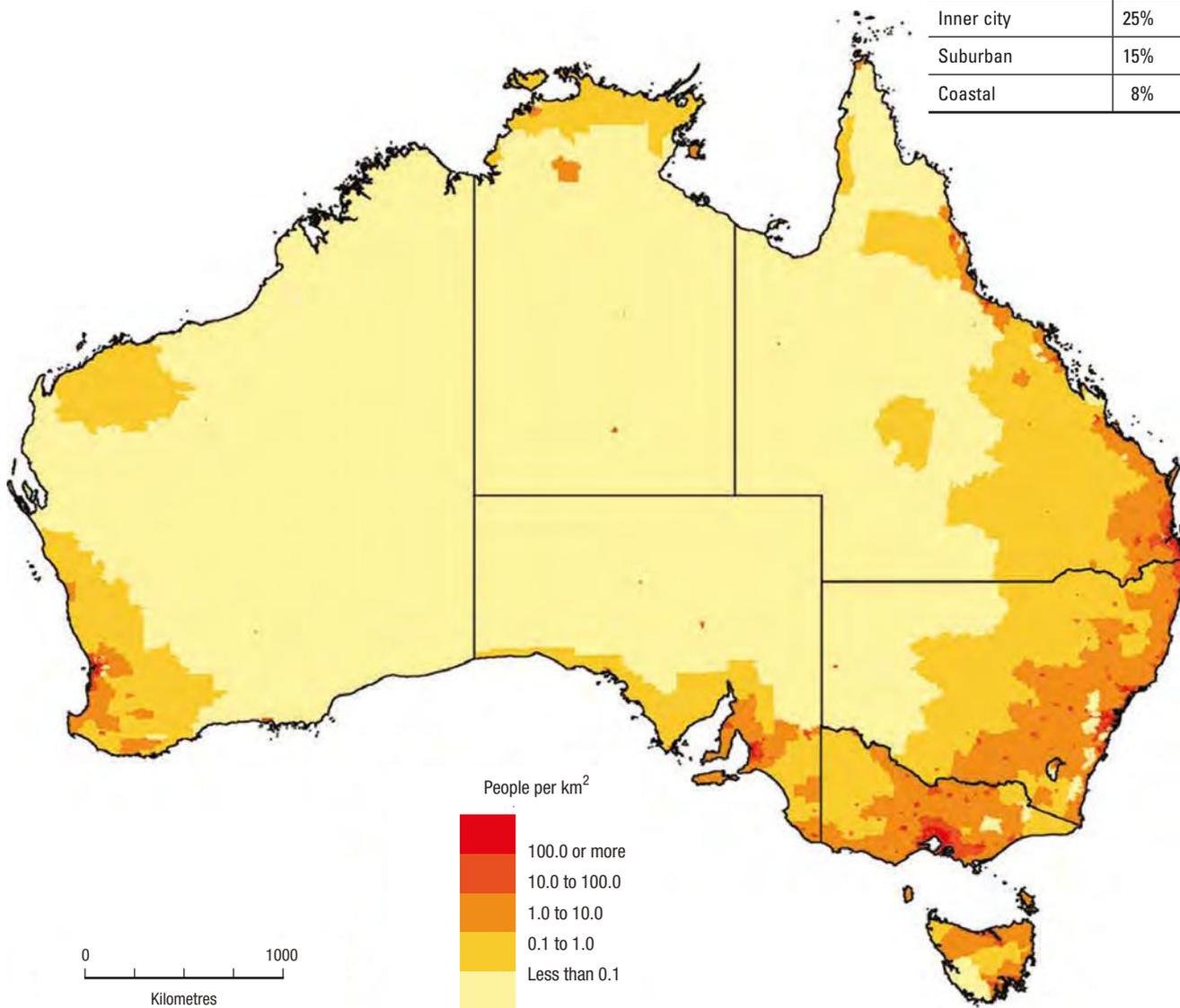


Figure 2.6.3e Population density, 2015

Table 2.6.3b Population change by state and territory, 2011-2015

State/Territory	Total population 2011 ('000)	Total population December 2015 ('000)	Percentage change
NSW	6917.7	7670.7	10.9
Victoria	5354.0	5996.4	12.0
Queensland	4332.7	4808.8	11.0
South Australia	1596.6	1702.8	6.7
Western Australia	2239.2	2603.9	16.3
Tasmania	495.4	517.4	4.4
Northern Territory	211.9	244.0	15.1
ACT	357.2	393.0	10.0
Australia	21504.7	23940.3	11.3

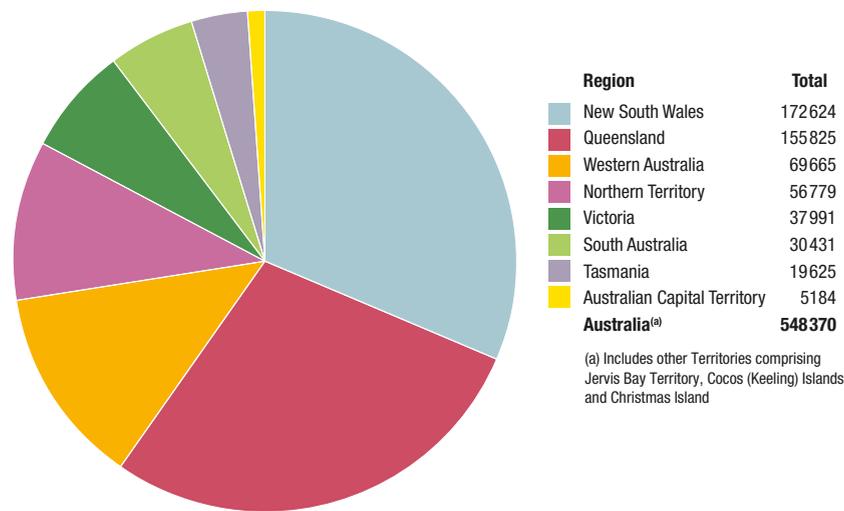


Figure 2.6.3f The distribution of Indigenous Australians by state and territory, 2011 Census

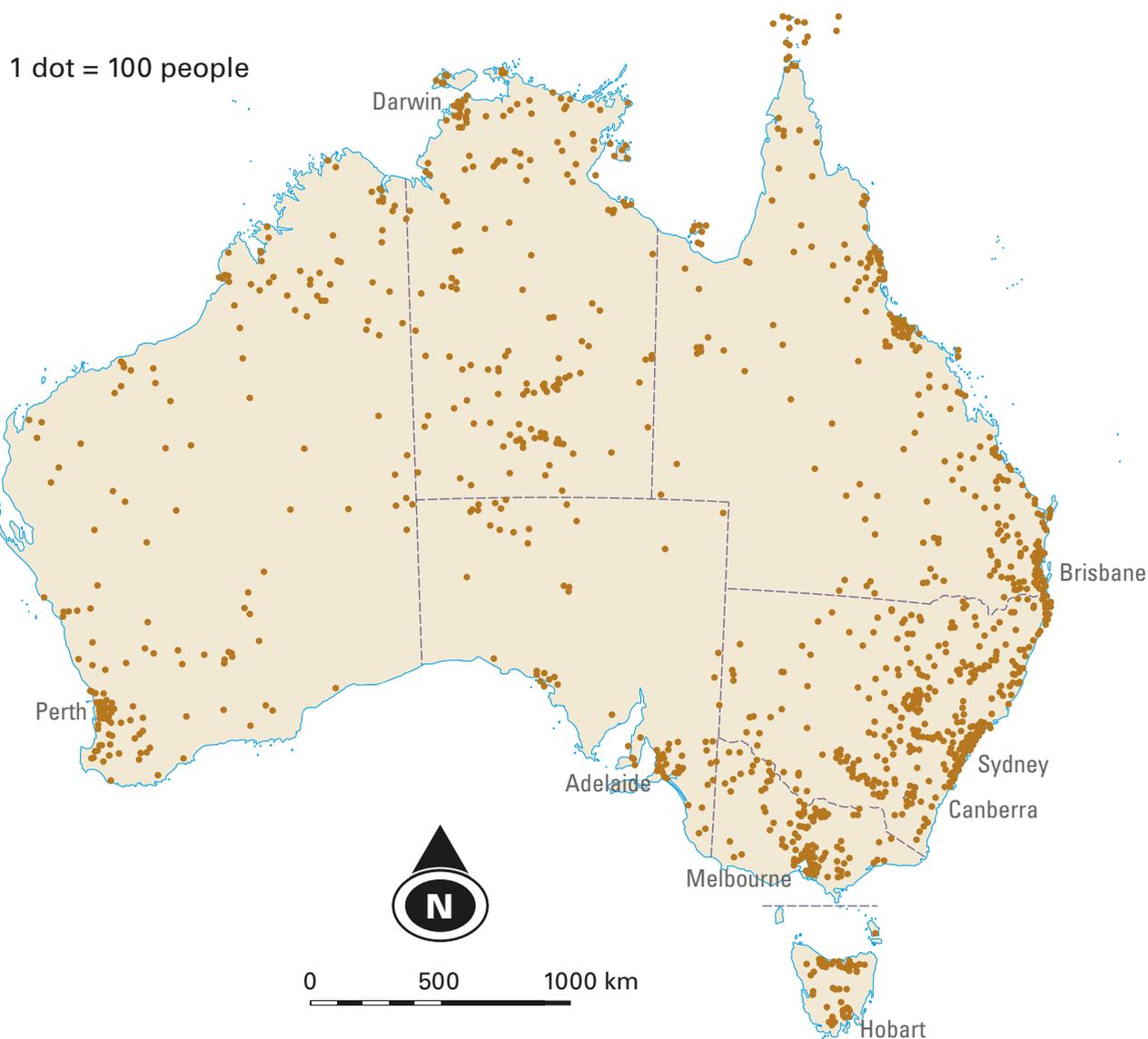


Figure 2.6.3g Dot map showing the distribution of Indigenous Australians

ACTIVITIES

- 1 Study Figure 2.6.3a (page 65). Write a paragraph describing the spread of European settlement since 1788.
- 2 Study Figure 2.6.3b (page 65). Describe the distribution of the Australian population. Working in groups, brainstorm the reasons for the pattern identified.
- 3 Study Figure 2.6.3d 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?
- 4 Study Figure 2.6.3e 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 km²?
- 5 Study Figures 2.6.3f and 2.6.3g. Write a paragraph describing the distribution of Indigenous Australians.
- 6 Study Figure 2.6.3f 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?
- 7 Write an extended response outlining the nature of internal migrations taking place within Australia.
- 8 Study Table 2.6.3a and describe how the distribution of the Australian population changed between 1901 and 2015.
- 9 Study Table 2.6.3b. Construct a column graph to illustrate the population change by state and territory, 2011–16. Account for the population growth experienced by Western Australia.
- 10 Study Table 2.6.3b. Identify the states and territories that experienced a growth rate greater than that of Australia as a whole.
- 11 Write an extended response outlining the principal movements of Australia's population.

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 million 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 2010 and 2060. Meanwhile other groups with higher birth rates will increase.
- The number of Latinos will more than double, from 56.6 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 46 million to 61.8 million by 2060 (up from 13.3 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 groups other than single-race, non-Latinos.

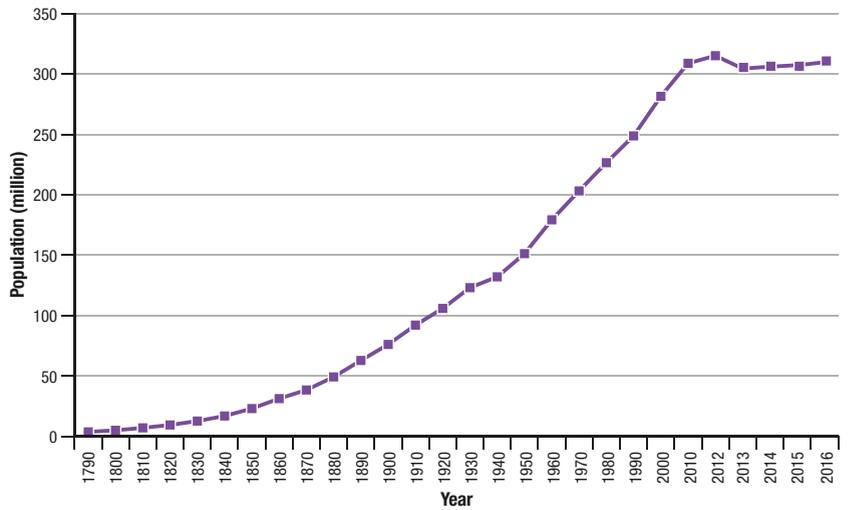


Figure 2.6.4a Growth of the US population, 1790–2016

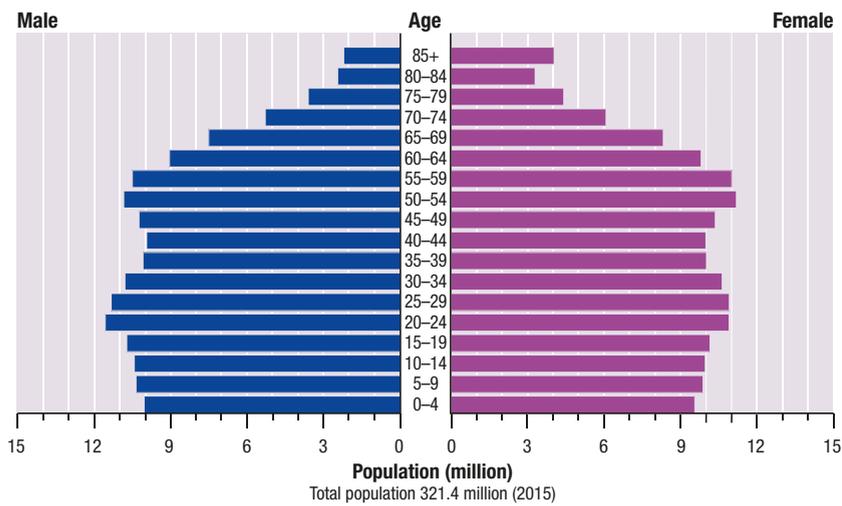


Figure 2.6.4b The age and sex structure of the US population, 2015

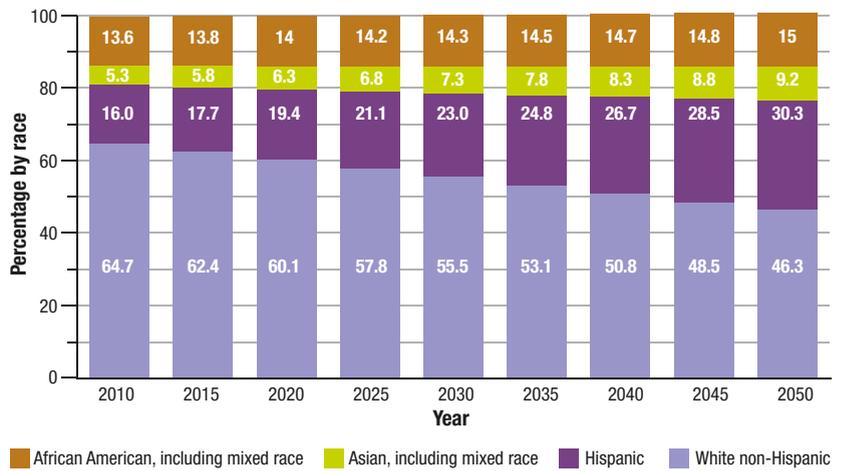


Figure 2.6.4c Projections of the changing ethnic composition of the US population, 2010–50



Figure 2.6.4d Times Square, New York City

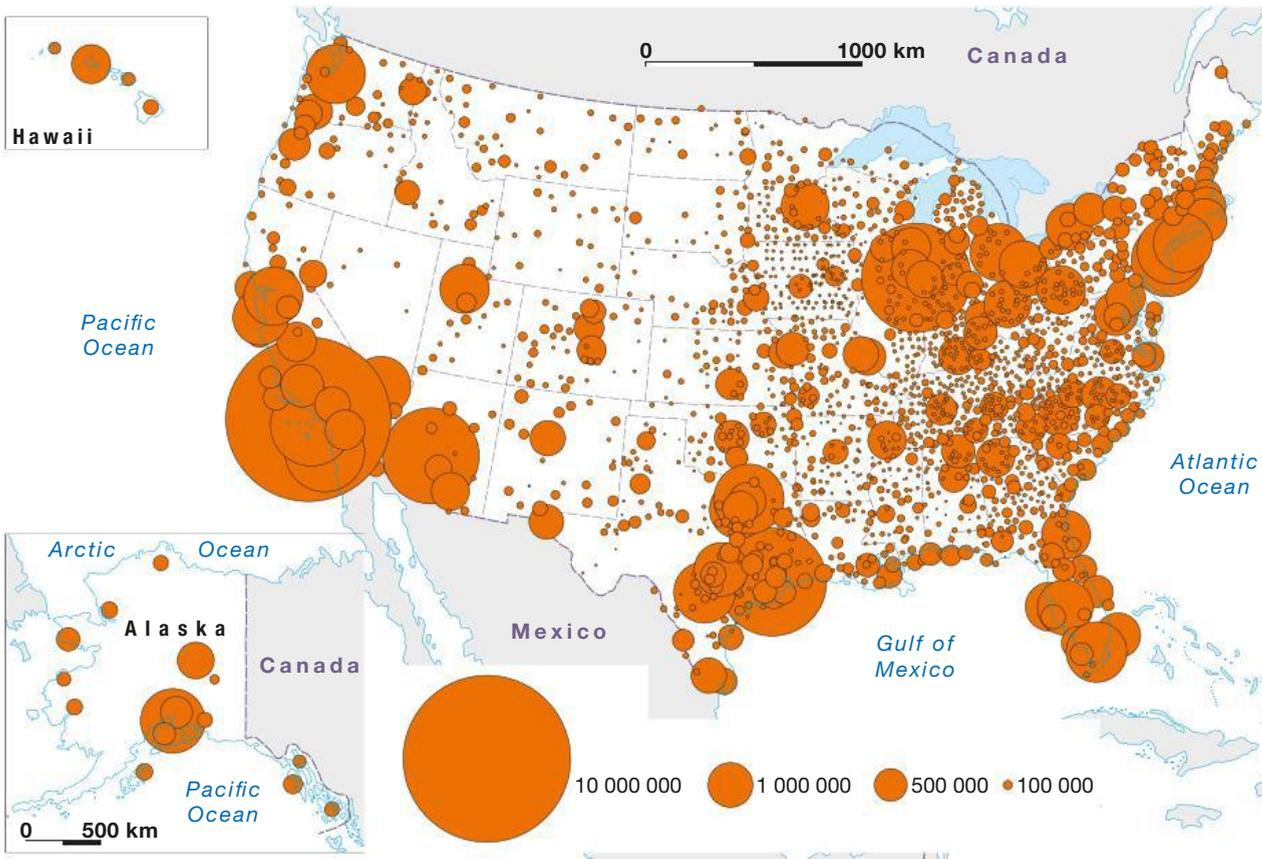


Figure 2.6.4e Distribution of the US population, 2010 Census

Population distribution of the United States

The population of the United States 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 per cent of Americans live in metropolitan areas. This means that more than three-quarters of the US population shares just 3 per cent of the land area.

The most densely settled parts of the United States 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 United States' most populace state). The central plains of the United States 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.

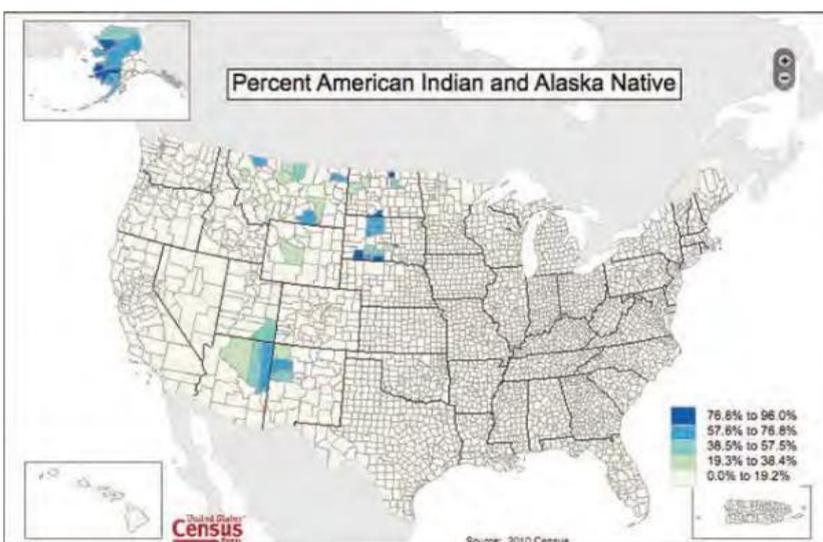


Figure 2.6.4f Distribution of the US' indigenous peoples, 2010 Census

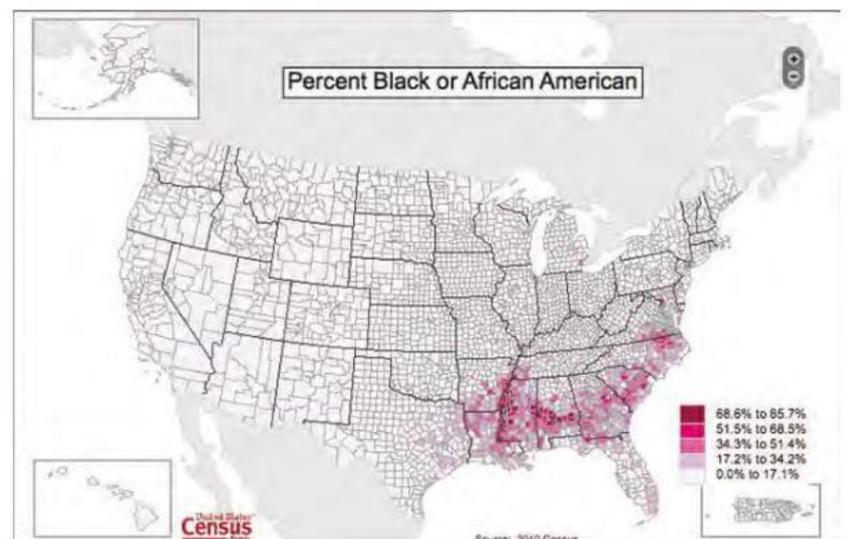


Figure 2.6.4g Distribution of African Americans, 2010 Census

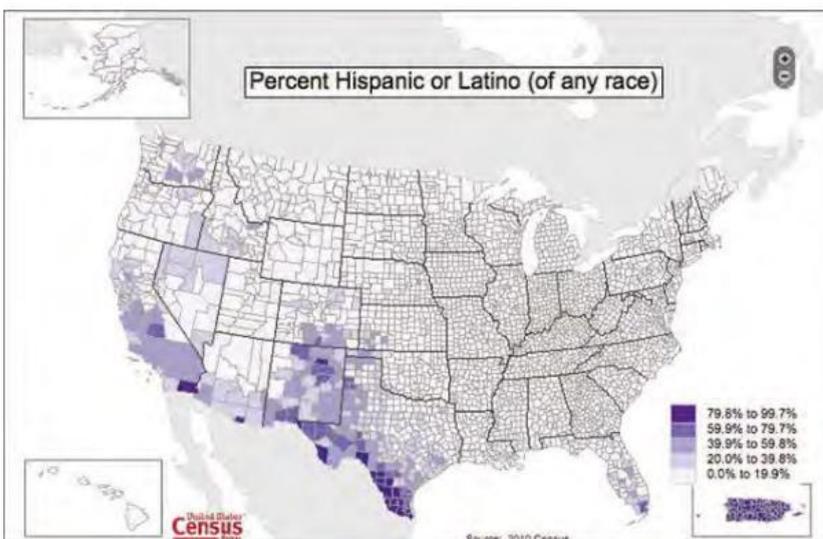


Figure 2.6.4h Distribution of Hispanic Americans, 2010 Census

United States census

The United States conducts a census every 10 years. The last one was in 2010. The next is scheduled for 2020.

Changing race/ethnicity of America's teenagers

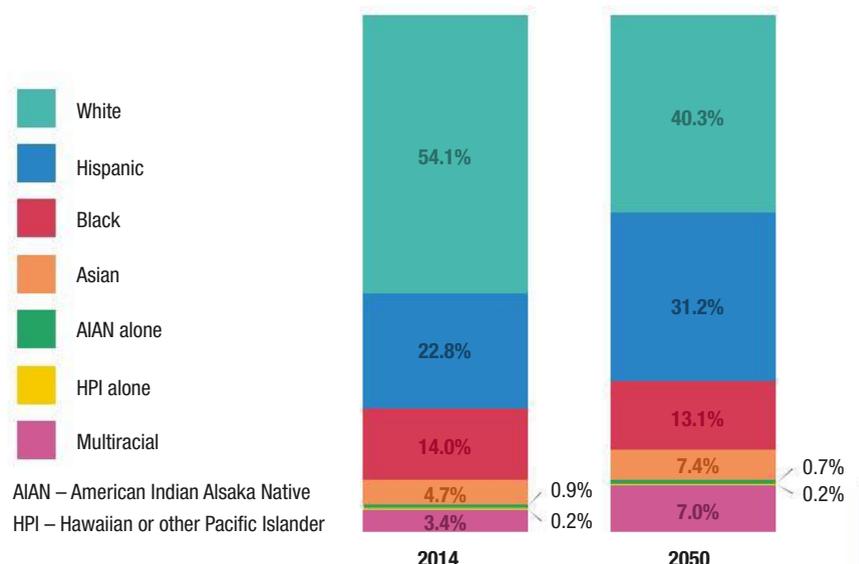


Figure 2.6.4i The proportion of adolescents who are racial and ethnic minorities is expected to rise in the future. More than half of US adolescents (54 per cent) were white in 2014, but by 2050 that proportion is projected to drop to 40 per cent as Hispanic and multiracial teens, in particular, come to represent a larger share of the population.

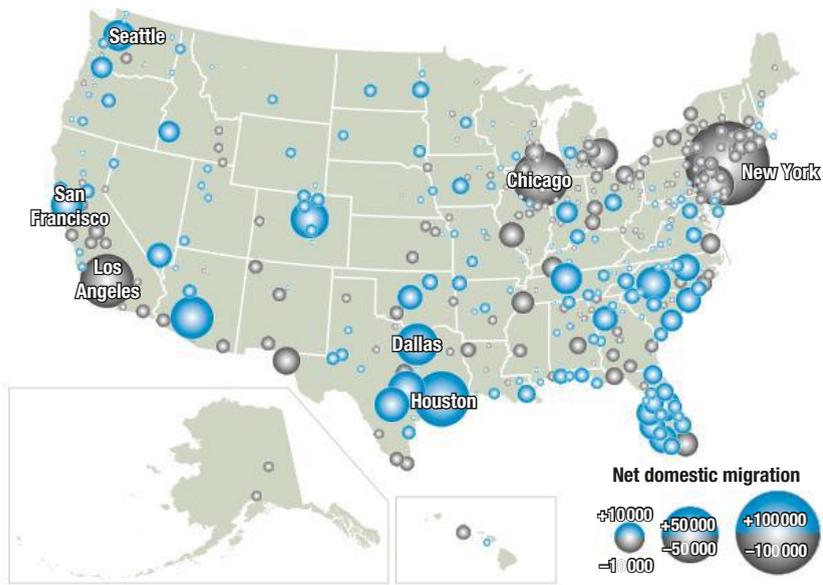


Figure 2.6.4j United States: net domestic migration, 2012–13

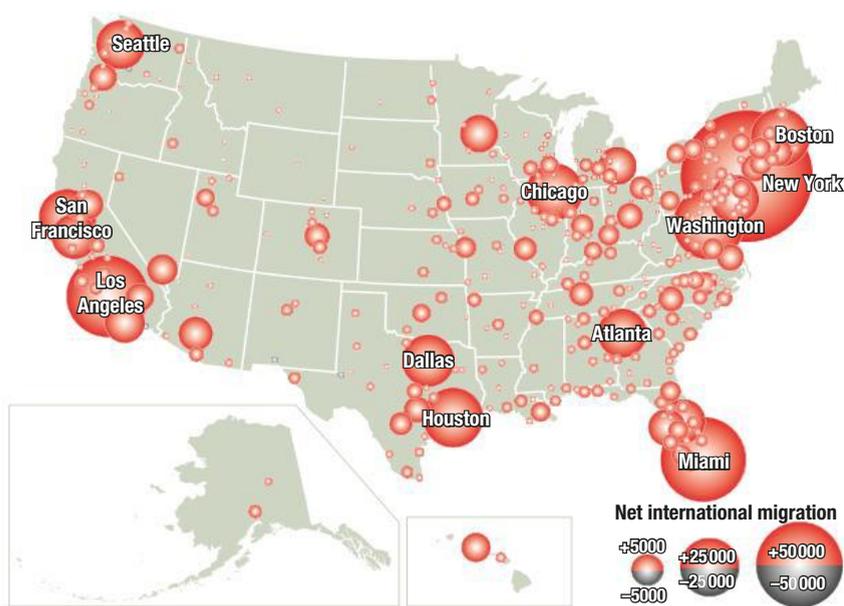


Figure 2.6.4k United States: net international migration, 2012–13

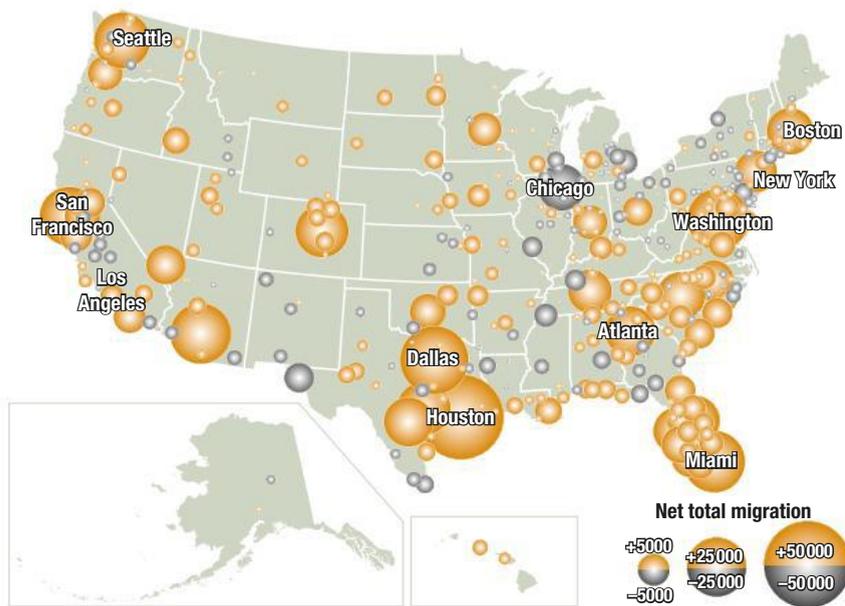


Figure 2.6.4l United States: total net migration, 2012–13. New York and Los Angeles are losing more Americans than they're gaining, but the flood of immigrants more than makes up for it.

Population movements

America's largest cities, which are currently gaining population at impressive rates, are driving much of the population growth across the nation. But that growth is the result of two very different migrations — one coming from the location choices of Americans themselves, the other shaped by where new immigrants from outside the United States are heading.

While many cities are attracting a net-inflow of migrants from other parts of the United States, several large cities, for example, New York, Los Angeles and Miami, there is actually a net outflow of Americans to the rest of the country. Immigration is driving population growth in these places. Sunbelt cities such as Houston, Dallas and Phoenix, and knowledge hubs like Austin, Seattle, San Francisco and Washington, DC are gaining much more from domestic migration.

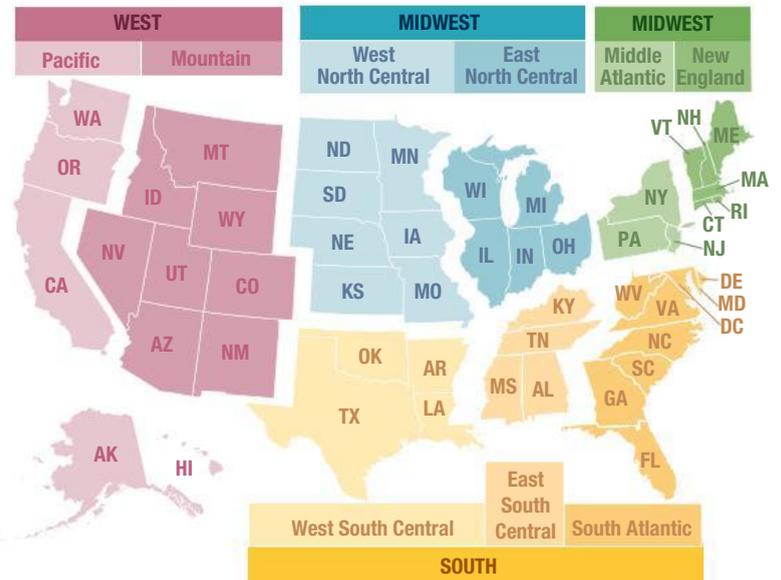


Figure 2.6.4m Regions of the United States



Figure 2.6.4n Top state-to-state migration flows, 2010–11



Figure 2.6.4o The ethnic diversity of the American population is increasing.

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 7.2, page 164) and Calgary (1.1 million) have more than a million residents.

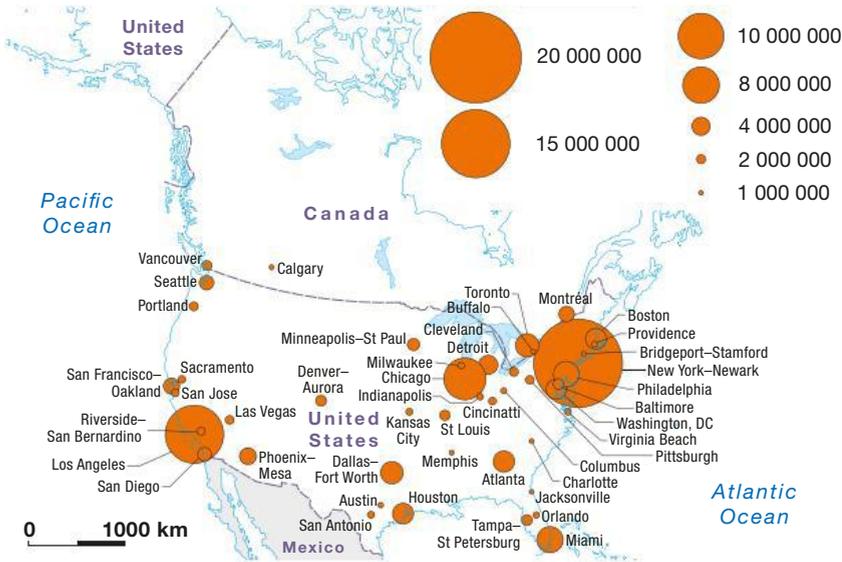


Figure 2.6.4p Proportional circle graph showing distribution of major North American urban concentrations

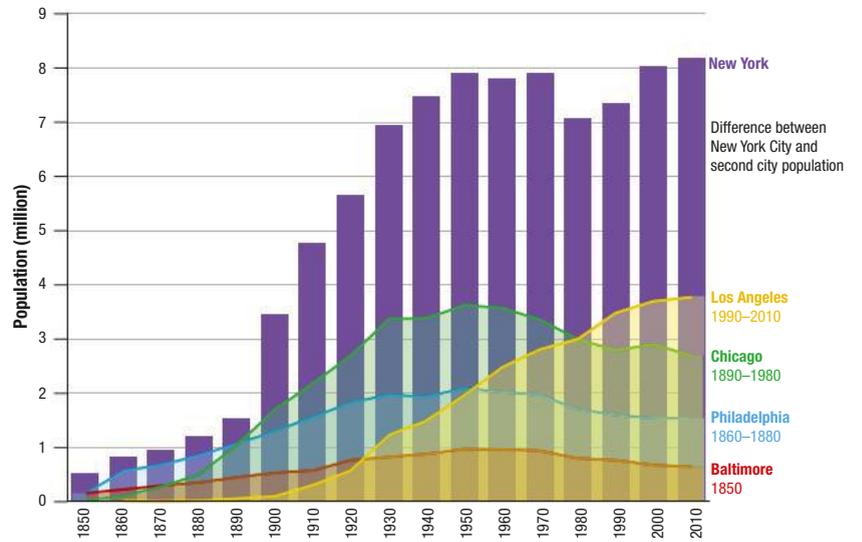


Figure 2.6.4q Population trends: selected US cities, 1850–2010

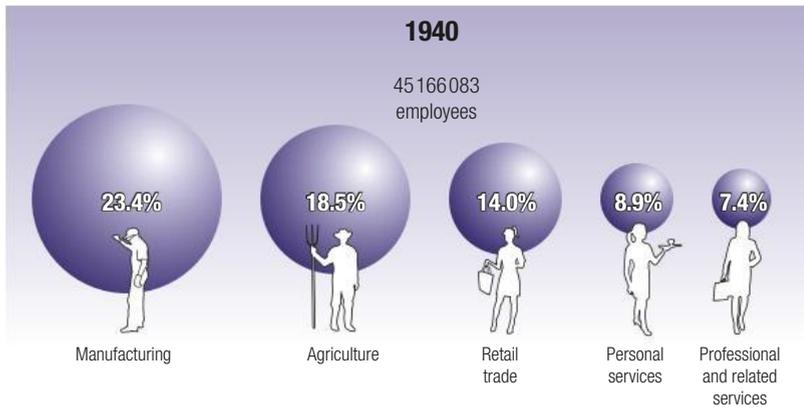


Figure 2.6.4r Changing structure of US employment 1940–2010

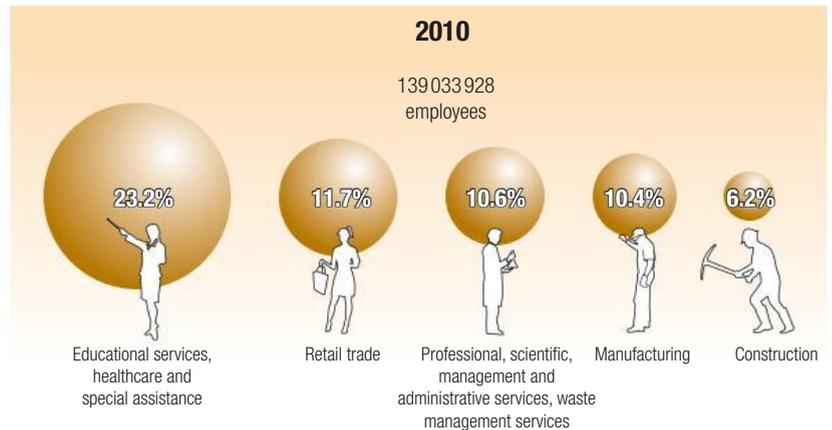


Figure 2.6.4s Washington, DC is the capital city of the United States.

ACTIVITIES

- Study Figure 2.6.4a (page 68). Describe the general trend in the rate of US population growth since 1790.
- Study Figure 2.6.4b (page 68) and answer the following questions:
 - Estimate the number of Americans under the age of 15 years in 2015. What percentage of the total population did this represent?
 - Estimate the number of Americans over the age of 65 years in 2015. What percentage of the total population did this represent?
- Using data from Figure 2.6.4c (page 68) describe the projected changes in the ethnic composition of the US population between 2010 and 2050.
- Study Figure 2.6.4e (page 69). With the aid of Figure 2.6.4m and Figure 2.6.4p describe the distribution of the US population in 2010. Explain how the population distribution of the United States differs from that of Australia.
- Study Figures 2.6.4f to 2.6.4h (page 69). Describe the distribution of:
 - indigenous Americans
 - African Americans
 - people of Hispanic origin.
- Undertake research into the reasons for the distribution of African Americans and those of Hispanic origin.
- Study Figure 2.6.4i (page 69). Using data from the graph describe the projected change in the race/ethnicity composition of American teenagers between 2014 and 2050.
- Study Figures 2.6.4j and 2.6.4k. Explain what these maps tell us about the impact of domestic and international migration on the population distribution of the United States as shown in the map showing total net migration (Figure 2.6.4l).
- Study Figure 2.6.4n. Identify the two largest inter-state movements of people in 2010–11.
- Study Figure 2.6.4p. Identify North America's largest urban concentrations. Describe their distribution.
- Study Figure 2.6.4q. Describe how the trends in New York's population compare with those of Los Angeles, Chicago, Philadelphia and Baltimore.
- Study Figure 2.6.4r. Using data from the graphic, describe the change in the structure of US industry and employment in the period 1940 to 2010.

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 (CO₂) 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 0.87°C, with about two-thirds of the increase occurring since 1980. In May 2013, atmospheric greenhouse gas concentrations reached 400 parts per million – their highest level in at least the

past 650 000 years. 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 heatwaves, 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 m above sea level.

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

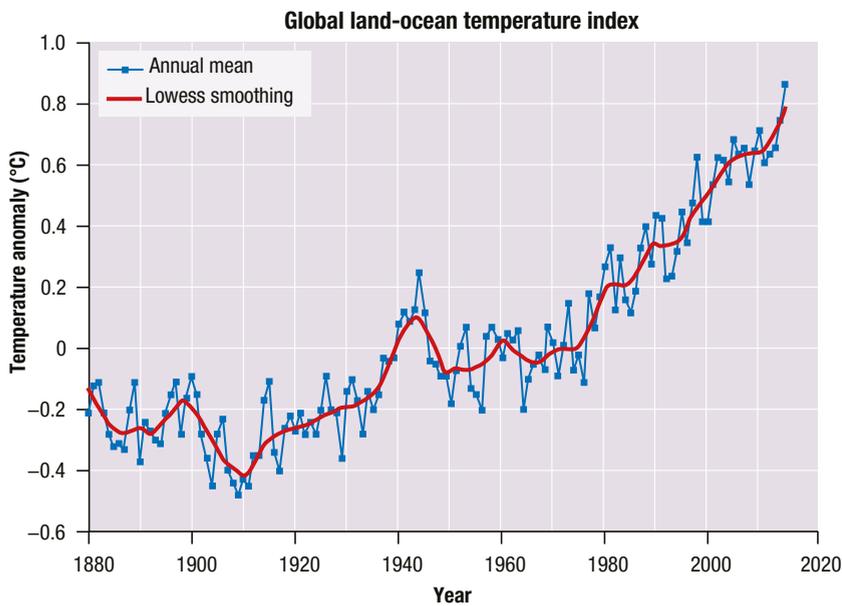


Figure 2.7.1a Trends in global temperatures, 1880–2015; how much warmer or colder a year was compared with the average temperature between 1951 and 1980

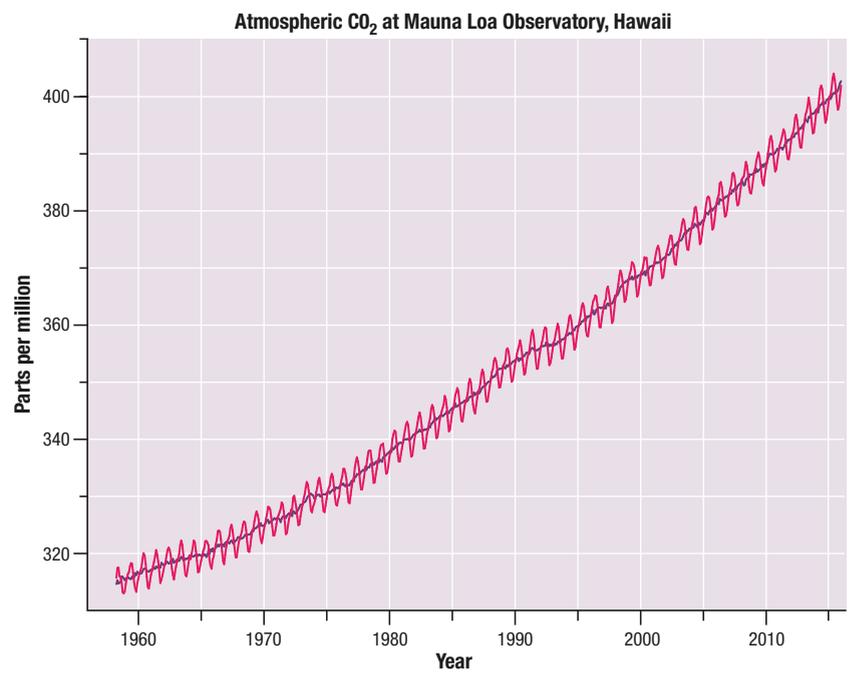


Figure 2.7.1b Atmospheric CO₂ concentrations, 1958–2015. In 1850, about 280 out of every 10 million air molecules were CO₂. By 2015, the concentration exceeded 404 parts per million. Scientists predict that if no steps are taken to slow this trend, the concentration will increase to 700 parts per million by 2100.

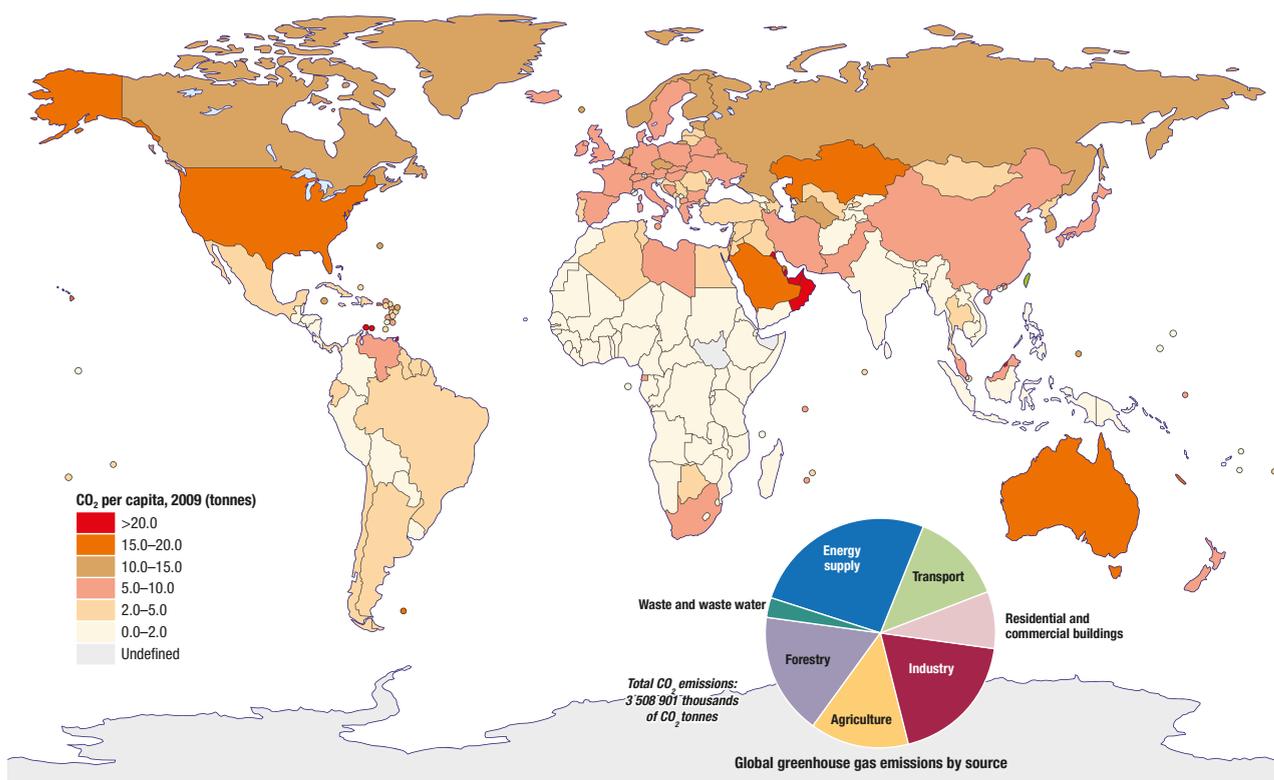


Figure 2.7.1c CO₂ emissions per capita, 2015. The inset graph shows the sources of CO₂ emissions.

Table 2.7.1a Top 10 CO₂-emitting countries and Australia's rank, 2014

Rank	Country	Emissions ('000kt)
1	China	10 540
2	United States	5 334
3	India	2 341
4	Russia	1 766
5	Japan	1 278
6	Germany	767
7	Iran	618
8	South Korea	610
9	Canada	565
10	Brazil	501
15	Australia	409

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.

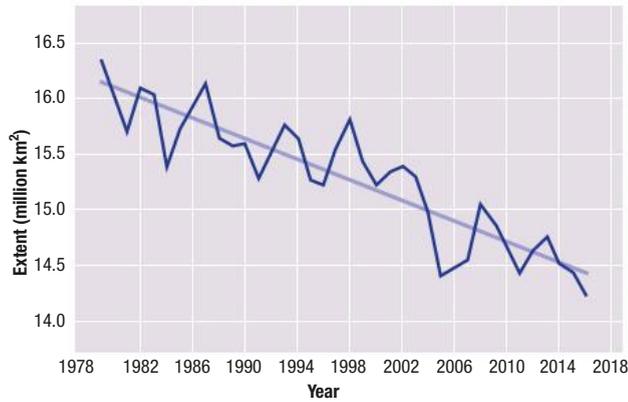


Figure 2.7.1d Extent of Arctic sea ice, 1979–2016

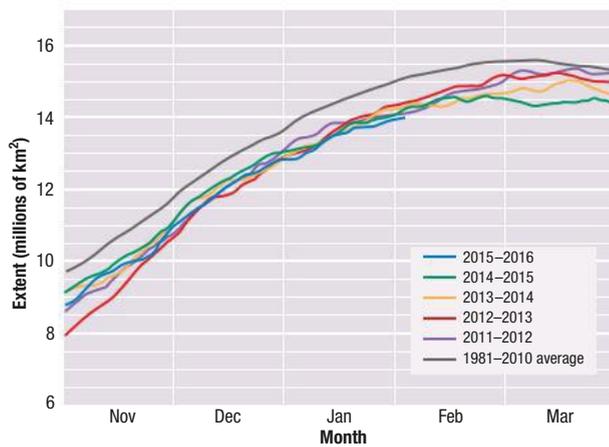


Figure 2.7.1e Annual Arctic sea ice extent (area of ocean with at least 15% sea ice)

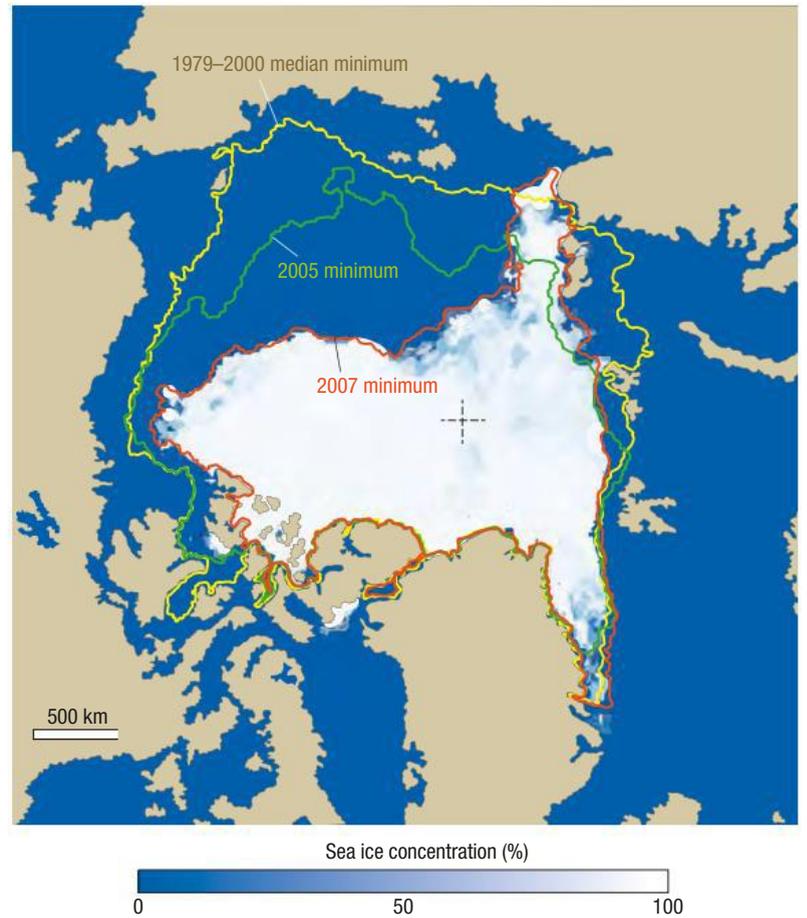


Figure 2.7.1f Arctic sea ice extent, September 2007. Arctic sea ice reached a record low in September 2007, below the previous record set in 2005 and substantially below the long-term average.

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.

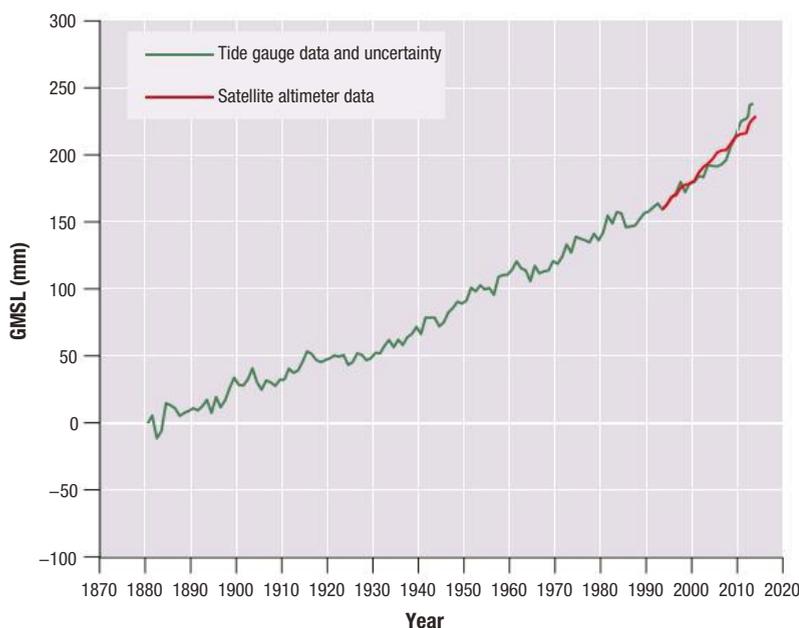


Figure 2.7.1g Global mean sea level change (GMSL), 1880–2015

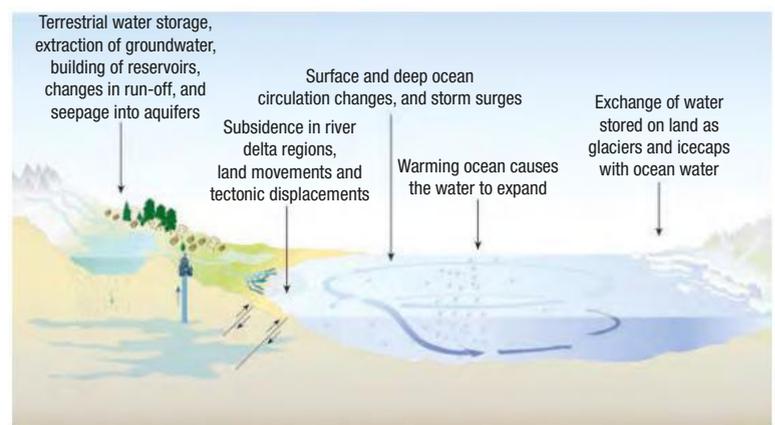


Figure 2.7.1h Causes of sea-level change. Source: GRID-Arendal



Figure 2.7.1i Rising sea levels pose a threat to coastal settlements.

GLACIERS IN RETREAT

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.

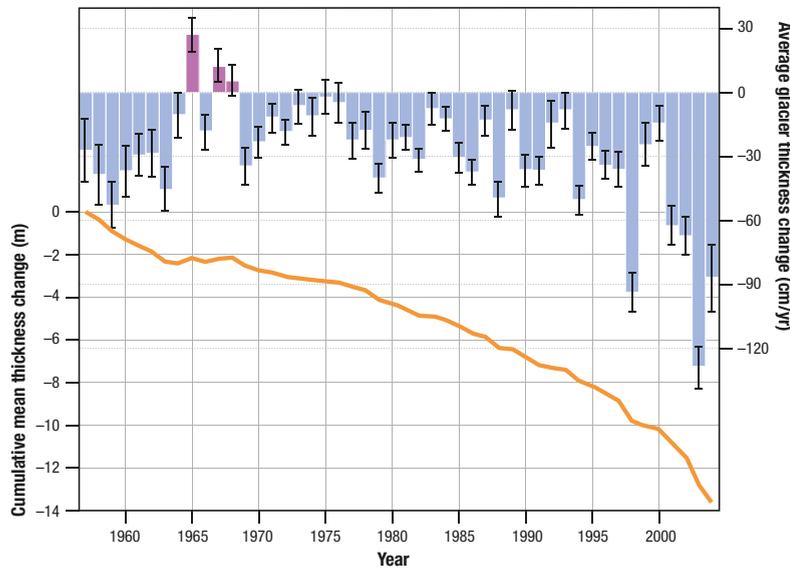


Figure 2.7.1j Change in glacial volume worldwide, 1955–2009



Figure 2.7.1k Muir Glacier, United States, photographed from the same vantage point in 1941 (top), 1950 (left) 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 and 1950 there was only bare rock.

ACTIVITIES

- Study the introductory text on page 72 and then answer the following questions:
 - What are the key signs that the global climate is changing?
 - What effects do CO₂ emissions have on the atmosphere?
 - What are the likely effects of global climate change?
- Study Figure 2.7.1a (page 72) and then answer the following questions:
 - How much hotter was it in 2015 than the average temperature between 1951 and 1980?
 - In what year did the sustained upwards trend in global temperatures become established?
- Study Figure 2.7.1b (page 72) and then answer the following questions:
 - By how much did atmospheric CO₂ concentrations increase between 1960 and 2016?
 - In what year did the atmospheric concentrations of CO₂ first exceed 360 parts per million?
- Study Figure 2.7.1c (page 72) and then complete the following tasks:
 - With the aid of an atlas, identify five countries with CO₂ emissions per capita greater than 15 tonnes.
 - Describe the distribution of countries with CO₂ emissions per capita below 2 tonnes.
- Study the pie graph in Figure 2.7.1c (page 72) and then complete the following questions:
 - What is the largest single source of CO₂ emissions?
 - What percentage of total emissions is energy related?
 - What percentage of CO₂ emissions comes from industry?
 - What is the total amount of CO₂ produced by agriculture?
- Study Figure 2.7.1d (page 73) and then answer the following questions:
 - By how much did the average monthly extent of sea ice change between 1978 and 2016?
 - In what year did sea ice extent reach its lowest level?
 - In what year did sea ice extent last exceed 16 million km²?
- Study Figure 2.7.1e (page 73). Compare the Arctic sea ice extent in the years since 2010 with the 1981–2010 average.
- Study Figure 2.7.1f (page 73). Describe the change evident in the spread of the Arctic ice sheet between the 1979–2000 median minimum and 2007.
- What is the total amount of CO₂ emitted by energy supply?
- Study Table 2.7.1a (page 72). Construct a column graph showing the 10 largest CO₂-emitting countries. Add Australia to this graph.
- Study Figure 2.7.1g (page 73). By how much did mean sea level change between 1980 and 2015?
- Study Figure 2.7.1h (page 73). Write a report outlining the factors that cause sea level to change.
- Study Figure 2.7.1j and then complete the following tasks:
 - By how much has the thickness of glacial ice changed between 1955 and 2009?
 - Has the decline in glacial volume accelerated or slowed since 1980? Explain how you arrived at this answer.
- Study Figure 2.7.1k. Construct a series of comparative photo sketches to highlight the trends in glacial retreat shown in the photographs.



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 healthcare and education.

Table 2.8.1a World's 20 wealthiest countries, 2015

Country	Gross national income per capita (US\$)
Monaco	186 950
Lichtenstein	115 530
Norway	106 140
Qatar	85 430
Switzerland	84 180
Luxembourg	77 000
Australia	60 070
Denmark	58 590
Sweden	57 810
United States	54 960
Singapore	52 090
Iceland	49 730
Netherlands	48 940
San Marino	51 470
Canada	47 500
Austria	47 120
Rep. of Ireland	46 680
Finland	46 360
Germany	45 790
Belgium	44 360

Table 2.8.1b World's 10 poorest countries, 2015

Country	Gross national income per capita (US\$)
Guinea	470
Gambia	470
Madagascar	420
Dem. Rep. of the Congo	410
Niger	390
Liberia	380
Malawi	350
Central African Republic	320
Burundi	260
Somalia	150

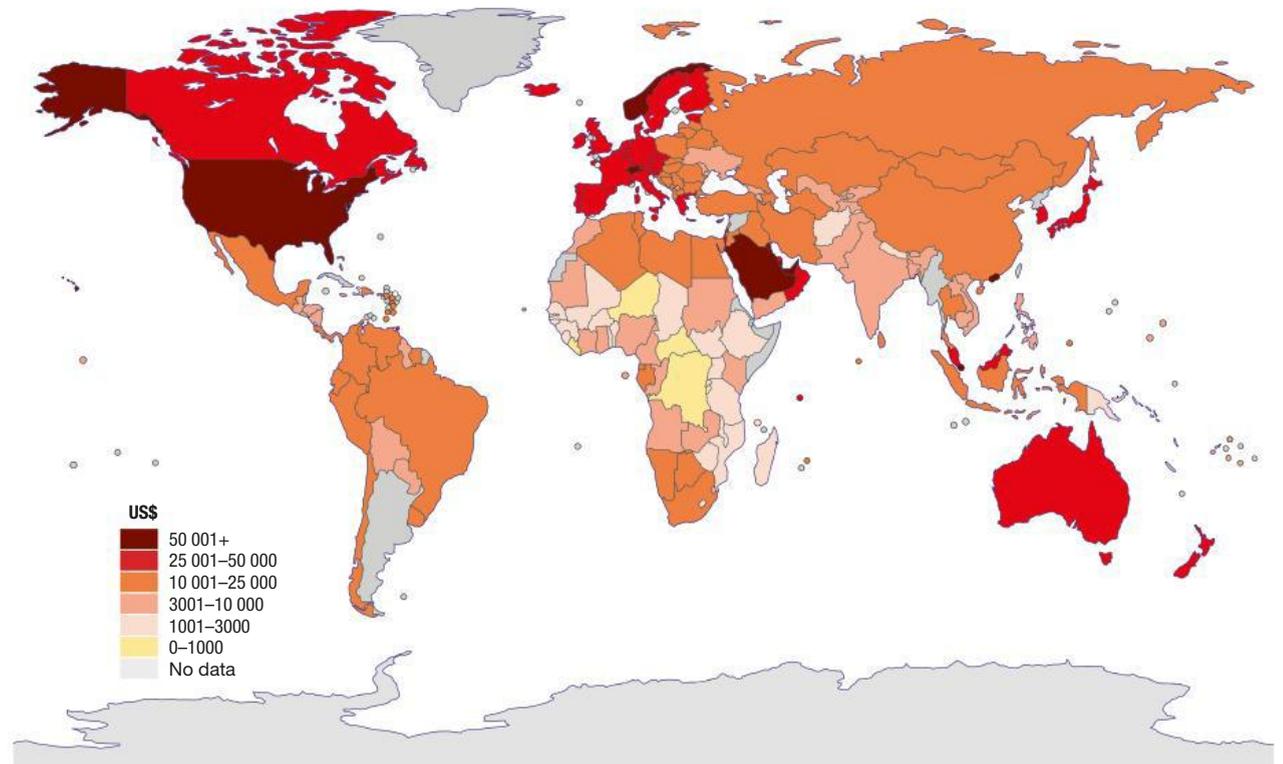


Figure 2.8.1a Gross national income per capita, 2015

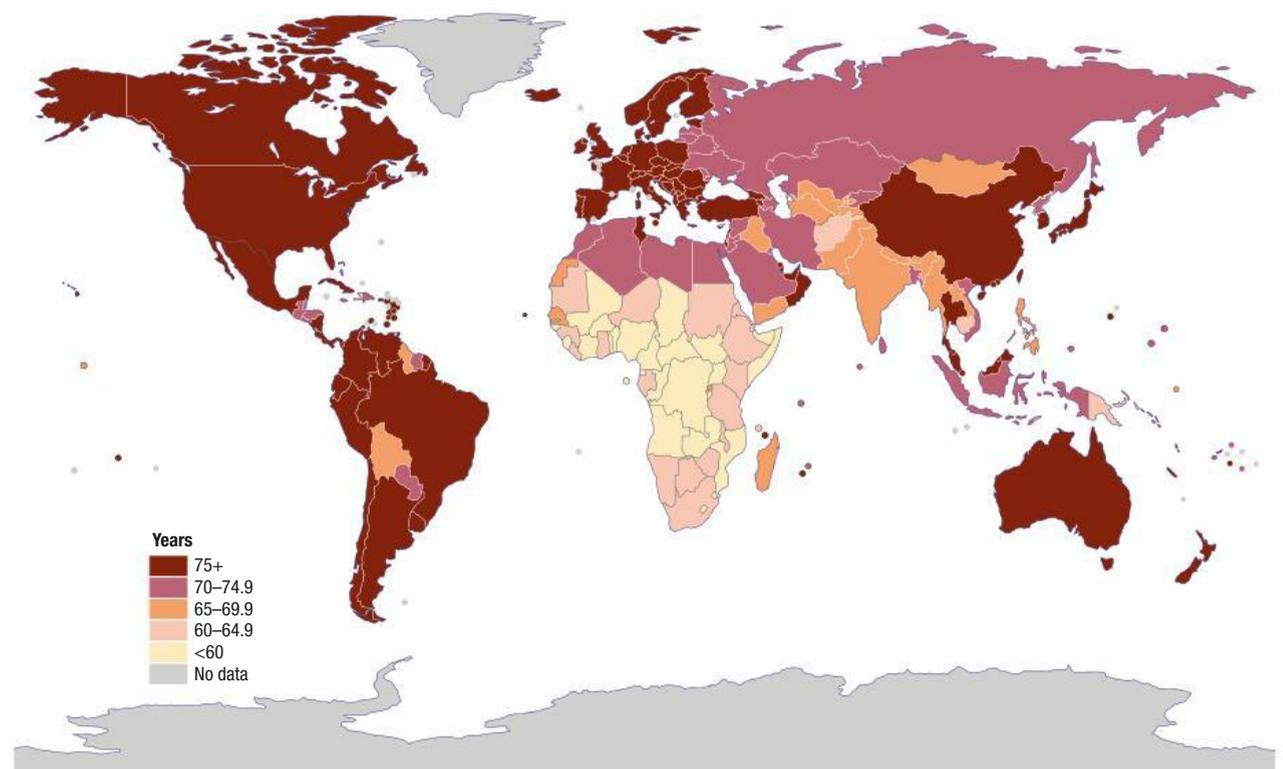


Figure 2.8.1b Life expectancy at birth, 2015

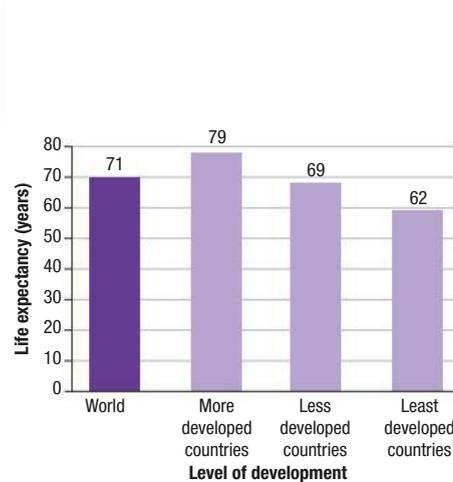


Figure 2.8.1c Life expectancy at birth by region, based on level of development, 2015

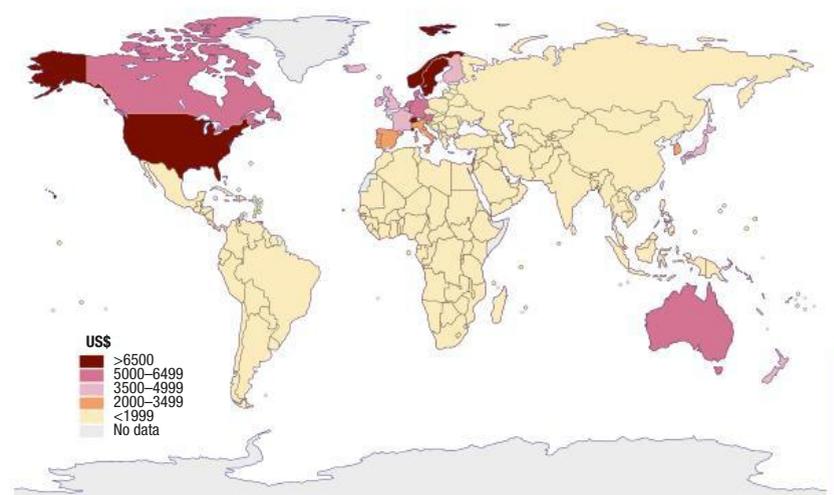


Figure 2.8.1d Health expenditure per capita, 2014

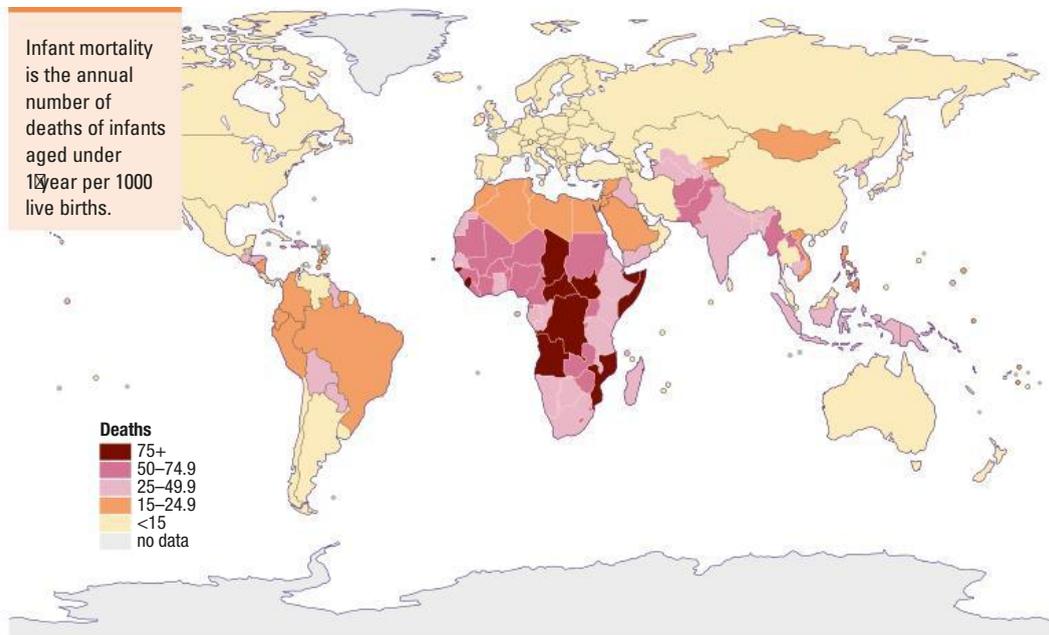


Figure 2.8.1e Infant mortality per 1000 live births, 2015

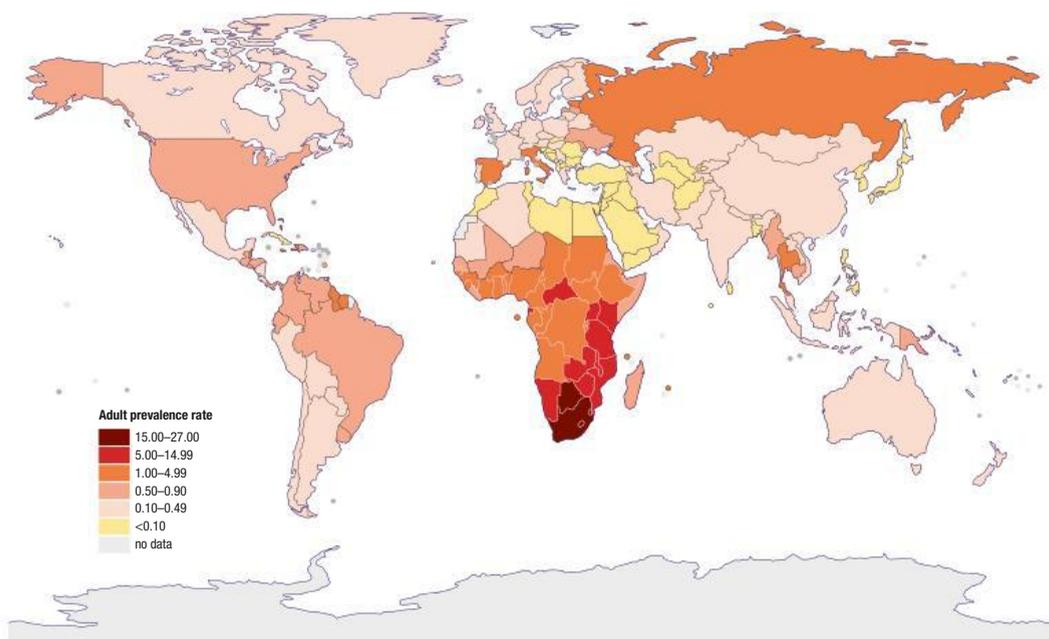


Figure 2.8.1g Adult HIV/AIDS infection rate as a percentage of the population aged 15-49, 2012

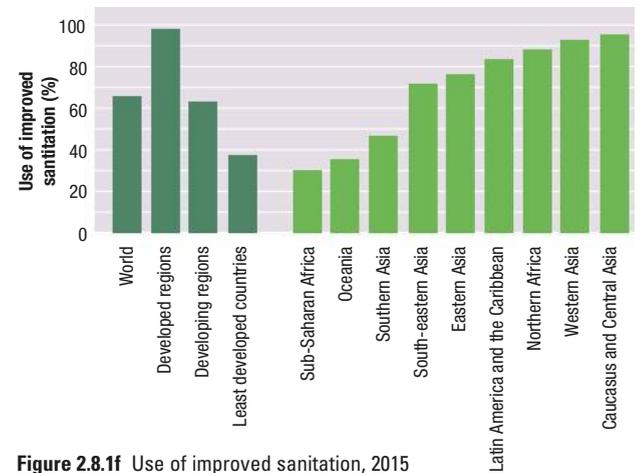


Figure 2.8.1f Use of improved sanitation, 2015

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 2014 about 36.9 million people were living with HIV and it resulted in 1.2 million deaths. Since the disease's appearance 39 million people have died worldwide. 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 2.8.1h Children orphaned as a result of HIV/AIDS, Malawi, Africa

ACTIVITIES

- Study Figure 2.8.1a (page 75). Identify the regions of the world with the highest and lowest gross national income per capita.
- Study Table 2.8.1a (page 75). 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.
- Study Table 2.8.1b (page 75). With the aid of an atlas, locate the countries listed in the table. What do they all have in common?
- Study Figure 2.8.1b (page 75). With the aid of an atlas, identify those regions of the world that have the lowest life expectancy.
- Study Figure 2.8.1c (page 75). By how many years does the average life expectancy of the more developed world exceed that of the least developed world?
- Study Figures 2.8.1b (page 75) to 2.8.1e. Explain the link between the data presented in Figure 2.8.1d and the information provided in Figures 2.8.1b, 2.8.1c and 2.8.1e.
- Study Figure 2.8.1e. 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.
- Study Figure 2.8.1f and then complete the following questions:
 - Which region of the world has the lowest proportion of its population able to access improved sanitation?
 - What percentage of Southern Asia's population had access to improved sanitation in 2015?
 - Which regions had a level of access to improved sanitation above the world average?
- Study Figure 2.8.1g. With the aid of an atlas, name the countries with more than 10 per cent of their adult population infected with HIV/AIDS.
- Write a report using data from the maps, tables and graphs in Unit 2.8.1 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.



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.

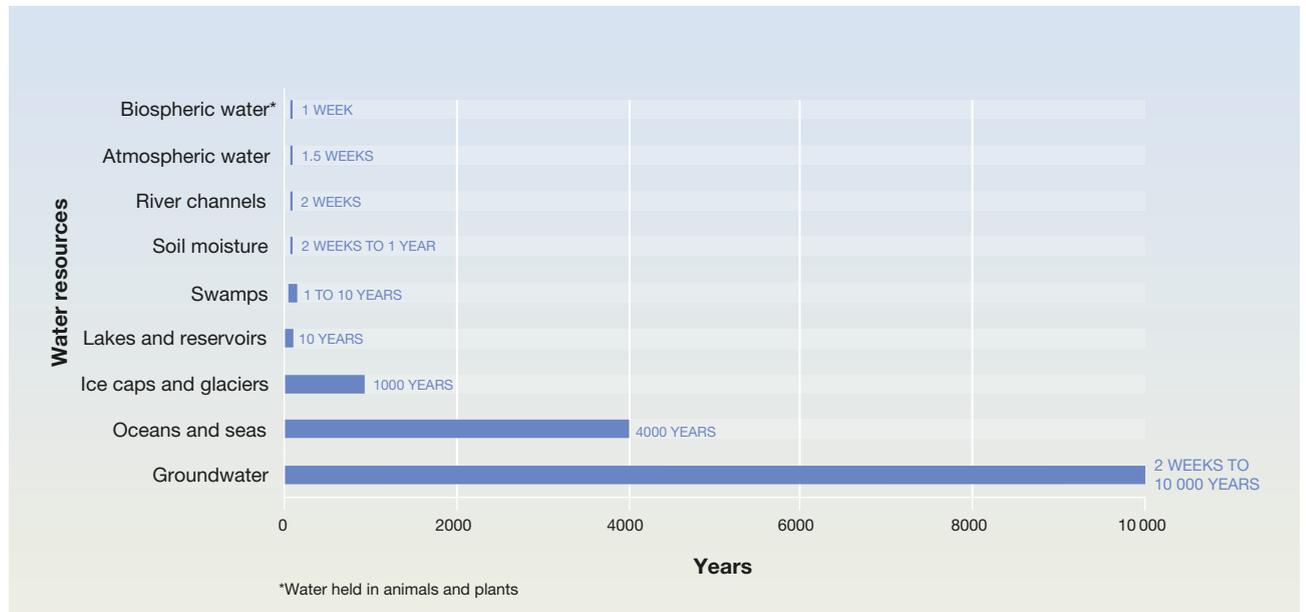


Figure 2.8.2a Estimated storage times of the world's water resources

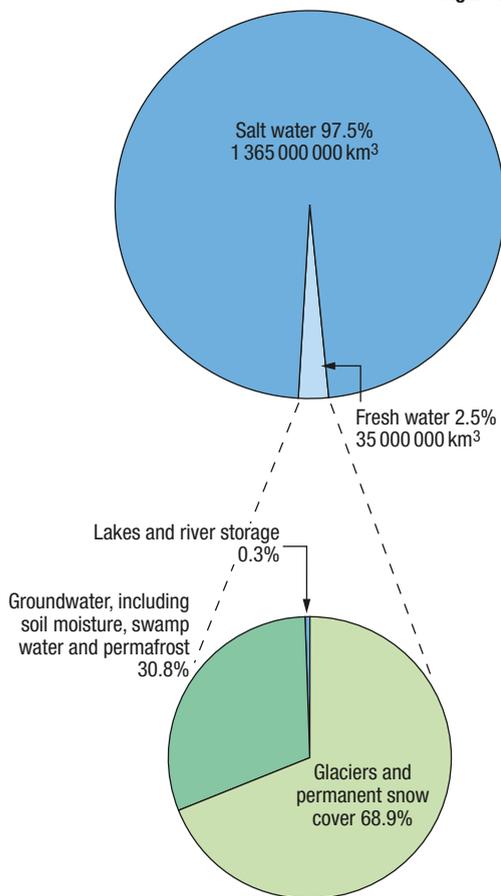


Figure 2.8.2b Total global salt water and fresh water estimates

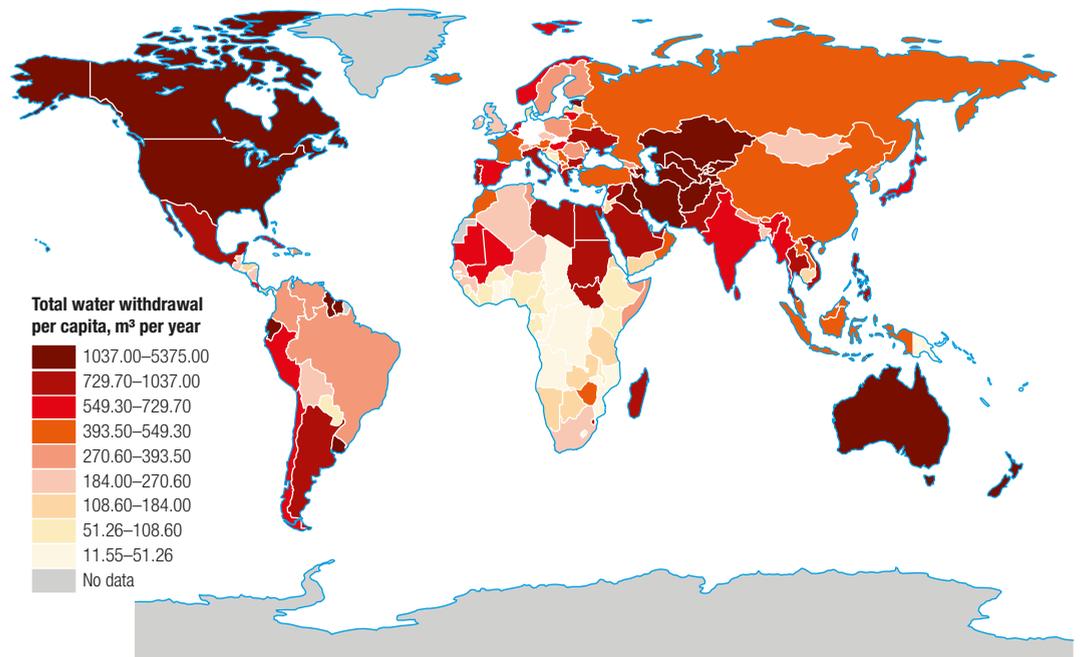


Figure 2.8.2c Total water use per year

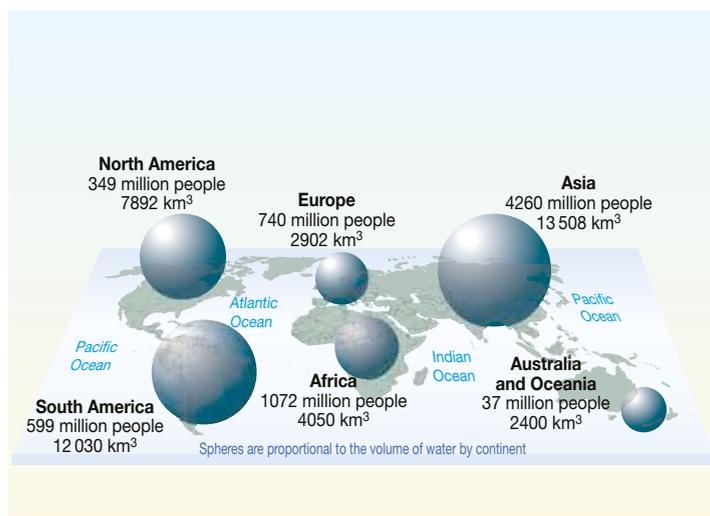


Figure 2.8.2d Water resources by continent, annual average volume

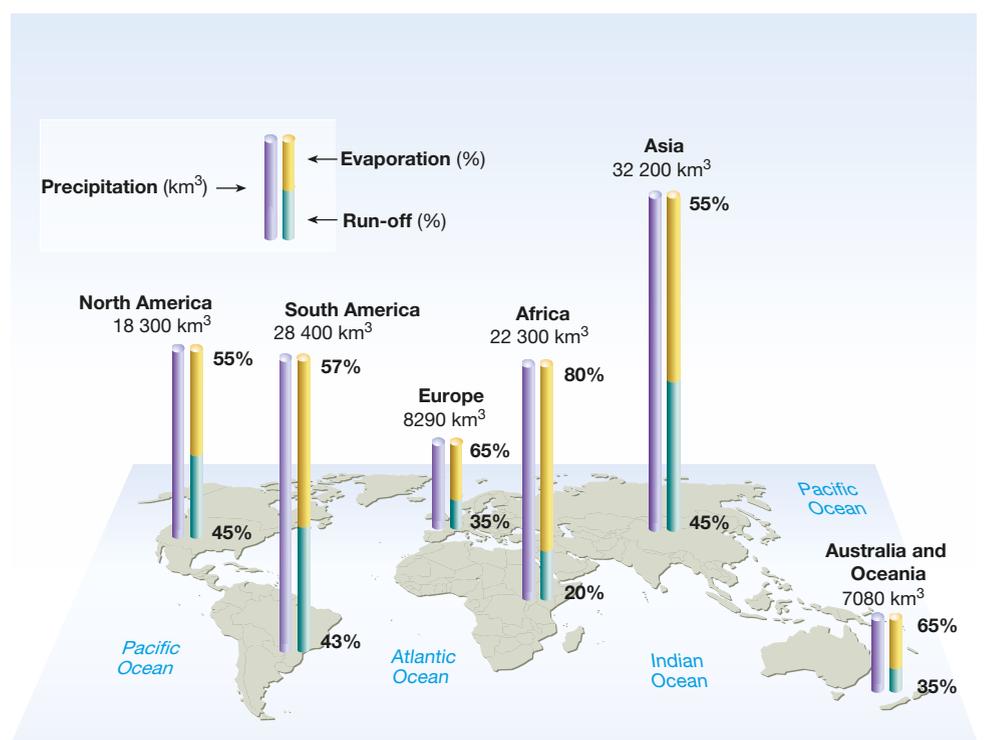


Figure 2.8.2e Precipitation, evaporation and run-off by region

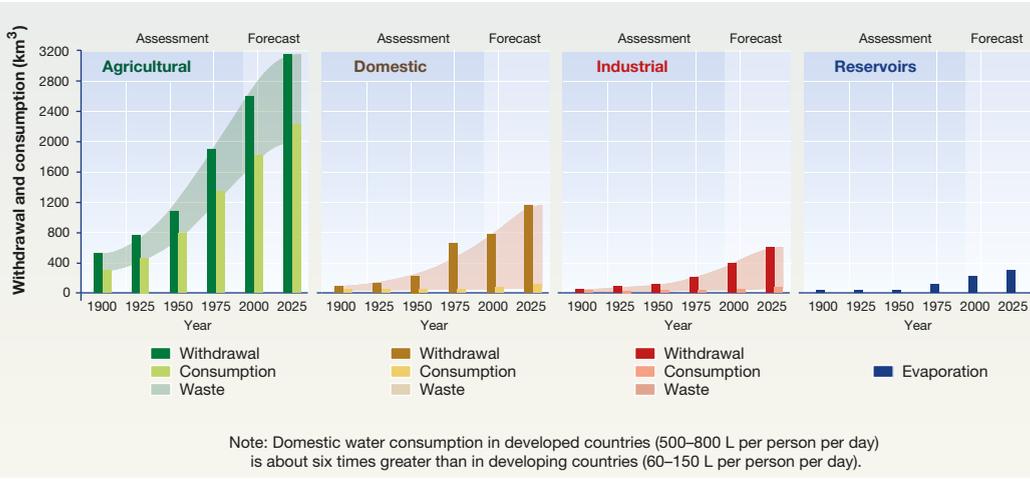


Figure 2.8.2f Global water use: withdrawal and consumption by sector, 1900–2025

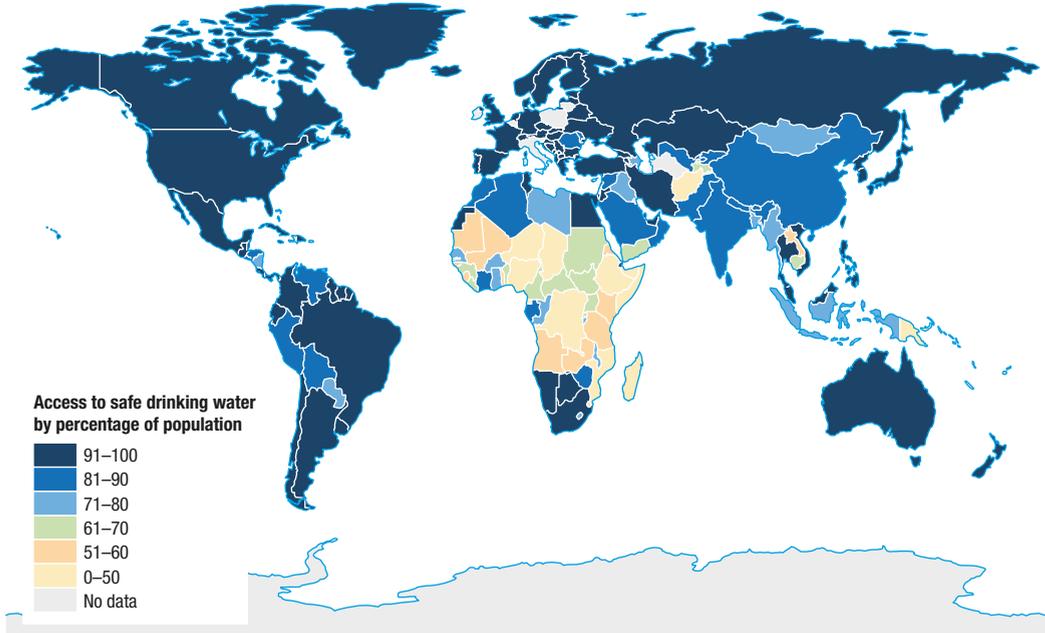


Figure 2.8.2g Access to safe drinking water by percentage of population, 2015

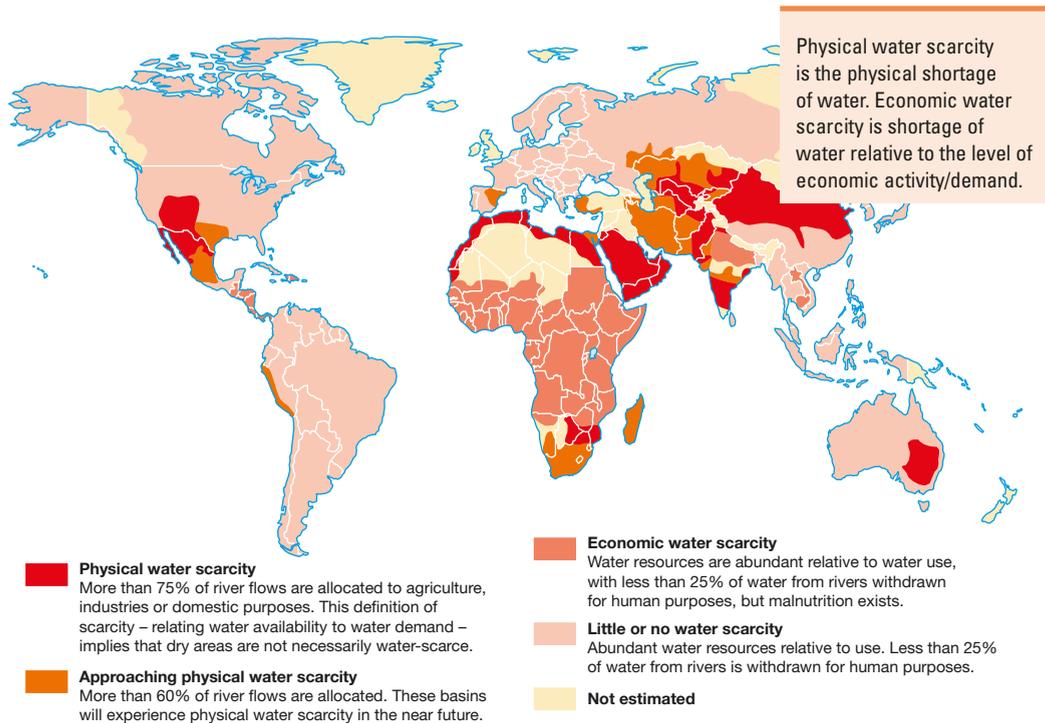


Figure 2.8.2h Projected water scarcity, 2025

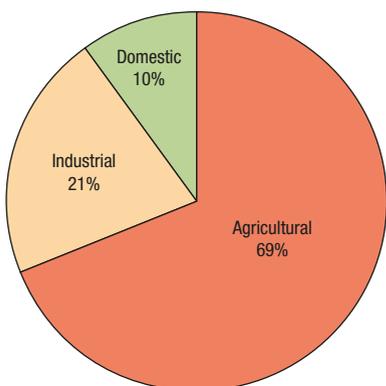


Figure 2.8.2i Global water use by sector



Figure 2.8.2j Refugee women wait to get water from a water-well as they live under hard conditions, Dafur, Sudan.

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

- Study Figure 2.8.2a (page 77). 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?
- Study Figure 2.8.2b (page 77) and then complete the following tasks:
 - Using the data in the graph showing the distribution of the world's fresh water, calculate the volume of the world's fresh water stored in glaciers and permanent snow cover.
 - Undertake internet research to find out what permafrost is.
- Study Figure 2.8.2c (page 77) and then, with the aid of an atlas, complete the following tasks:
 - Identify those parts of the world that have annual per capita water use greater than 1037 m³ a year.
 - What is the annual per capita water use of China?
 - On what continent are the countries with the lowest annual per capita use of water located?
- Using data from Figure 2.8.2d (page 77), calculate the annual average volume of water available for each 100 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.
- Study Figure 2.8.2d (page 77) and then complete the following questions:
 - Which continental landmass has the largest annual average volume of water?
 - What is the average annual volume of water on the driest of the continental landmasses shown in the graph?
 - By how much does the average annual volume of water available in South America exceed that available in North America?
- Study Figure 2.8.2e (page 77) and then complete the following questions:
 - Which region receives the greatest precipitation?
 - Which of the regions featured has the least precipitation?
 - Which region(s) has the highest percentage of run-off?
 - Which region has the greatest rate (%) of evaporation?
 - What are the implications of these data for agriculture in Africa?
- Study Figure 2.8.2f and then complete the following tasks:
 - Rank the sectors according to the amount of water consumed in 2000.
 - How much water was withdrawn for agriculture in 2000?
 - What percentage of agricultural withdrawals was wasted in 2000?
 - By how much did domestic withdrawal of water increase between 1950 and 2000?
 - Which water use sector has the highest percentage of waste relative to consumption in 2025?
- Study Figure 2.8.2g. 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.
- Study Figure 2.8.2h and then, with the aid of an atlas, complete the following tasks:
 - Which parts of the world are likely to experience economic water scarcity in 2025?
 - Which parts of the world are likely to experience physical water scarcity in 2025?
 - 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.
- Study Figure 2.8.2i. Name the sector that accounts for the greatest share of water use.



Figure 3.1a Map of Australia

ACTIVITIES

- Name the strait separating:
 - mainland Australia from Tasmania
 - Cape York Peninsula from Papua New Guinea.
- Name the oceans to the west and east of the continent.
- Name the sea in which the Great Barrier Reef is located.
- In which state or territory would you find the following landform feature?
 - Macdonnell Ranges
 - Musgrave Ranges
 - Flinders Ranges
 - Gibson Desert.
- Identify the highest peak in each state and territory.
- Which is Australia's most southerly mainland capital city?
- Which is Australia's most easterly capital city?
- What is the direction of:
 - Adelaide from Melbourne
 - Hobart from Sydney?
- What is the straight-line distance between:
 - Adelaide and Darwin
 - Perth and Brisbane?
- Name the island located at:
 - lat. 39°52'S long. 143°45'E
 - lat. 34°45'S long. 137°00'E
 - lat. 25°30'S long. 153°00'E.
- Name the landform feature located at:
 - lat. 17°20'S long. 145°45'E
 - lat. 25°21'S long. 131°02'E
 - lat. 28°15'S long. 138°08'E
 - lat. 36°27'S long. 148°16'E.
- Locate the following places on the physical map of Australia.
 - Cape Byron: the mainland's most easterly point
 - Steep Point: the continent's most westerly point
 - Cape York Peninsula: the mainland's most northerly point
- Name a river that drains the Arnhem Land Plateau in the Northern Territory.
- Name the river that flows into Western Australia's Shark Bay.
- Name the river that separates New South Wales from Victoria.
- Name the gulf on which Adelaide is located.
- Wilson's Promontory: the mainland's most southerly point
- South East Cape: Tasmania's most southerly point.



Canberra is Australia's capital city and, with a population of 380 000 people, is the country's largest inland urban centre and the eighth-largest overall. The site of Canberra was selected for the location of the nation's capital in 1908 as a compromise between rivals Sydney and Melbourne, Australia's two largest cities. It is unusual among Australian cities, being an entirely planned city. Following an international contest for the city's design, a blueprint by American architect Walter Burley Griffin was selected. Construction commenced in 1913.

ACTIVITIES

- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Study Figure 3.2a and the map extract. Identify the features labelled 1 to 12.
- 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.

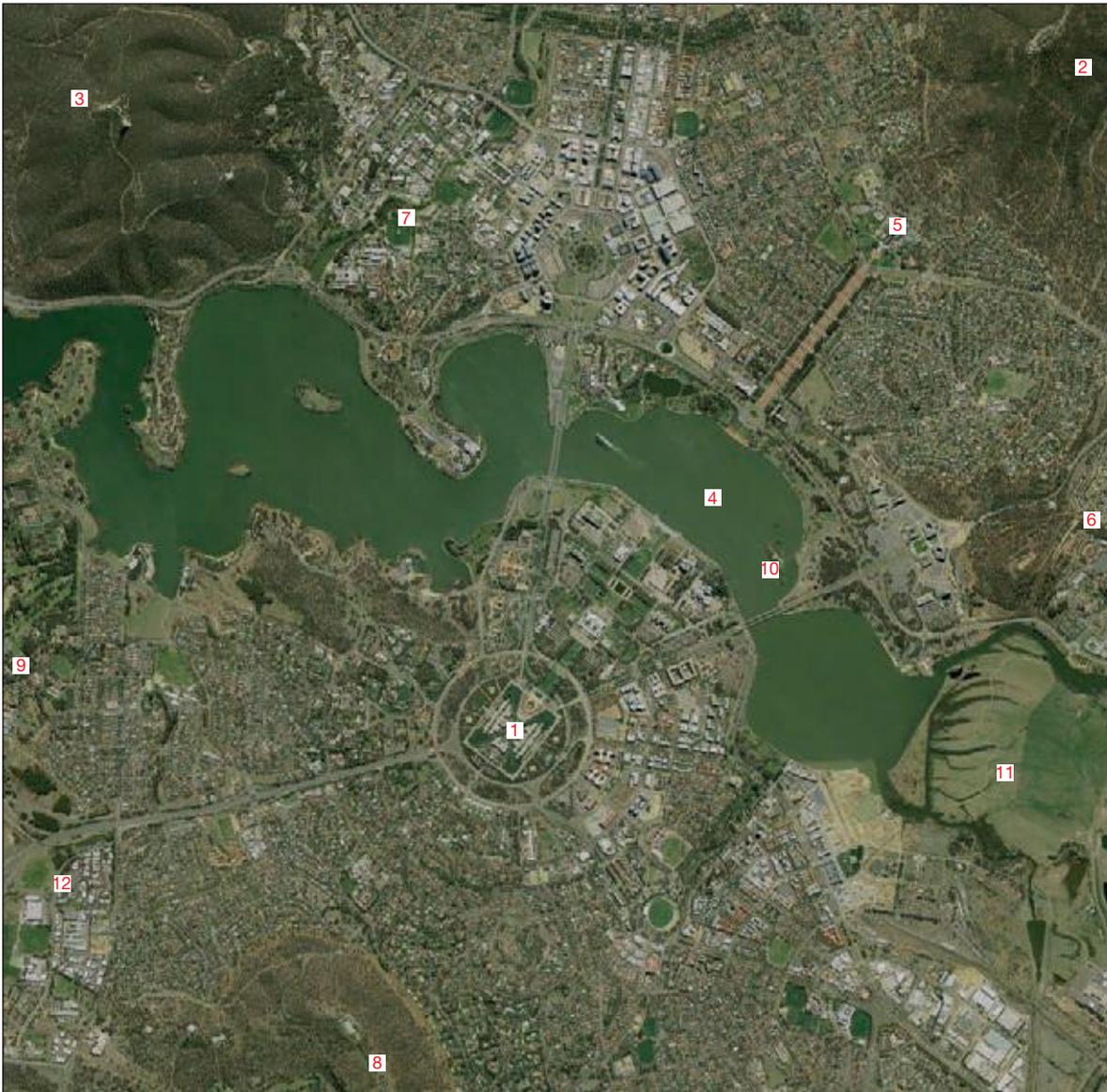
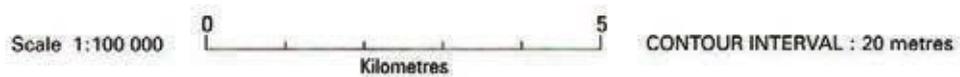


Figure 3.2a Aerial photograph of central Canberra



Built-up area; National route marker		Gate; Cattle grid; Road bridge		Contour with value; Depression contour	
Distance in kilometres		Railway, multiple track; Station; Railway bridge		Wind break	
Principal road and highway, sealed surface		Railway, single track; Railway tunnel		Vegetation dense; medium; scattered	
Secondary road, sealed surface		Power transmission line		Orchard, plantation or vineyard; Pine plantation	
Secondary road, unsealed surface		Mine; Windmill; Yard; Quarry		Lake, perennial; Stream, perennial	
Minor road, sealed surface		Building/s; Church; Ruin; Drive-in theatre		Lake, intermittent; Stream intermittent	
Minor road, unsealed surface		Trig station; Bench mark; Spot elevation		Swamp perennial; Intermittent	
Vehicular track, unsealed surface		Nature Conservation Reserve boundary		Land subject to inundation; Sand	
Embankment; Cutting		State border		Bore or well; Spring; Tank or small dam	

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

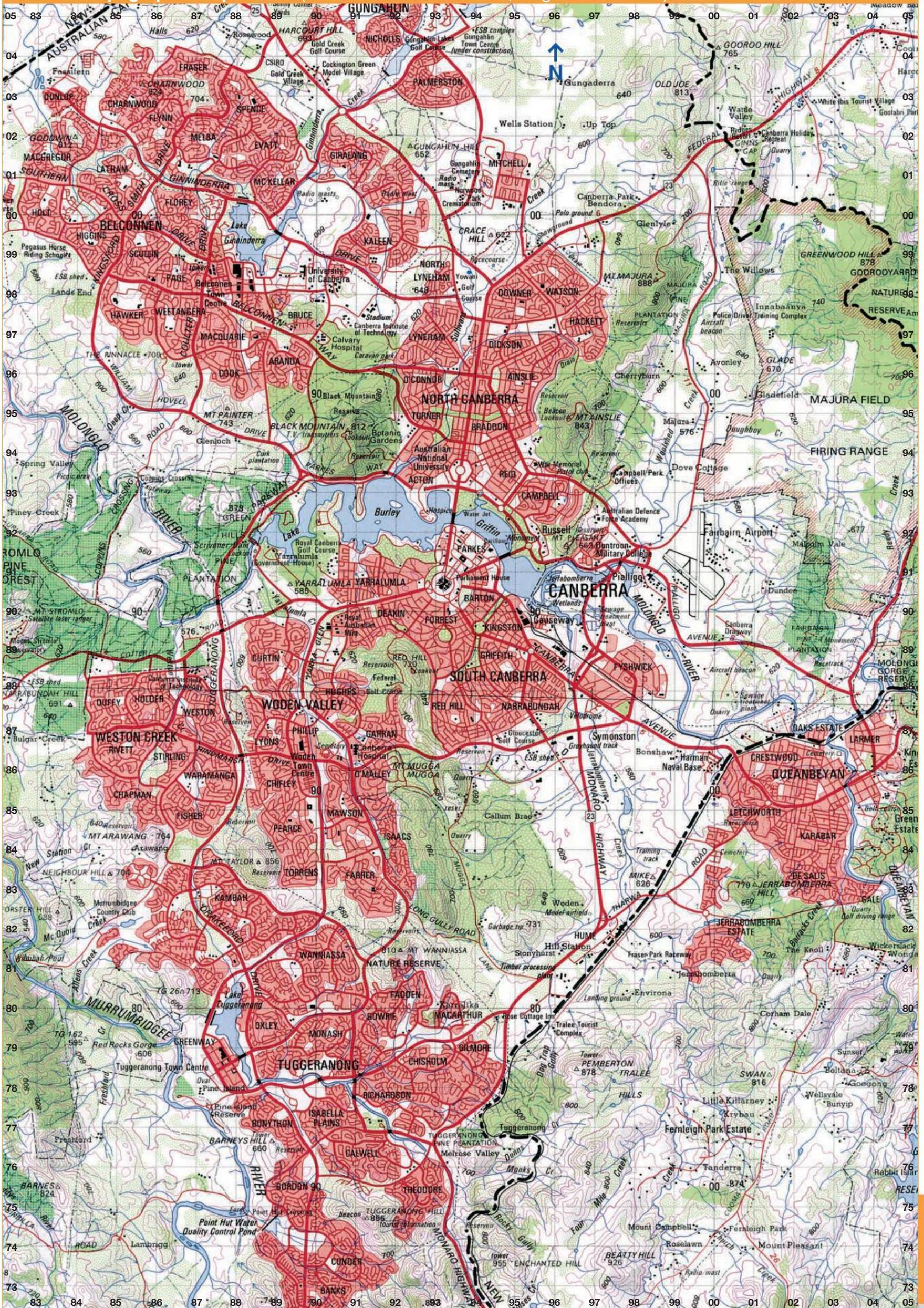




Figure 3.3a Eden in New South Wales

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 Curralo Lagoon?
- 9 What type of landform is 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 Study Figure 3.3a and the map extract. Identify the features numbered 1–6.
- 23 In what direction was the camera facing when the photograph in Figure 3.3a was taken?

Eden is a town on the south coast of New South Wales, 478 km 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.

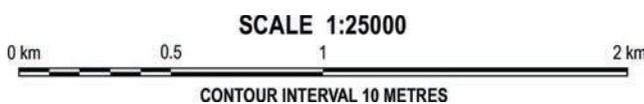
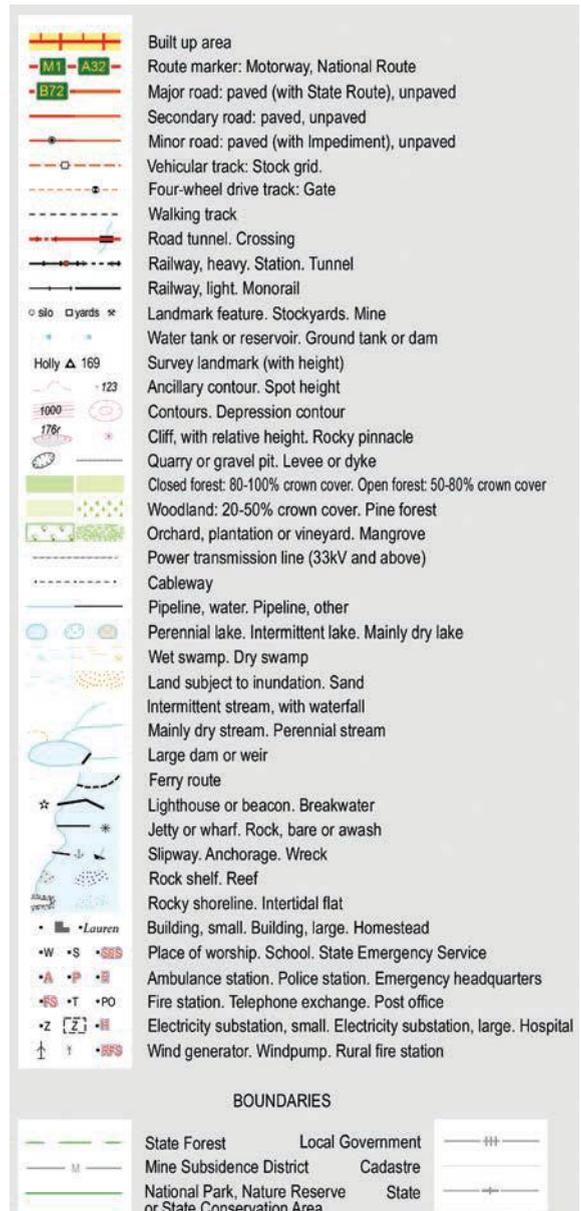
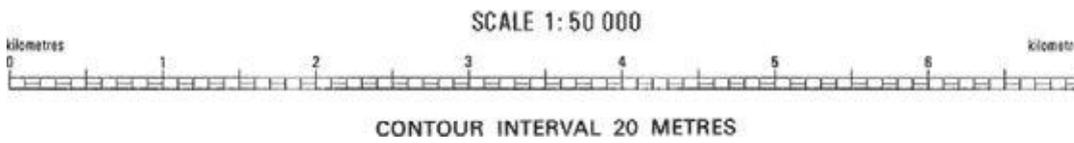






Figure 3.4a Oblique aerial photograph of Thredbo, New South Wales

Thredbo is a village and ski resort in the Snowy Mountains of New South Wales. It is about 500 km south of Sydney. Thredbo has the longest ski runs in Australia, and this attracts around 700 000 winter visitors annually. In summer, Thredbo is a hiking and summer sport destination. Mountain bike riding is an increasingly popular recreational activity. Work on developing the resort commenced in 1957.



ACTIVITIES

When completing these activities refer to the legend on page 80.

- 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 3.4a and 3.4b 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.

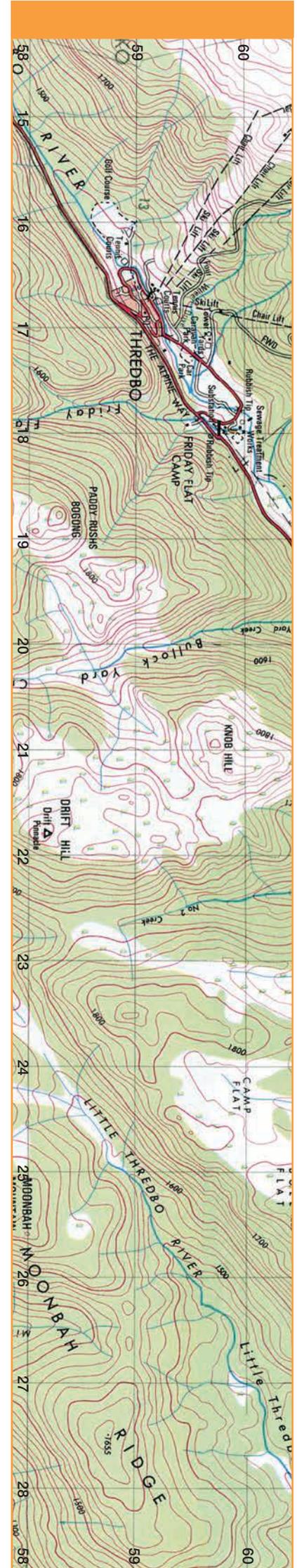
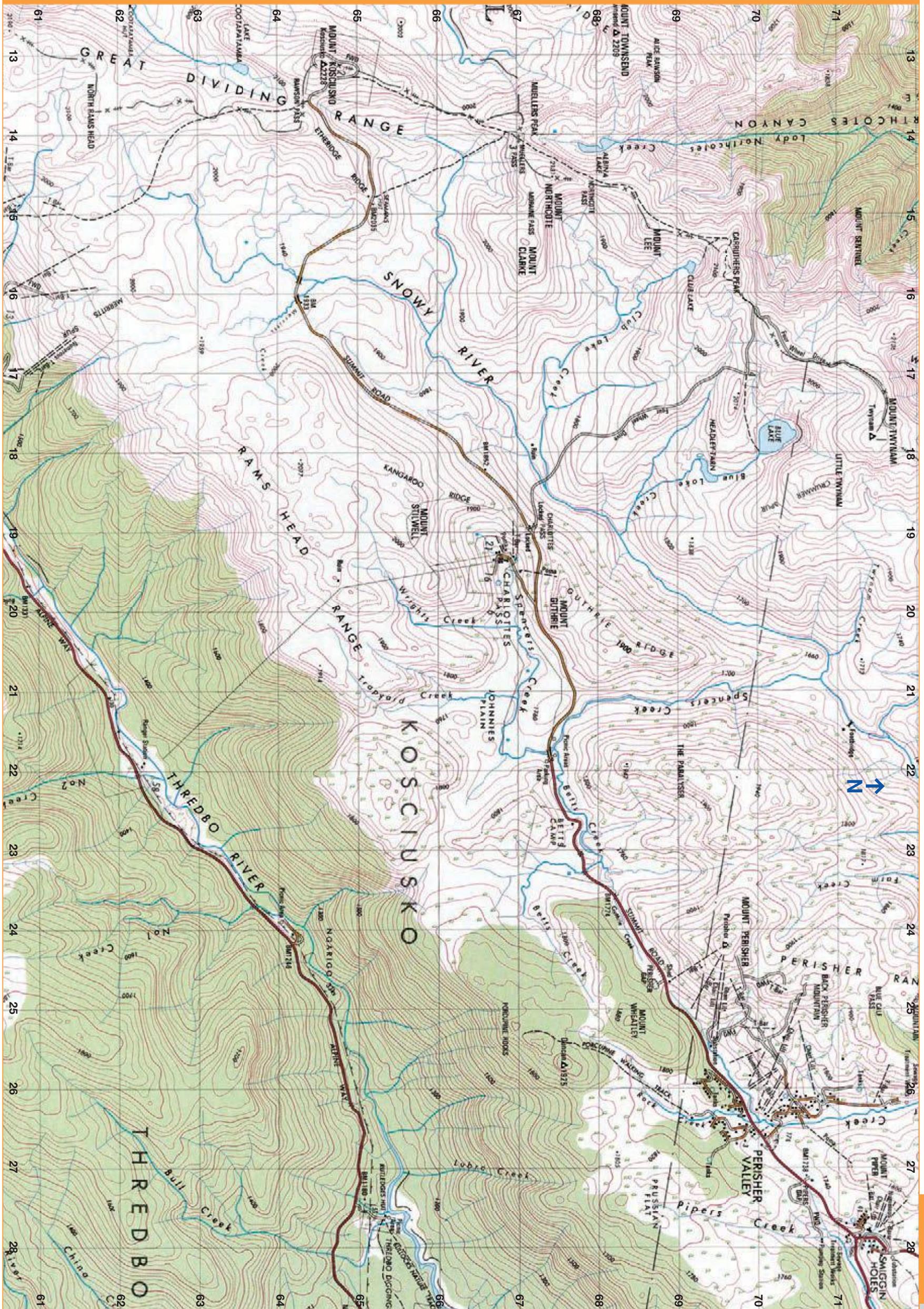


Table 3.4a Climate data for Thredbo (Village), elevation 1380 m, latitude 36°51'S, longitude 148°30'E

	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 3.4b 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



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 3.5a A sample of community views

ACTIVITIES

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

- 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.
- Which set of views do you agree with?
- 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.
- 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.
- Discuss in class the statement: 'The resort should go ahead'.
- At the end of the debate, conduct a secret ballot to determine whether the class will recommend that the resort should go ahead.
- Write an exposition outlining the arguments you would use to justify your point of view on the issue.

ACTIVITIES

- What is the scale of the map extract?
- What is the contour interval used on the map extract?
- Identify the feature of the biophysical environment located at:
 - GR 855991
 - GR 685877
 - GR 847087
 - GR 785940.
- Identify the feature of the constructed environment located at:
 - GR 709021
 - GR 827082
 - GR 843043
 - GR 842052.
- What creek flows into the sea at GR 865092?
- What type of vegetation is found at AR 8408?
- What type of vegetation is found in AR 7486?
- What type of land use is found in AR 7608?
- Name the type of biophysical feature found in GR 835985.
- Identify the feature of the biophysical environment located 14 km to the north-east of South Brother Mountain (AR 6887).
- What is the direction of Kew (AR 7399) from Lake Cathie township (AR 8609)?
- In what direction does Herons Creek flow in AR 7503?
- Is the mouth of the Camden Haven River visible from the summit of Middle Brother Mountain (GR 695924)?
- What is the settlement pattern found in AR 7499?
- What is the aspect of the slope in AR 7996?
- What is the bearing of South Brother Mountain (GR 685877) from North Brother Mountain (GR 790971)?
- Estimate the straight-line distance between Diamond Head trig station (GR 811899) and Camden Head trig station (GR 848984).
- Estimate the distance by road from Kew (GR 738999) to the bridge at GR 714905.
- 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.
- Estimate the area of Queens Lake.
- What is the density of buildings in AR 7599?
- Estimate the height of the landform feature at GR 774028.
- What is the difference in elevation of North Brother Mountain (GR 790971) and South Brother Mountain (GR 685877)?
- Estimate the local relief experienced on a traverse from GR 736951 to GR 790971.
- Estimate the local relief in AR 8189.
- Calculate the gradient of the slope between GR 790971 and GR 790954.
- Undertake research. Identify the type of delta formed by the Camden Haven River. Explain how deltas such as this develop.
- The section of coast shown on the map extract is dominated by depositional landform features. What evidence is there to support this view?
- Write a report describing how landform has affected the area's drainage pattern and its settlement and communications patterns.
- 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)?

SCALE 1:100 000



CONTOUR INTERVAL 20 METRES

Built-up area, National route marker	Power transmission line (cross-country)	Orchard or vineyard; Mangrove
Principal road and highway; Cutting	Fence; Levee or bank	Swamp, perennial; intermittent
Secondary road; Embankment	Mine: Windmill, Quarry	Land subject to inundation; Ricefield
Road under construction	Building: Church; Ruins; Yard	Lake, perennial; Stream, perennial
Minor road	Trig station; Bench mark; Spot elevation	Lake, intermittent; Stream, intermittent
Vehicular track	Contour with value; Auxiliary contour	Lake, mainly dry; Stream, mainly dry
Bridge, road; Bridge, railway; Tunnel, railway	Depression contour; Cliff	Bore or well; Spring; Tank or small dam
Gate; Cattle grid	Forest, dense, medium; scattered	Breakwater; Pier; Wharf
Railway, multiple track; Station; Siding	Scrub, dense; medium; scattered	Wreck, exposed; Lighthouse
Railway, single track; Station with siding	Tropical rain forest; Pine plantation	Rock, bare or awash; Foreshore flat; Sand
Light railway or tramway	Windbreak	Reef; Ledge



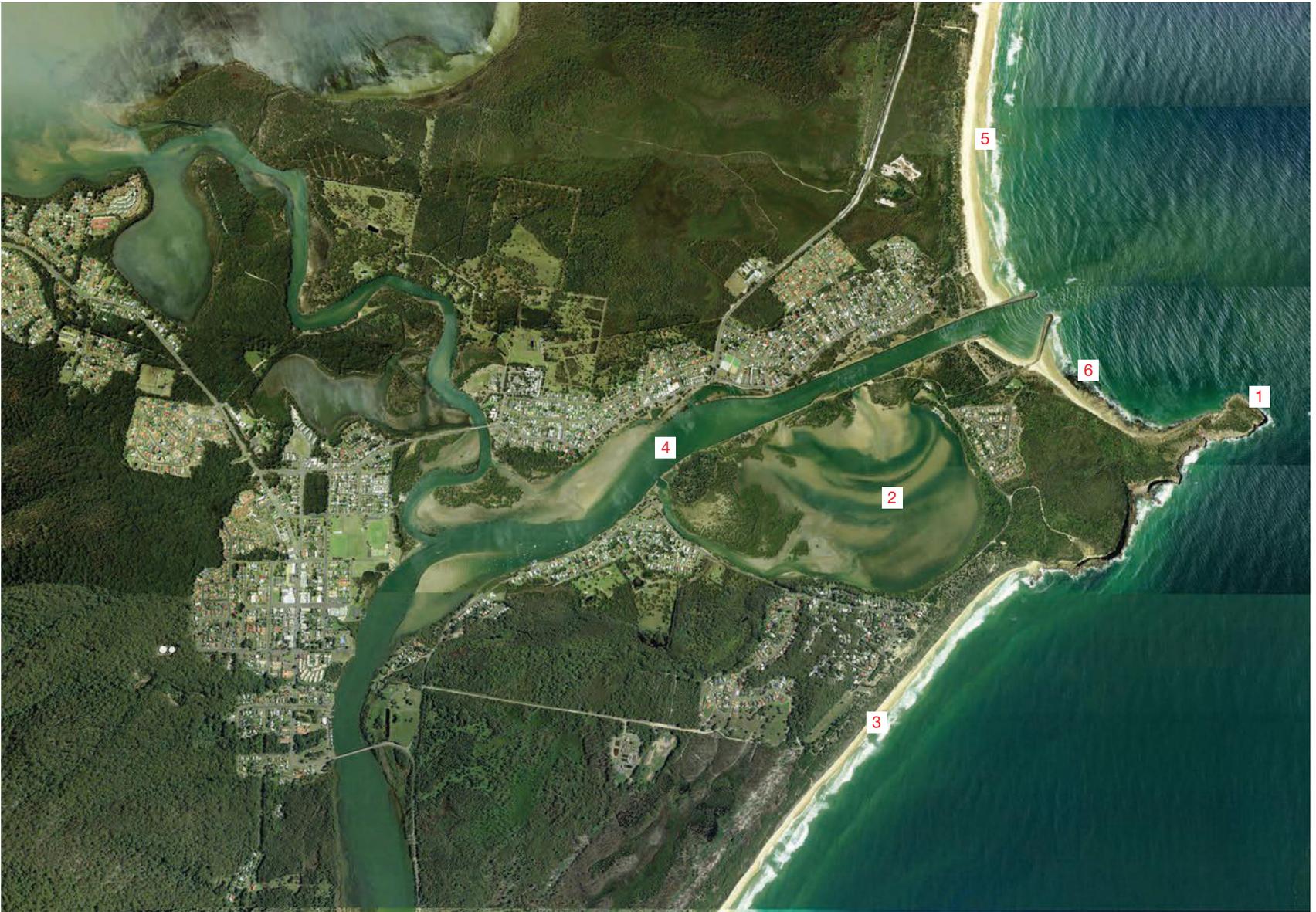


Figure 3.6a A collage of satellite photographs showing the areas covered by the Laurieton topographic map extract, Google Earth Image © 2016 CNEW / Astrium © 2016 Google, Image © 2016 TerraMetrics Data SIO, NOAA, US Navy, NGA, GEBCO

Laurieton is located near the mouth of the Camden Haven River on the Mid North Coast of NSW. The town lies between the

base of the Big Brother Mountain and the Camden Haven River. The town has a population of nearly 2000 people.

ACTIVITIES

- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Compare the Laurieton extract with the Camden Haven topographic map extract (Unit 3.5, page 87). Comment on the amount of detail provided on the Laurieton extract compared with the Camden Haven map.
- 4 Study Figure 3.6a and the map extract. Name the features numbered 1–6.
- 5 Identify the feature of the biophysical environment located at:
 - a GR 791973
 - b GR 795955
 - c GR 815988
 - d GR 820976.
- 6 Identify the feature of the constructed environment located at:
 - a GR 831001
 - b GR 846997
 - c GR 824975
 - d GR 811975.
- 7 Speculate on the type of land use found in Gogleys Lagoon, the Camden Haven Inlet and Herons Creek.
- 8 Name the type of vegetation found in AR 7997.
- 9 Name the drainage pattern evident on North Brother.
- 10 What is the direction of Perpendicular Point (AR 8599) from North Brother (AR 7997)?
- 11 What is the bearing of North Brother (AR 7997) from the survey marker at Laurieton (GR 848986)?
- 12 What is the straight-line distance between North Brother (AR 7997) and Perpendicular Point (AR 8599)?
- 13 What is the width of the opening of the Camden Haven Inlet?
- 14 What is the length of the North Brother walking track?
- 15 What is the aspect of the slope in AR 7998?
- 16 What is the aspect of the Dunbogan Beach?
- 17 What is the area of Gogleys Lagoon?
- 18 What is the density of buildings in AR 8196?
- 19 What is the elevation of the lookout (GR 785796)?
- 20 What is the difference in elevation of the Larrieton survey marker (AR 8498) and North Brother (AR 7997)?
- 21 Construct the cross-section from the locked gate at GR 801964 to the summit of North Brother (AR 7997). Use a vertical scale of 1 cm = 50 m.
- 22 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 21.
- 23 What is the gradient of the slope in the cross-section that you constructed in Activity 21?



	Built up area		
	Route marker: Motorway, National Route		
	Major road: paved (with State Route), unpaved		
	Secondary road: paved, unpaved		
	Minor road: paved (with impediment), 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, Lagoon 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, Wharf		
	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		Local Government
	Mine Subsidence District		Cadastre
	National Park, Nature Reserve or State Conservation Area		State

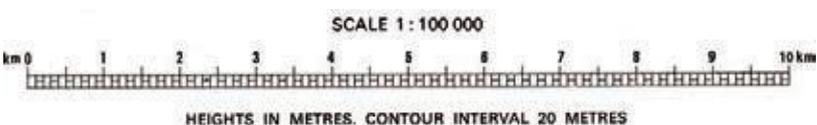




Figure 3.7a Satellite photograph of the Wallis and Myall Lake complex, Google Earth, Data SIO, NOAA, US Navy, NGA, GEBCO, © 2016 Google, Image © 2016 CNES / Astrium, Image © 2016 DigitalGlobe



Figure 3.7c Oblique aerial photograph of Forster-Tuncurry



Wallis Lake, together with the adjacent Myall Lake system, developed behind a sand-based barrier system. The twin towns of Forster and Tuncurry

have developed at the mouth of the Coolongolook River. The waterways surrounding Wallis Lake are well known for oyster production.

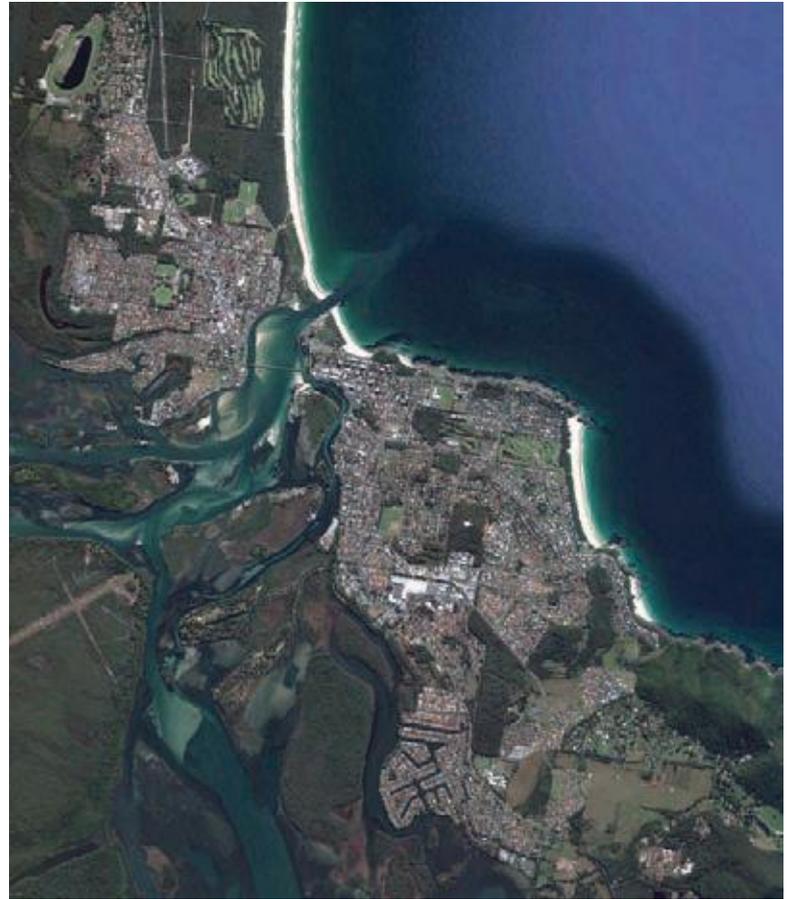


Figure 3.7b Satellite photograph of Forster-Tuncurry, Google Earth, Data SIO, NOAA, US Navy, NGA, GEBCO, © 2016 Google, Image © 2016 CNES / Astrium, Image © 2016 DigitalGlobe

ACTIVITIES



- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Study Figure 3.7a and the map extract. Identify the features labelled 1 to 8.
- 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 Study Figure 3.7c. In what direction was the camera pointing when the photograph was taken?
- 21 What is the height of the landform feature at GR 445263?
- 22 What is the difference in elevation of Booti Hill (AR 5524) and Yaric (AR 5519)?
- 23 Estimate the local relief experienced on a traverse from GR 461300 to GR 480336.
- 24 Estimate the local relief in AR 5519.
- 25 Calculate the gradient of the slope between Yaric (GR 556193) and GR 562200.
- 26 Identify the settlement pattern in AR 5620.

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





Figure 3.8a Satellite photograph of South West Rocks, Google Earth, Data SIO, NOAA, US Navy, NGA, GEBCO, © 2016 Google, Image © 2016 CNES / Astrium, Image © 2016 DigitalGlobe

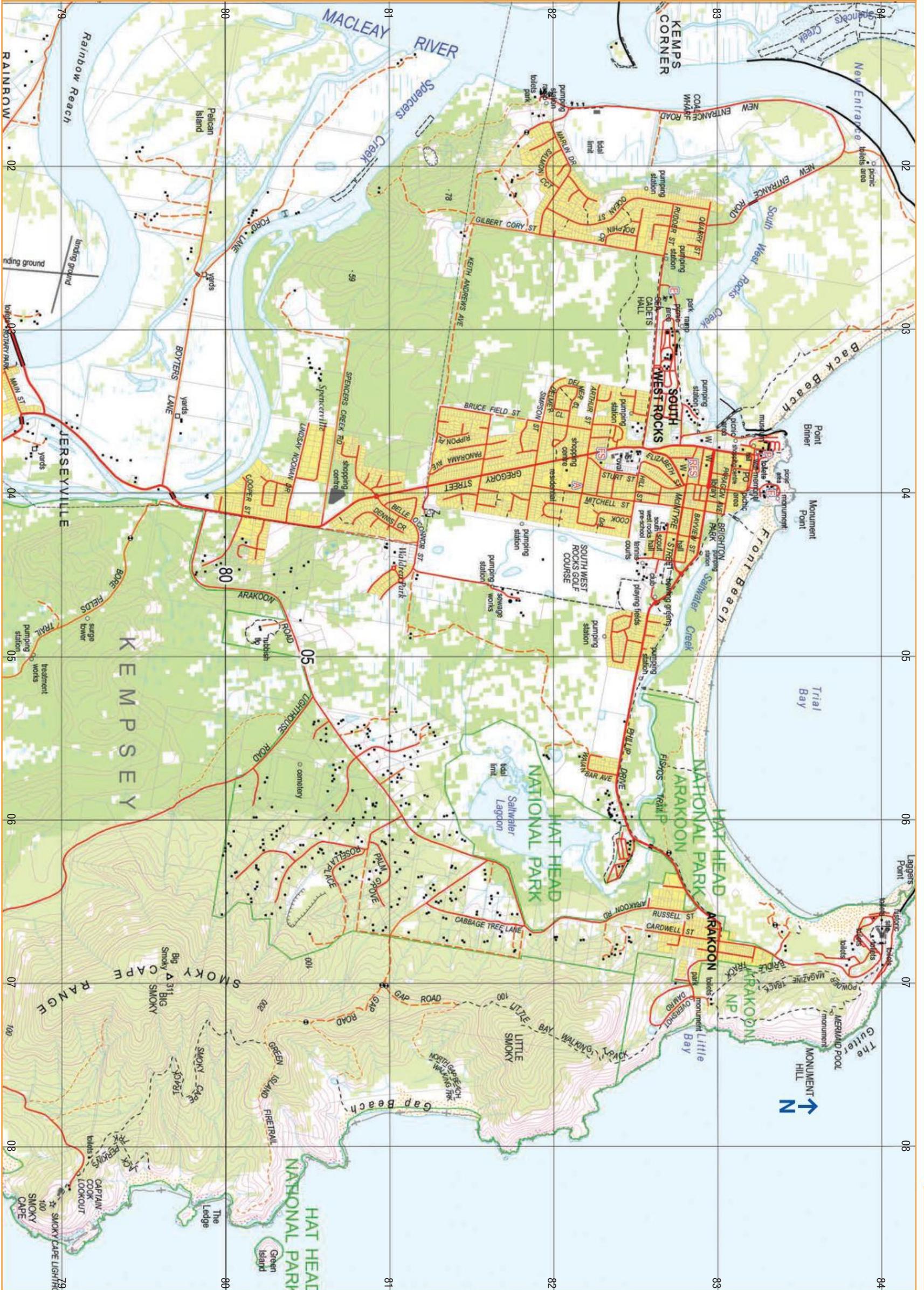
South West Rocks is located on the Mid North Coast of NSW, near the mouth of the Macleay River.

The region's spectacular beaches make the town a popular summer holiday destination.

ACTIVITIES

- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Study Figure 3.8a and the map extract. Identify the features numbered 1–8.
- 4 Identify the feature of the biophysical environment located at:
 - a GR 086803
 - b GR 060817
 - c GR 083789
 - d GR 069796.
- 5 Identify the feature of the constructed environment located at:
 - a GR 045822
 - b GR 048802
 - c GR 056804
 - d GR 046817.
- 6 What is the area reference of Little Smoky?
- 7 Name the type of vegetation found at GR 052802.
- 8 What tributary joins the Macleay River in AR 0181?
- 9 What creek flows into Trial Bay in AR 0383?
- 10 What is the direction of Big Smoky (AR 0679) from South West Rocks?
- 11 In what direction is Spencers Creek flowing in AR 0280?
- 12 What is the bearing of Big Smoky (AR 0679) from the summit of Little Smoky (AR 0781)?
- 13 What is the straight-line distance between the summit of Big Smoky (AR 0679) and the summit of Little Smoky (AR 0781)?
- 14 What is the aspect of the slope in AR 0782?
- 15 What is the area of Saltwater Lake?
- 16 What is the density of buildings in AR 0379?
- 17 What is the height of Little Smoky (AR 0781)?
- 18 What is the difference in elevation of Little Smoky (AR 0781) and Big Smoky (AR 0679)?
- 19 What is the elevation of the surface of the small lake at GR 076806?
- 20 Estimate the local relief experienced on a traverse from the summit of Big Smoky (AR 0679) to the summit of the small hill at GR 051791.
- 21 Construct the cross-section from GR 051791 to the summit of Big Smoky. Use a vertical scale of 1 cm = 50 m.
- 22 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 21.
- 23 What is the gradient of the slope between the summit of Big Smoky and the shoreline at GR 083796?
- 24 Describe the site of South West Rocks.







Coffs Harbour is located on the Mid North Coast of New South Wales about 540 km to the north of Sydney. With a population of 69 400 it is one of the largest urban centres in the North Coast region.

Coffs Harbour's economy once depended on bananas. The growing of blueberries, tourism and fishing are now the most important industries. It is also a popular destination for retirees and those seeking a more relaxed lifestyle.

Coastal resorts and commercial centres surround the area, which is dominated by mountains, covered in forest and banana plantations.

Coffs Harbour is the only place in New South Wales where the Great Dividing Range meets the Pacific Ocean.

Figure 3.9a Oblique aerial photograph of Coffs Harbour, Google Earth, Data SIO, NOAA, US Navy, NGA, GEBCO, © 2016 Google, Image © 2016 CNES / Astrium, Image © 2016 DigitalGlobe

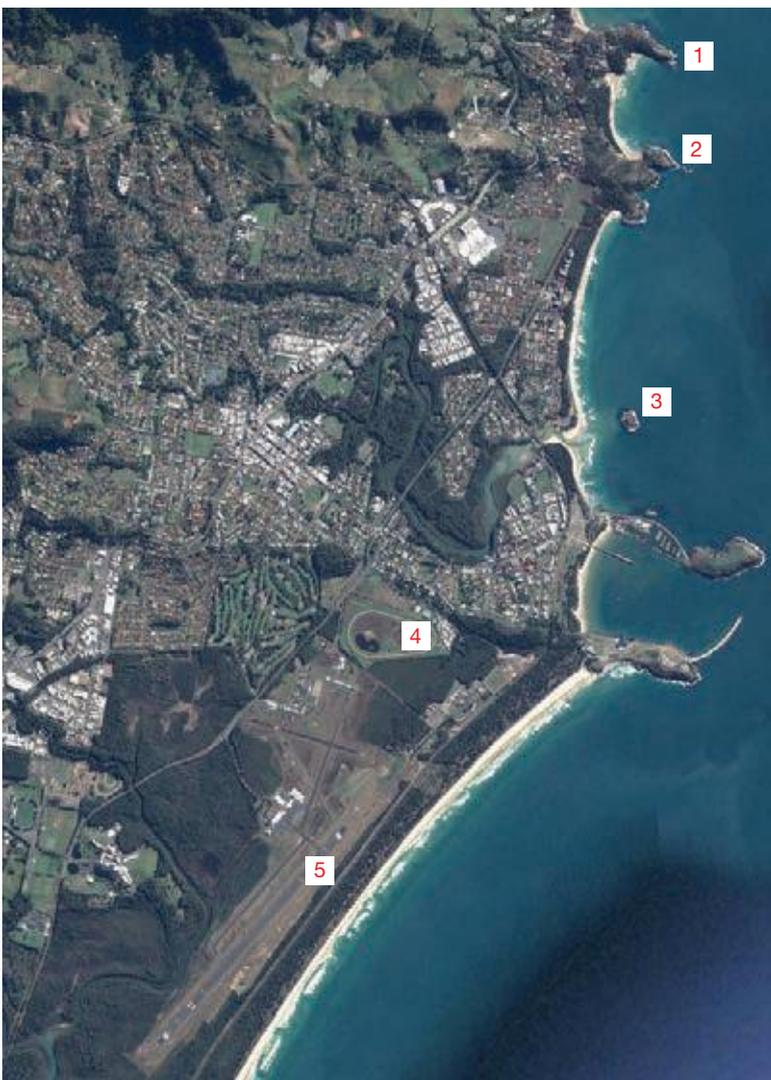
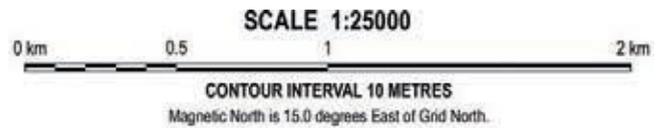


Figure 3.9b Satellite photograph of Coffs Harbour, Google Earth, Data SIO, NOAA, US Navy, NGA, GEBCO, © 2016 Google, Image © 2016 CNES / Astrium, Image © 2016 DigitalGlobe



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 142513
 - b GR 142503
 - c GR 138485
 - d GR 123455.
- 4 Identify the feature of the constructed environment located at:
 - a GR 127498
 - b GR 112452
 - c GR 099499
 - d GR 116485.
- 5 What is the area reference of the Coffs Harbour Jetty?
- 6 Study Figure 3.9a and the map extract. Identify the features numbered 1–5.
- 7 Study Figure 3.9a. In what direction was the camera pointing when the photograph was taken?
- 8 Study Figure 3.9b and the map extract. Identify the features numbered 1–5.
- 9 Name the type of biophysical feature found in AR 1447.
- 10 Name the type of land use centred on GR 100450.
- 11 Name the type of vegetation found in AR 1151.
- 12 On what waterway is Coffs Harbour located?
- 13 What is the direction of Little Muttonbird Island from Muttonbird Island?
- 14 In what direction is Coffs Creek flowing in AR 1248?
- 15 What is the distance by road at GR 094451 to the railway overpass at GR 128488?
- 16 What is the length of the Coffs Harbour Airport runway?
- 17 What is the length of the Corambirra Point breakwater?
- 18 What is the aspect of the slope in AR 1112?
- 19 What is the area of the Coffs Harbour?
- 20 What is the elevation of Muttonbird Island (AR 1447)?

<ul style="list-style-type: none"> Build up area Route marker: Motorway, National Route Major road: paved (with State Route), unpaved Secondary road: paved, unpaved Minor road: paved (with impediment), 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 	<ul style="list-style-type: none"> Holy & 105 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: 85-100% 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 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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
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Anglesea is a coastal community located on the Great Ocean Road in Victoria. The American-owned Alcoa corporation operated a power station and open-cut coalmine on the outskirts of the town until late 2015. The town is a popular summer holiday destination for people living in Melbourne and regional Victoria.



Figure 3.10a Oblique aerial photograph of Anglesea, Victoria



Figure 3.10b Satellite photograph of the area covered by the Anglesea topographic map extract, Google Earth, Data SIO, NOAA, US Navy, NGA, GEBCO, © 2016 Google, Image © 2016 CNES / Astrium, Image © 2016 DigitalGlobe

ACTIVITIES



- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Study Figure 3.10a and the map extract. In what direction was the camera pointing when the photograph was taken?
- 4 Study Figure 3.10b and the map extract. Identify the features numbered 1–6.
- 5 Identify the feature of the biophysical environment located at:
 - a GR 470434
 - b GR 543428
 - c GR 518448
 - d GR 462434.
- 6 Identify the feature of the constructed environment located at:
 - a GR 474383
 - b GR 455492
 - c GR 556463
 - d GR 500508.
- 7 What is the area reference of Eagle Nest Reef?
- 8 Name the type of land use found in AR 5346.
- 9 Name the type of vegetation found in AR 4842.
- 10 On what waterway is Anglesea located?
- 11 What is the direction of Point Roadknight (AR 5442) from the Point Light Station (AR 4738)?
- 12 In what general direction is Painkalac Creek flowing in AR 4639?
- 13 Name the drainage pattern evident on the Anglesea topographic map extract.
- 14 What is the bearing of Point Light Station (AR 4738) from Point Roadknight (GR 5442)?
- 15 What is the straight-line distance between the summit of Mount Ingoldsby (AR 5144) and Point Light Station (AR 4738)?
- 16 What is the distance by road from the intersection at GR 471386 to the intersection at GR 535438?
- 17 What is the aspect of the slope in AR 4942?
- 18 What is the area of the built-up area in Aireys Inlet and Fairhaven?
- 19 What is the height of the hill at:
 - a GR 483443
 - b GR 467467?
- 20 What is the elevation of the marsh/swamp in AR 4646?
- 21 Estimate the local relief experienced on a traverse from the spot height in AR 4745 to the summit of the hill at GR 467468.
- 22 What is the gradient of the slope between the spot height in AR 4942 and the shoreline at GR 497420?
- 23 Identify the likely recreational activities available in the area covered by the map extract.



<p>Built up area. [Symbol]</p> <p>Freeway, route marker, highway, bridge [Symbol]</p> <p>Secondary road: sealed, unsealed. [Symbol]</p> <p>Local road: sealed, unsealed. [Symbol]</p> <p>Vehicular track: 2WD, 4WD [Symbol]</p> <p>Walking track or bicycle track [Symbol]</p> <p>Private access, proposed road. [Symbol]</p> <p>Great Dividing Trail [Symbol]</p> <p>Surf Coast Walk, Bicentennial National Trail. [Symbol]</p> <p>Australian Alps Walking Track. [Symbol]</p> <p>Road Restrictions: (MVO) (SSC) (SHWL) (RU) (DWO) (RPC)</p> <p>Gate or cattlegrid, levee bank. [Symbol]</p> <p>Embankment, cutting. [Symbol]</p> <p>Railway, tramway. [Symbol]</p> <p>Railway station, railway siding. [Symbol]</p> <p>Railway/tramway: disused, dismantled. [Symbol]</p> <p>Railway bridge, railway tunnel. [Symbol]</p>	<p>Building, post office, church, public hall. [Symbol]</p> <p>School, police station, fire station, ambulance. [Symbol]</p> <p>SES, hospital. [Symbol]</p> <p>Neighbourhood safer place, emergency marker. [Symbol]</p> <p>Pipeline, disappearing underground. [Symbol]</p> <p>Power transmission line. [Symbol]</p> <p>Trigonometric station, spot elevation. [Symbol]</p> <p>Landmark area: quarry. [Symbol]</p> <p>Landmark object: tank or well, tanks to scale. [Symbol]</p> <p>Mine, helipad. [Symbol]</p> <p>Landmark area, recreation area. [Symbol]</p> <p>Tree cover: scattered or medium, and dense. [Symbol]</p> <p>Plantation. [Symbol]</p> <p>Orchard or vineyard. [Symbol]</p> <p>Contours, rocky outcrop, hill shading. [Symbol]</p> <p>Depression contours. [Symbol]</p> <p>Csff. [Symbol]</p> <p>Sand. [Symbol]</p> <p>Sand dunes. [Symbol]</p>	<p>River, creek, crossing, adit. [Symbol]</p> <p>Aqueduct, channel, drain. [Symbol]</p> <p>Lake: perennial, intermittent. [Symbol]</p> <p>Dam or weir, dam carrying road. [Symbol]</p> <p>Falls, rapids. [Symbol]</p> <p>Rapids in large river. [Symbol]</p> <p>Lock. [Symbol]</p> <p>Waterholes, swimming pool. [Symbol]</p> <p>Water well or water point, spring. [Symbol]</p> <p>Land subject to inundation. [Symbol]</p> <p>Swamp or marsh. [Symbol]</p> <p>Shoreline with mud or sand flats, mangroves. [Symbol]</p> <p>Rock: bare or awash, rocky ledge or reef. [Symbol]</p> <p>Exposed wreck, lighthouse. [Symbol]</p> <p>Breakwater, pier or jetty, boat ramp. [Symbol]</p> <p>Navigation beacon, wharf. [Symbol]</p> <p>Parks under National Parks Act. [Symbol]</p> <p>Crown land, restricted area. [Symbol]</p> <p>Local Government Area boundary. [Symbol]</p> <p>State boundary. [Symbol]</p> <p>1:50 000 double format index.</p>
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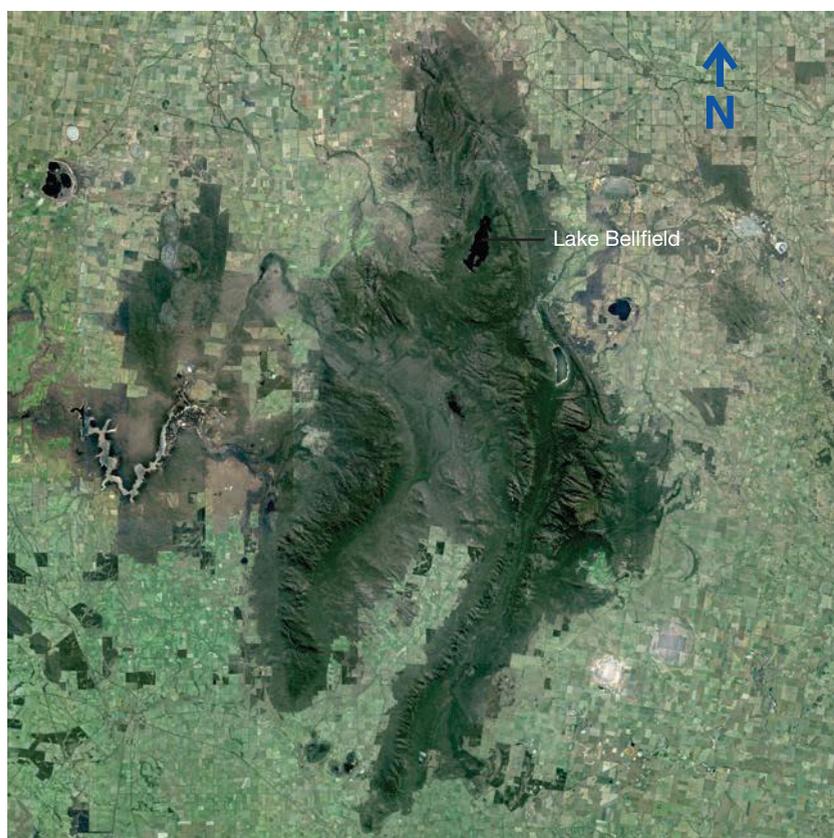


Figure 3.11a Satellite photograph of the Grampians National Park, Google Earth © 2016 Google, Image Landsat / Copernicus

ACTIVITIES

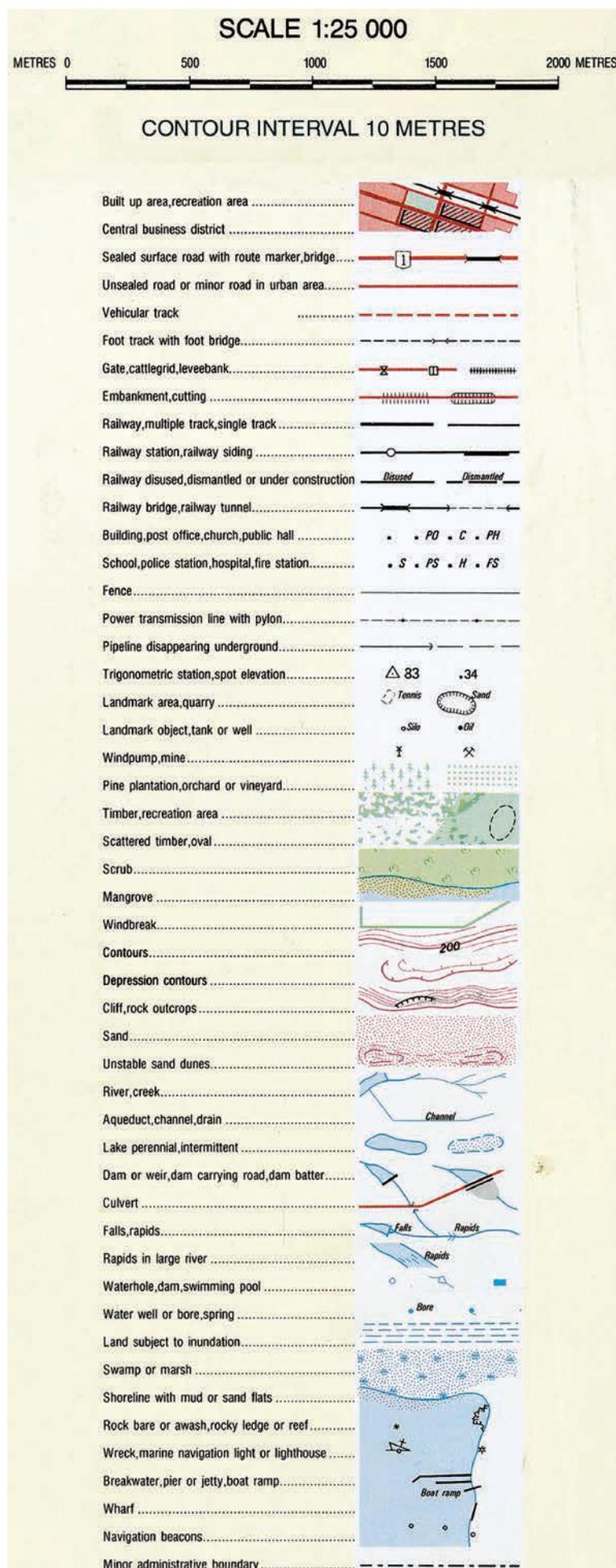


- What is the scale of the map extract?
- Study Figure 3.11a. Describe the land use in the area surrounding the Grampians National Park.
- Identify the feature of the biophysical environment located at:
 - GR 382840
 - GR 336870
 - GR 363876
 - GR 350823
 - GR 337867.
- Identify the feature of the constructed environment located at:
 - GR 373845
 - GR 358855
 - GR 364845
 - GR 357863
 - GR 383883.
- What type of vegetation is found in AR 3584?
- What type of commercial land use is found in AR 3589?
- Name the feature of the constructed environment located 3 km north-west of Little Joe Hill (AR 3785).
- In which direction does the creek flow in AR 3788?
- What is the aspect of the slope in AR 3686?
- What is the bearing of Sundial Peak (AR 3583) from Bellfield Peak (AR 3485)?
- What is the length of the Lake Bellfield dam wall?
- What is the height of Relph Peak (AR 3486)?
- Estimate the elevation of the surface of Lake Bellfield.
- Estimate the height of the landform feature at GR 345854.
- What is the difference in elevation of Peverill Peak (AR 3687) and Bellfield Peak (AR 3485)?
- Estimate the density of buildings in AR 3685.
- Calculate the average gradient of the slope between Sundial Peak (AR 3583) and the shore of Lake Bellfield (GR 369825).
- 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.
- Calculate the vertical exaggeration of the cross-section that you constructed in Activity 18.
- 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.
- Calculate the vertical exaggeration of the cross-section that you constructed in Activity 20.
- 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.
- Calculate the vertical exaggeration of the cross-section that you constructed in Activity 22.
- List four land uses present on the map extract.
 - Locate two features of the built environment and two features of the physical environment on which one of these land uses depends.

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 to the area's spectacular scenery.

Lake Bellfield was created in the 1960s by the construction of a straight dam wall

across Fyans creek at the upper end of the valley between the Mount William Range and the Wonderland Range. The reservoir is fed by numerous streams which originate in these ranges. The lake is also used for local and regional recreation including swimming, fishing, windsurfing, canoeing and picnics.



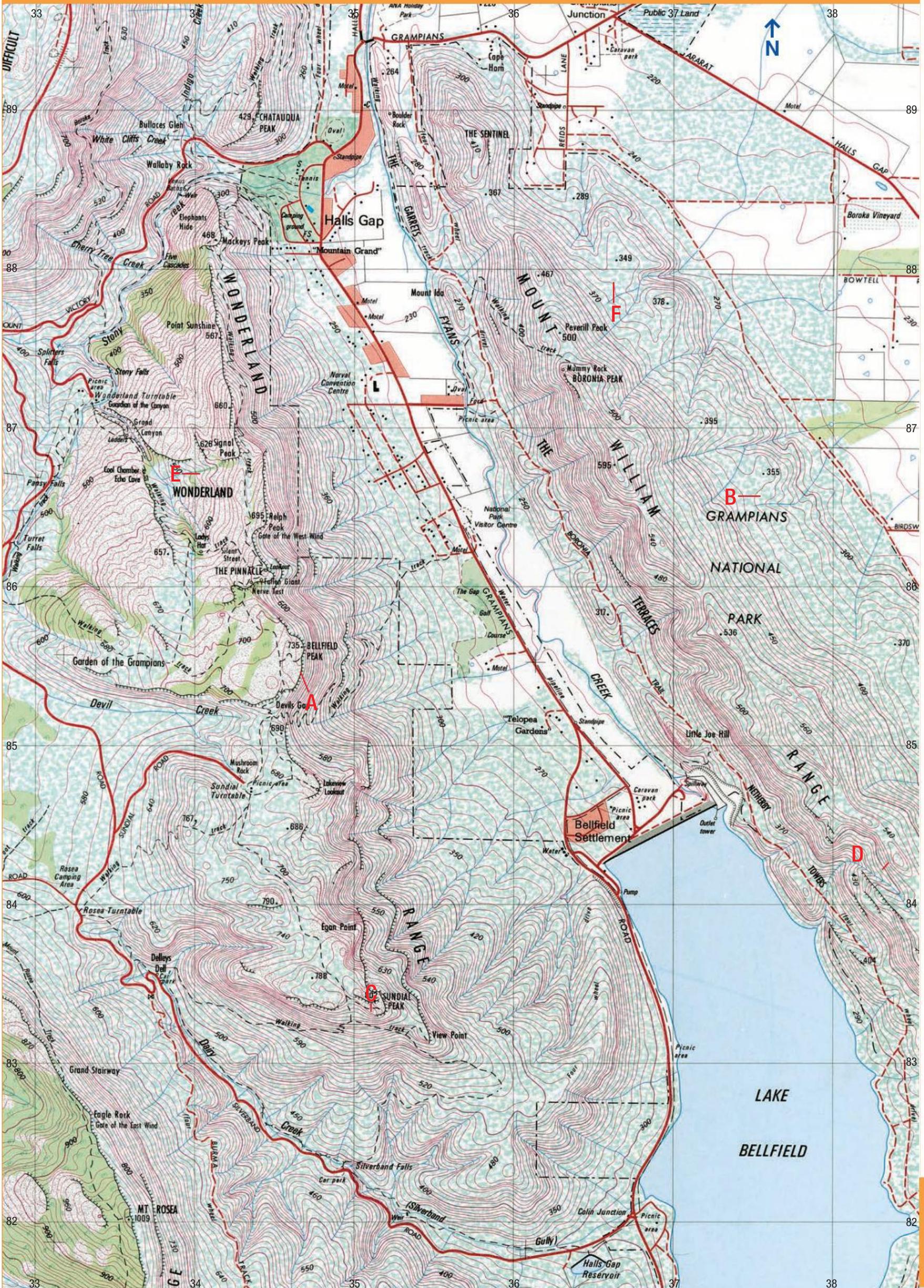




Figure 3.12a Spectacular Lake Pedder before its inundation



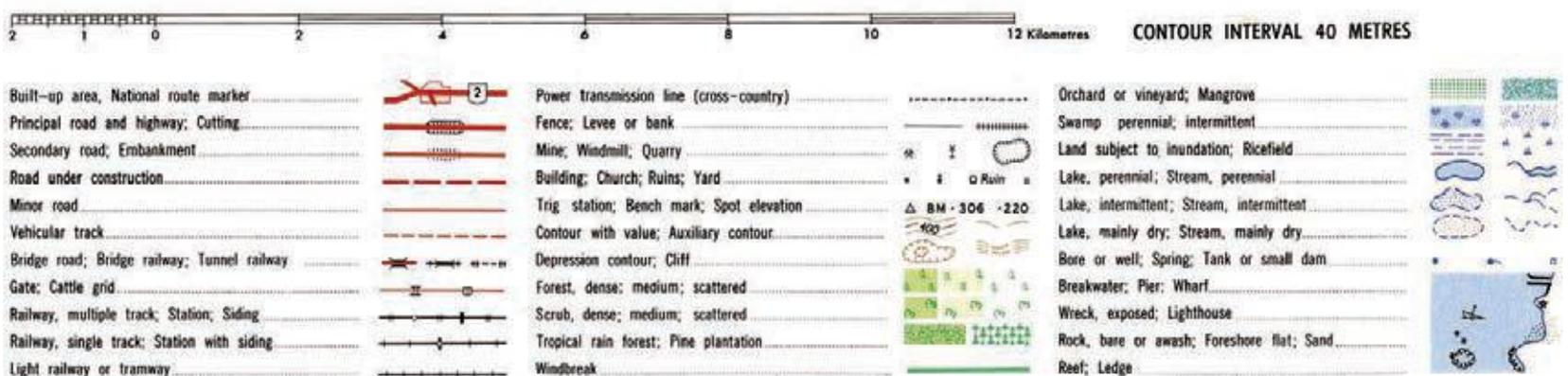
Figure 3.12b The waters of the 'new' Lake Pedder have inundated the Lake Pedder shown in Figure 3.12a. Google Earth, Image © CNES / Astrium, © 2016 Google.

ACTIVITIES

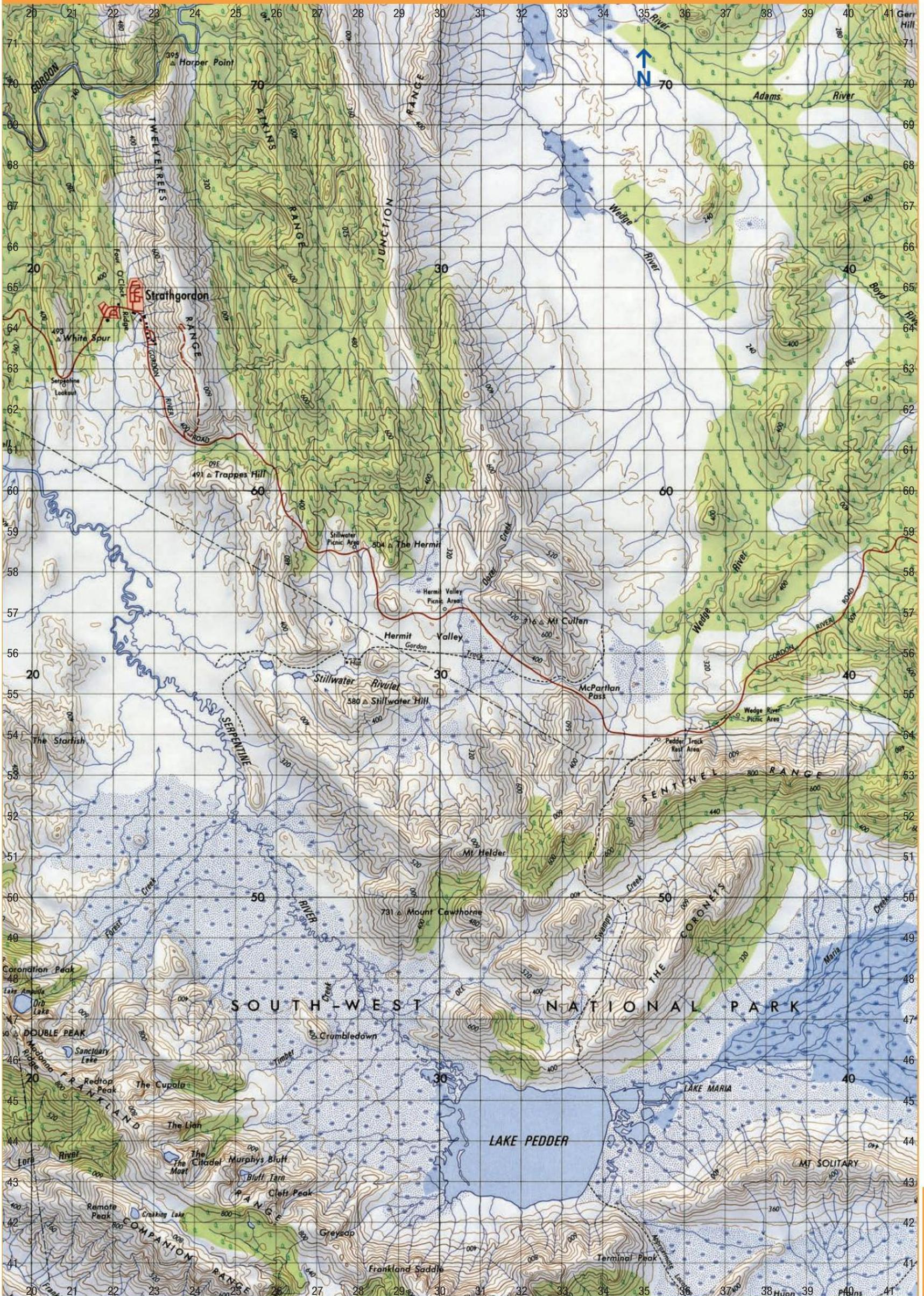


- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Identify the feature of the biophysical environment located at:
 - a GR 325568
 - b GR 313394
 - c GR 290496
 - d GR 333552
 - e GR 252432.
- 4 Identify the feature of the constructed environment located at:
 - a GR 277558
 - b GR 207627
 - c GR 279586
 - d GR 373545.
- 5 Study Figure 3.12a. 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 flood plain 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 (development, movement and decline of glaciers) 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.

SCALE 1:100 000



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



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.



Figure 3.13a View of Cradle Mountain across Dove Lake



Figure 3.13b View from the slopes of Cradle Mountain



Figure 3.13c View of Cradle Mountain across Dove Lake

ACTIVITIES

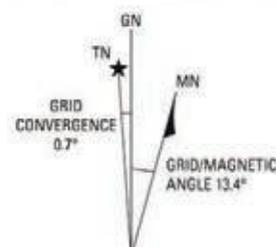


- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Identify the feature of the biophysical environment located at:
 - a GR 103849
 - b GR 116886
 - c GR 135879
 - d GR 110873.
- 4 Identify the feature of the constructed environment located at:
 - a GR 116902
 - b GR 125885
 - c GR 108875
 - d GR 111895.
- 5 What is the grid reference of the Scout Hut in the north-west quadrant?
- 6 What type of landform is found at AR 1284?
- 7 What is the type of vegetation found in:
 - a AR 1088
 - b AR 1189?
- 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 AR 1089?
- 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 AR 1388?
- 13 What is the straight-line distance between the summit of Cradle Mountain and Mount Campbell?
- 14 What is the bearing of Little Horn (AR 1285) from Cradle Mountain (AR 1184)?
- 15 Estimate the area of Dove Lake.
- 16 What is the difference in elevation between Cradle Mountain (AR 1184) and Little Horn (AR 1285)?
- 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 (AR 1288)?
- 19 What geomorphological processes are responsible for the landscape and landform features found on the Cradle Mountain topographic map extract?
- 20 Study Figure 3.13a and the map extract. Identify the features numbered 1–4.
- 21 In what direction was the camera pointing when the photograph was taken?
- 22 Study Figure 3.13b and the map extract. Identify the features numbered 1–2.
- 23 In what direction was the camera pointing when the photograph was taken?
- 24 Study Figure 3.13c and the map extract. What is the grid reference of the boatshed?
- 25 Construct a photo sketch of Figure 3.13c. Label the features of the biophysical environment.

LEGEND

Highway with A route marker	
Main road with C route marker	
Other road with bridge	
Distance markers	
Vehicular track with gate	
Overland Track; Other walking track	
Walking route; Transmission line	
Overnight campsite; Campsite; No camping	
Private hut; Hut; Building; Car park	
Trig station; Spot height; Cave	
Lookout; Power station; Waterfall	
Swamp; Timber (green areas)	
Contours (40m interval)	
Park boundary	
Other park / reserve boundary	

Roads and vehicular tracks on this map **do not** necessarily indicate a public right of way.

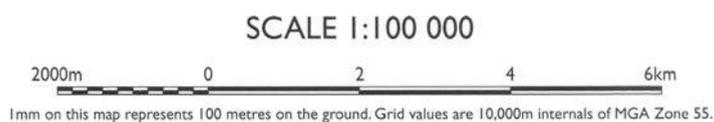


True North, Grid North and Magnetic North are shown diagrammatically for the centre of this map. Magnetic North is correct for 2005 and moves easterly by 0.1° in about two years.





Figure 3.14a Satellite photograph of Lake St Clair, Google Earth, © 2016 Google, Image © 2016 CNES / Astrium



Lake St Clair is a lake in the central highlands of Tasmania. It forms part of the Cradle Mountain–Lake St Clair National Park. It has an

area of approximately 45 km² and a maximum depth of 200 m. This makes it Australia's deepest lake.



Figure 3.14b Cradle Mountain viewed from Dove Lake

LEGEND	
Highway with A route marker	
Main road with C route marker	
Other road with bridge	
Restricted access road with gate	
Distance markers	
Overland Track; Other walking track	
Vehicular track; Transmission line	
Overnight hut & campsite; Campsite; No camping	
Private hut; Hut (Emergency use only)	
Ranger hut (Infrequently occupied); Building	
Trig station; Spot height; Tower; Cave	
Lookout; Power station; Waterfall: >20m, <20m ..	
Subject to flooding; Timber (green areas)	
Swamp; Contours (40m interval)	
Cradle Mtn - Lake St Clair NP boundary	
Other park; Reserve boundary	

ACTIVITIES

- What is the scale of the map?
- What is the contour interval used on the map extract?
- Identify the feature of the biophysical environment located at:
 - GR 189516
 - GR 195541
 - GR 272599
 - GR 345390.
- Identify the feature of the constructed environment located at:
 - GR 254581
 - GR 346384
 - GR 254496
 - GR 318370.
- What type of landform features are found in AR 2246?
- What type of vegetation is found at GR 230620?
- What tributary joins Narcissus River at GR 251515?
- What river flows from Lake Petrarach (GR 243439) to Lake St Clair in AR 3137?
- What is the direction of flow of Hamilton Creek in AR 2148?
- In what direction is the Alma River flowing in AR 1941?
- What type of recreational activity is available in AR 2457?
- What is the direction of Castle Crag (GR 251598) from Walled Mountain (AR 1856)?
- What is the bearing of:
 - Mt Ida (GR 3047) from Mount Gould (AR 2152)
 - Mount Ossa (GR 198641) from Cathedral Mountain (GR 202623)
 - Mount Spurling (GR 310525) from Lamonts Lookout (GR 250451)?
- What is the aspect of the slope in:
 - AR 2063
 - AR 3041
 - AR 2544
 - AR 2745?
- What is the straight-line distance between the summit of Mount Ossa (AR 1964) and Mount Byron (AR 2246)?
- 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)?
- Estimate the area of Lake Meston in the north-east quadrant.
- What is the elevation of:
 - Lake Marion
 - Lake St Clair
 - Lake Helen (AR 2645)?
- What is the elevation of the lake found on Gould Plateau?
- What is the difference in elevation between Mount Olympus (GR 270448) and Mt Ida (GR 308478)?
- What is the difference in elevation between Lake St Clair and Mount Byron?
- Construct the cross-section between Mount Olympus (GR 270448) and Mt Ida (GR 308478).
- Estimate the local relief experienced in a traverse from the summit of Mount Olympus to the shores of Lake St Clair (GR 283455).
- 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.
- Calculate the vertical exaggeration of the cross-section that you constructed in Activity 24.
- 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.
- Calculate the vertical exaggeration of the cross-section that you constructed in Activity 26.
- Write a paragraph outlining why the area shown on the map extract is suited to the production of hydro-electricity.
- Study Figure 3.14a and the map extract. Identify the features numbered 1–6.







Figure 3.15a Wineglass Bay viewed from The Hazards



Figure 3.15b Wineglass Bay and The Hazards

ACTIVITIES



- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Study Figure 3.15a and the map extract. In which direction was the camera facing when the photograph was taken?
- 4 Study Figure 3.15b. Construct a photo sketch highlighting the features of the biophysical environment. In which direction was the camera facing when this photograph was taken?
- 5 Study Figure 3.15c and the map extract. Identify the features numbered 1–6.
- 6 Identify the feature of the biophysical environment located at:
 - a GR 048354
 - b GR 072321
 - c GR 073313
 - d GR 064302.
- 7 Identify the feature of the constructed environment located at:
 - a GR 078368
 - b GR 043368
 - c GR 063369
 - d GR 074343.
- 8 What is the area reference of Mount Dove?
- 9 Name the type of biophysical feature found in AR 0730.
- 10 Name the type of vegetation found in AR 0836.
- 11 What river flows into Parsons Cove at GR 061331?
- 12 What is the direction of Mount Parsons (AR 0832) from Coles Bay (AR 0635)?
- 13 In what direction is Deep Creek flowing in AR 0431?
- 14 What is the bearing of Mount Mayson (GR 060316) from Mount Dove (AR 0732)?
- 15 What is the bearing of Mount Parsons (AR 0832) from Mount Dove (AR 0732)?
- 16 What is the straight-line distance between the summit of Mount Mayson (AR 0531) and the summit of Mount Parsons (AR 0832)?
- 17 What is the length of Deep Gap Creek (AR 0431)?
- 18 What is the aspect of the slope in:
 - a AR 0731
 - b AR 0532?
- 19 What is the height of the dammed water body in AR 0736?
- 20 What is the difference in elevation of Mount Amos (AR 0732) and Mount Dove (AR 0732)?
- 21 Estimate the local relief experienced on a traverse from the summit of Mount Amos (AR 0732) to the summit of Mount Dove (AR 0732).
- 22 Construct the cross-section from the shoreline at GR 085315 to the summit of Mount Dove in AR 0732. Use a vertical scale of 1 cm = 50 m.
- 23 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 22.
- 24 What is the gradient of the slope in the cross-section you constructed in Activity 22?
- 25 What is the gradient of Loony Creek in the south-west quadrant of the topographic map extract?



Figure 3.15c Satellite photograph of Freycinet National Park, Google Earth, Image © 2016 TerraMetrics, © 2016 Google, Data SIO, NOAA, US Navy, NGA, GEBCO, Images © 2016 CNES / Astrium

Freycinet National Park is located on the east coast of Tasmania, 125 km northeast of Hobart. It occupies a large area of the Freycinet Peninsula. Bordering the national park is the small settlement of **Coles Bay**.

The standout features of Freycinet National Park include Wineglass Bay (rated by travel companies as one of the world's ten best beaches), the red and pink granite formations, and a series of jagged granite peaks known as 'The Hazards'.

Scale 1:25,000

0 500 1,000 2,000 Metres

<p>Built up area with commercial buildings</p> <p>Roads maintained for continuous public use</p> <p>Roads of restricted use or access</p> <p>Walking track or horse trail; Railway line</p> <p>Transmission line with pylon positions</p> <p>Building; Police station; Fire station; School</p> <p>Post Office; Picnic area; Public toilets</p> <p>Caravan park; Camping ground; Refuse disposal</p> <p>Landmark feature; Mine; Feature of historic or special interest</p> <p>Area feature; Sports Ground; Cemetery</p>		<p>Trig station beacon; Spot elevation; Excavation</p> <p>Contour with value; Depression contour</p> <p>Rock scree; Broken rocky surface</p> <p>Dense forest; Medium forest</p> <p>Low dense vegetation; Distinctive grass</p> <p>Scrub; heath or sedge; Submerged trees</p> <p>Orchard; Timber plantation</p> <p>Windbreak</p> <p>Indefinite shoreline or floodbank; Levee</p> <p>Tidal rocks or ledge; Offshore rock, bare or awash</p> <p>Navigation light or lighthouse; Exposed wreck</p> <p>Sand; Tidal reef</p> <p>Saline coastal flat; Tidal flats</p> <p>Jetty; Launching ramp</p>		<p>Swamp; perennial, intermittent</p> <p>Wet area; Subject to flooding</p> <p>Watercourse; waterfall, rapids</p> <p>Local Government Area name</p> <p>Local Government Area boundary</p> <p>Other administrative boundaries</p> <p>Reserve boundary; Vinculum or joining symbol</p> <p>Property boundary; Land parcel boundary and identifier</p> <p>Locality boundary with locality name</p>	
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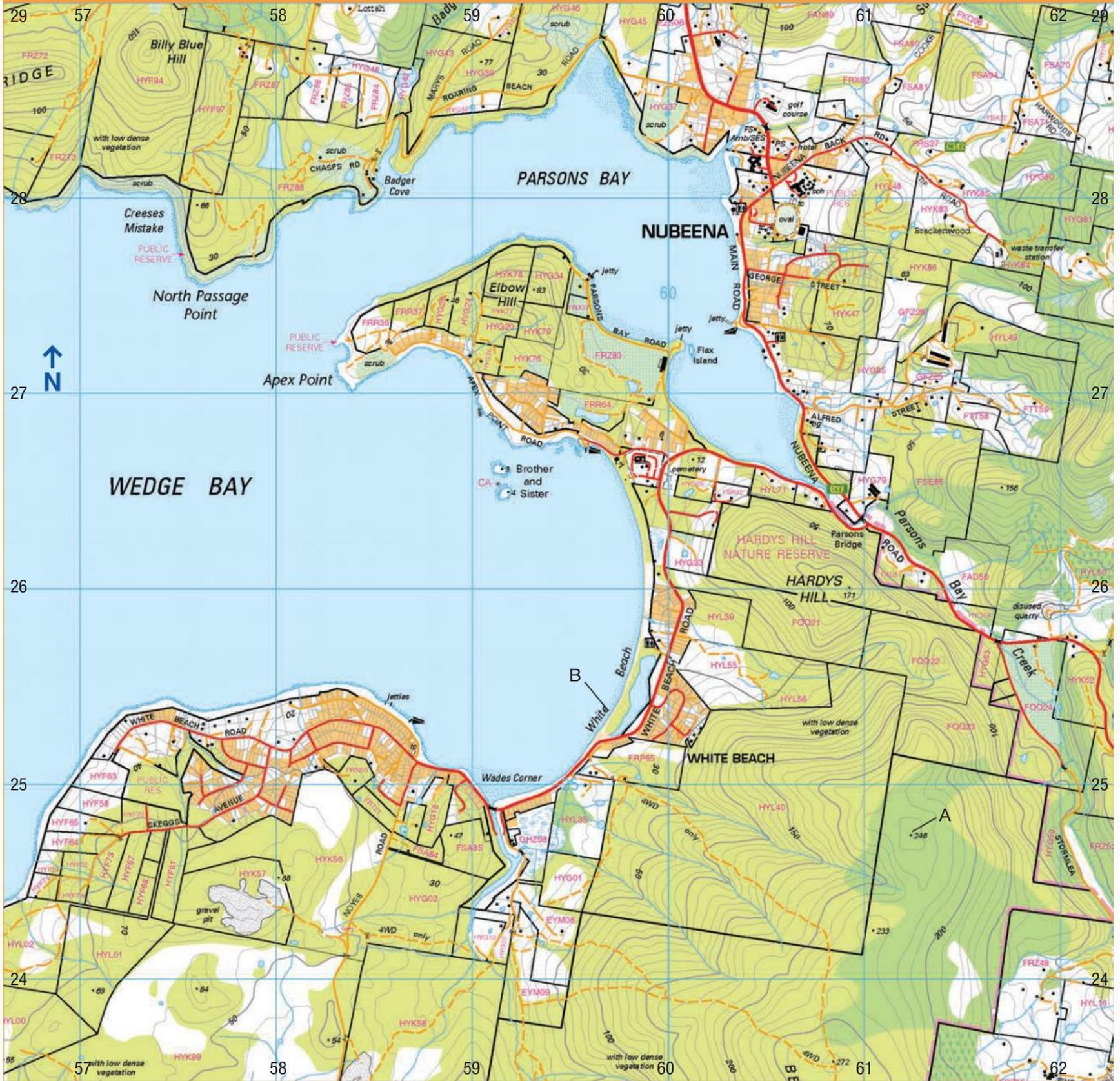
BOUNDARIES: Cadastral and administrative boundaries shown on this map are NOT authoritative and are shown as at... Boundaries of Crown Land (including Reserves) extend to low water mark. The land parcel identifier, e.g. A81234, can be used to gain title, property and survey references.

INFORMATION: Title and Survey information can be obtained from the Land Data Registration Branch, DPIPWE. Topographical information is available from Geodata Services Branch, DPIPWE and property details from Service Tasmania. Land information may be accessed also at www.thefirst.tas.gov.au

Coles Bay topographic map extract (Coles Bay: latitude 42°08'S, longitude 148°23'E)



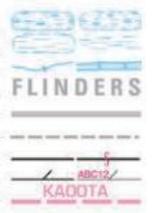
Wedge Bay topographic map extract (Nubeena: latitude 43°10'S, longitude 147°75'E)



SCALE 1:25000
0 km 0.5 1 2 km

CONTOUR INTERVAL 10 METRES
Magnetic North is 15.0 degrees East of Grid North.

<p>Built-up area with commercial buildings</p> <p>Roads maintained for continuous public use</p> <ul style="list-style-type: none"> Highway Major arterial road Minor arterial or Collector road Local road Touring route numbers <p>Roads of restricted use or access</p> <ul style="list-style-type: none"> Other road with bridge Vehicular track with gate <p>Walking track or horse trail; Railway line</p> <p>Transmission line with pylon positions</p> <p>Building; Police station; Fire station; School</p> <p>Post Office; Picnic area; Public toilets</p> <p>Caravan park; Camping ground; Refuse disposal</p> <p>Landmark feature; Mine; Feature of historic or special interest</p> <p>Area feature; Sports Ground; Cemetery</p>	<p>Trig station beacon; Spot elevation; Excavation</p> <p>Contour with value; Depression contour</p> <p>Rock scree; Broken rocky surface</p> <p>Dense forest; Medium forest</p> <p>Low dense vegetation; Distinctive grass</p> <p>Scrub; heath or sedge; Submerged trees</p> <p>Orchard; Timber plantation</p> <p>Windbreak</p> <p>Indefinite shoreline or floodbank; Levee</p> <p>Tidal rocks or ledge; Offshore rock, bare or awash</p> <p>Navigation light or lighthouse; Exposed wreck</p> <p>Sand; Tidal reef</p> <p>Saline coastal flat; Tidal flats</p> <p>Jetty; Launching ramp</p>	<p>Swamp; perennial, intermittent</p> <p>Wet area; Subject to flooding</p> <p>Watercourse; waterfall, rapids</p> <p>Local Government Area name</p> <p>Local Government Area boundary</p> <p>Other administrative boundaries</p> <p>Reserve boundary; Vinculum or joining symbol</p> <p>Property boundary; Land parcel boundary and identifier</p> <p>Locality boundary with locality name</p>
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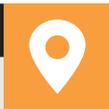
BOUNDARIES: Cadastral and administrative boundaries shown on this map are NOT authoritative and are shown as at boundaries of Crown Land (including Reserves) extend to low water mark. The land parcel identifier, e.g. ABC12, can be used to gain title, property and survey references.

INFORMATION: Title and Survey information can be obtained from the Land Data Registration Branch, DPI/PWE. Topographical information is available from Geodata Services Branch, DPI/PWE and property details from Service Tasmania. Land information may be accessed also at www.thelist.tas.gov.au

Port Arthur topographic map extract (latitude 43°18'S, longitude 147°84'E)



ACTIVITIES



- 1 What is the scale of the map extracts?
- 2 What is the contour interval used on the map extracts?
- 3 Identify the feature of the biophysical environment located on the Port Arthur map extract at:
 - a GR 705223
 - b GR 662218.
- 4 Identify the feature of the constructed environment located on the Wedge Bay map extract:
 - a GR 603274
 - b GR 587253.
- 5 Name the types of vegetation found in AR 6621 on the Port Arthur map extract.
- 6 What river flows into Mason Cove (AR 6922) on the Port Arthur map extract?
- 7 In what direction is Parsons Bay creek flowing in AR 6125 on the Wedge Bay map extract?
- 8 What is the aspect of the slope in AR 6024 on the Wedge Bay map extract?
- 9 What is the density of buildings in AR 6923 on the Port Arthur extract?
- 10 What is the height of Billy Blue Hill in AR 5728 on the Wedge Bay map extract?
- 11 What is the height of Mount Tonga in AR 6724 on the Port Arthur map extract?
- 12 Construct the cross-section from the spot height at GR 611243 (Point A) to the shoreline of Wedge Bay at GR 596253 (Point B). Use a vertical scale of 1 cm = 50 m.
- 13 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 12.
- 14 What is the gradient of the slope in the cross-section that you constructed in Activity 12?
- 15 Use Google Earth to explore the area covered by the Port Arthur map extract. What features of the biophysical and constructed environments can you identify?

Port Arthur is a small town and former convict settlement on the Tasman Peninsula, Tasmania. Port Arthur is one of Australia's most significant

heritage areas and an open-air museum. **Nubeena**, on Wedge Bay, is a small, scenic village near the Port Arthur Historic Site.



Figure 3.16a Port Arthur Historic Site, Google Earth © Google

The **Barossa Valley** is located 60 km northeast of Adelaide, South Australia. It is famous for being one of Australia's major wine-producing regions. It is also an important tourist destination. It is a valley formed by the North Para River. The Barossa Valley Ways is the main road through the valley. The wine

industry plays an important role in the Barossa. It is the main source of employment for residents.

Tanunda, the largest town in the valley, is generally recognised as the most German of the towns. It dates back to the 1840s when the first German settlers arrived in the area.

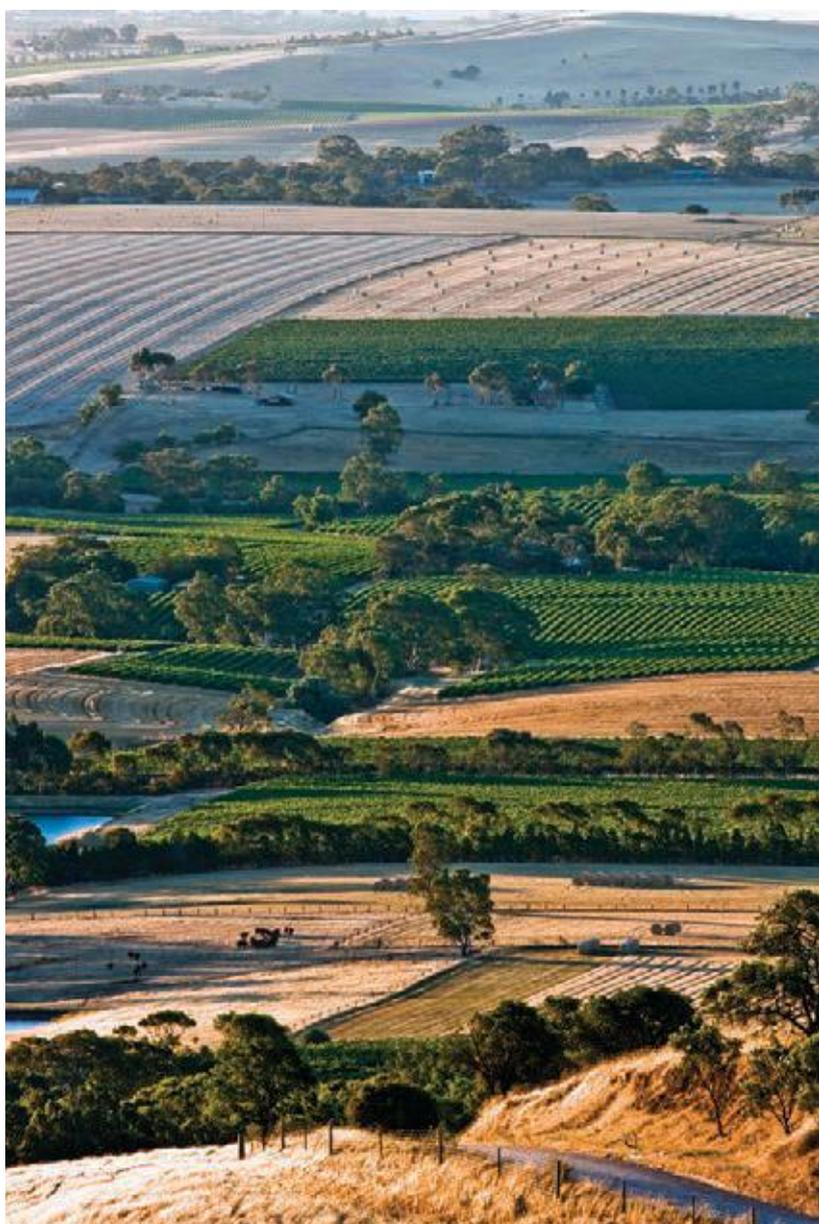
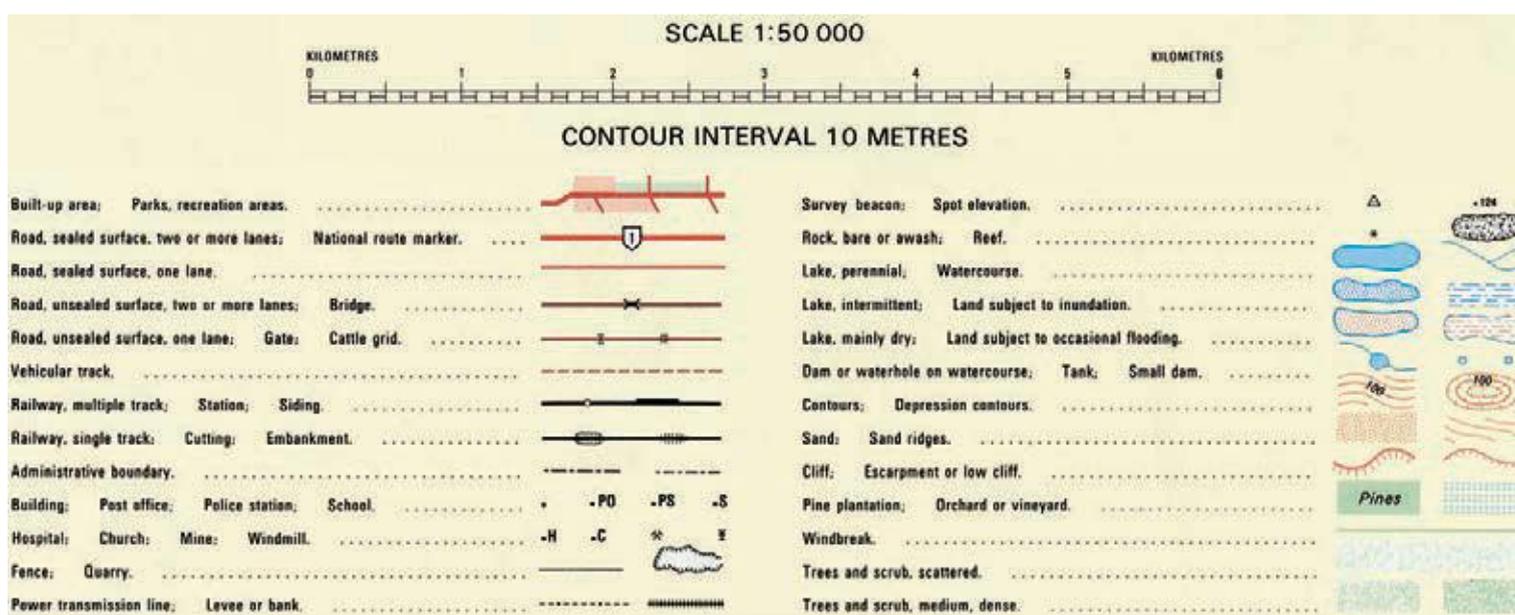


Figure 3.17a Barossa Valley vineyards

ACTIVITIES

- What is the scale of the map extract?
- What is the contour interval used on the map extract?
- Identify the feature of the biophysical environment located at:
 - GR 147702
 - GR 127663
 - GR 110664
 - GR 093688.
- Identify the feature of the constructed environment located at:
 - GR 100715
 - GR 121728
 - GR 108658
 - GR 071688
 - GR 085714.
- What waterway flows into the Gawler River at GR 116768?
- What type of vegetation is found in AR 0870?
- What type of vegetation is found in AR 1476?
- What type of land use is found in AR 0968?
- Name the physical feature found in AR 0867.
- What is the standard of road linking GR 134664 and GR 150658?
- What is the direction of Tanunda from Lyndoch?
- In which direction is the North Para or Gawler River flowing in AR 0972?
- Identify the feature of the built environment located 3.5 km to the south of the intersection at GR 116768.
- What is the aspect of the slope in AR 1271?
- What is the bearing of Pewsey Vale Peak (GR 127663) from the Orlando Winery (GR 100714)?
- What is the straight-line distance between Lyndoch railway station (GR 064686) and Tanunda railway station (GR 128774)?
- Estimate the distance by rail from Lyndoch railway station (GR 064686) to Tanunda railway station (GR 128774).
- 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.
- Estimate the area of the golf course centred on GR 095737.
- What is the density of buildings in AR 0872?
- What is the density of buildings in AR 0872?
- What is the height of the landform feature at GR 090660?
- Estimate the height of McLaren Hill (GR 090689).
- What is the difference in elevation of Pewsey Vale Peak (AR 1266) and the shed at GR 152657?
- Estimate the local relief experienced on a traverse from GR 077667 to GR 084651.
- Estimate the local relief in AR 1372.
- Calculate the gradient of the slope between the spot height at GR 135722 and GR 130729.
- What is the gauge of the railway line linking Lyndoch and Tanunda?
- Name the settlement pattern evident in AR 1373.
- Name the settlement pattern found in the north-west quadrant of the map extract.
- Undertake internet research. Account for the large number of German place names in the Barossa Valley.





Albany is a port city 418 km southeast of Perth, the capital of Western Australia. Albany is the oldest permanently settled town in Western Australia, predating Perth and Fremantle by over two years. With a population of 30 600, the city is the state's sixth-largest population centre.

Albany played an important role in Australia's military history. Ships carrying the Australian Imperial Force and the

New Zealand Expeditionary Force (later known collectively as Anzacs) gathered at Albany in late October 1914 prior to their departure for the battlefields of World War I. The first detachment departed in convoy on 1 November 1914, with a second detachment departing in late December 1914. Albany was the last place in Australia that many of these Anzacs would ever see.

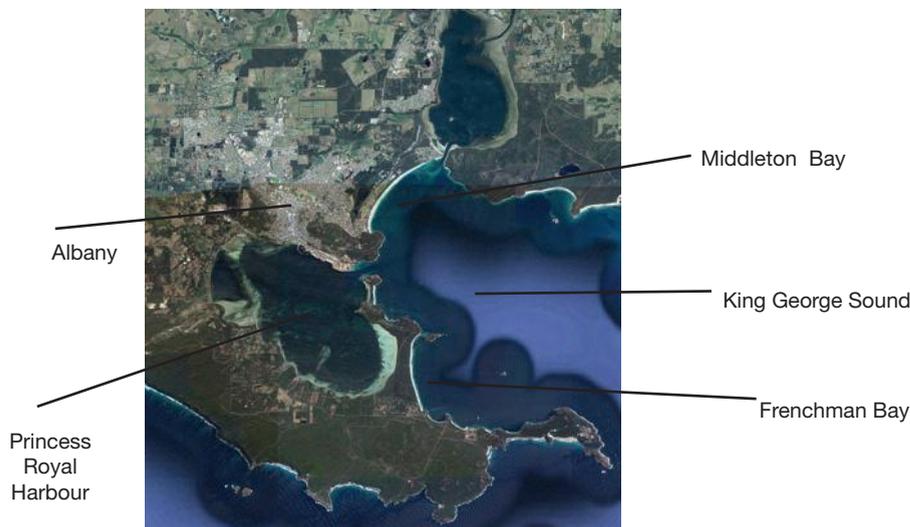


Figure 3.18a The location of Albany relative to the surrounding geography of southern Western Australia, Google Earth, Image © 2016 CNES / Astrium © 2016 Google, Data SIO, NOAA, US Navy, NGA, GEBCO

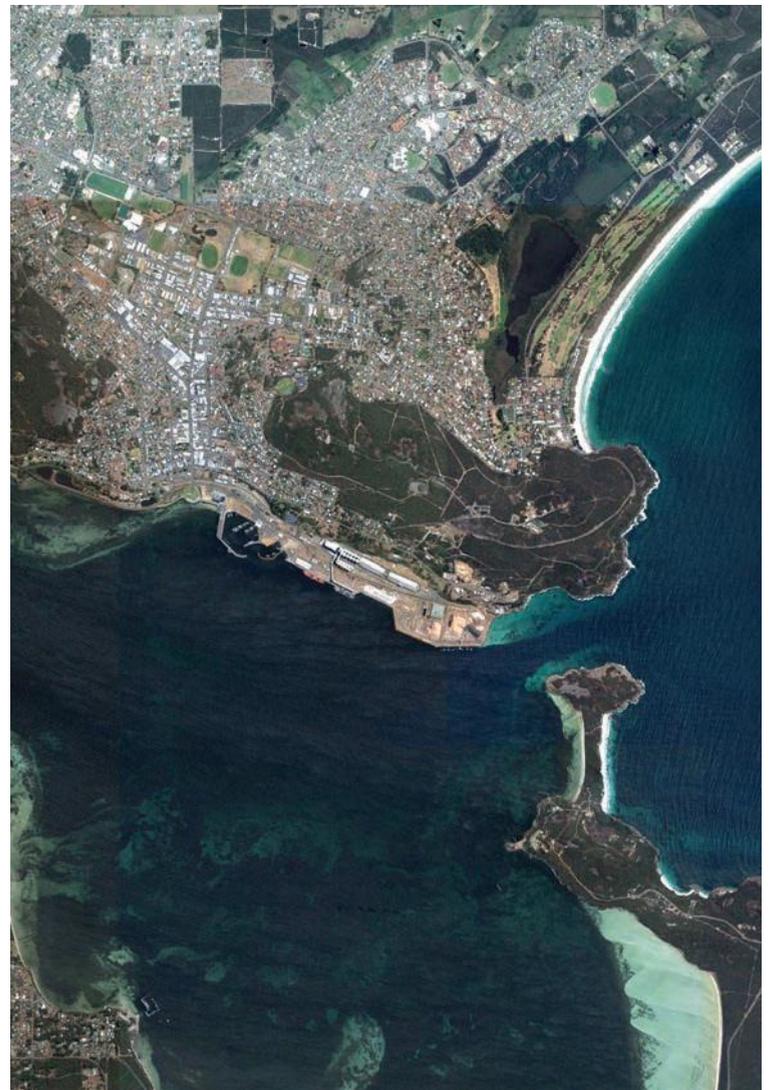


Figure 3.18b Satellite photograph of Albany, Western Australia, Google Earth, Image © Terrametrics, Image © 2016 CNES / Astrium © 2016 Google, Data SIO, NOAA, US Navy, NGA, GEBCO

Landgate Topographic Map Series - 2014

<ul style="list-style-type: none"> State Highway, Sealed Main Road, Sealed Main Road, Roundabout Minor Road, Sealed Minor Road, Unsealed Minor Road, Roundabout Laneway, Unsealed Track Road, Unsealed Proposed Road Rail, Single Line Rail, Multiple Lines Railway Siding 	<ul style="list-style-type: none"> Road and Rail Bridge Road and Rail Footbridge Road Footbridge Walk Trail Walk or Cycle Trail Boat Ramp Jetty Wharf Causeway 	<ul style="list-style-type: none"> Building Ruin Building Shape Silo Brewery Winery Church Police Station State Emergency Service 	<ul style="list-style-type: none"> Communication Tower Lookout Tower Lighthouse Lit Beacon Historic Site Monument Hill Mountain Rock, Awash Rock, Exposed Spot Height 	<ul style="list-style-type: none"> Cliff Sand Ridge Rock, Exposed Sand, Exposed Fence BMX Race Track Car or Motorcycle Race Track Conveyor Belt, On Sump Storage Tank, Water 	<ul style="list-style-type: none"> Water Tank Earth Dam, Perennial Minor River, Non-perennial Drain Coastline Groyne Channel Earth Dam Estuary, Perennial Lake, Perennial Lake, Non-perennial Marsh, Non-perennial Reservoir Swamp, Perennial Swamp, Non-perennial Subject to Inundation Tailing Pond Storage Tank, Oil Storage Tank, Water 	<ul style="list-style-type: none"> Caravan and Tourist Park Cemetery and Crematorium Campsite Golf Course Park or Reserve Racecourse Depot, Maintenance Depot, Storage Earthworks Stockpile Commercial Centre Industrial Area Market Garden Orchard Plantation Shopping Centre Urban Area Prepared Playing Ground
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ACTIVITIES

- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Study Figure 3.18a. Describe the location of Albany. Suggest why this site was selected for the development of a port.
- 4 Study Figure 3.18b and the map extract. Locate the following features on the satellite photograph: Albany's port facilities, Mount Clarence, Mount Adelaide, golf course, Lake Seppings and Ataturk Entrance. After whom was Ataturk Entrance named?
- 5 Identify the feature of the biophysical environment located at:
 - a GR 586628
 - b GR 605623
 - c GR 604642
 - d GR 603614.
- 6 Identify the feature of the constructed environment located at:
 - a GR 584634
 - b GR 606633
 - c GR 607617
 - d GR 574625.
- 7 What is the area reference of Quarantine Hill?
- 8 Name the type of biophysical feature found in AR 6060.
- 9 Name the types of land use found in AR 5865.
- 10 What waterway is located in AR 5865?
- 11 What is the direction of Quarantine Hill (AR 6059) from Mount Clarence (AR 5862)?
- 12 In what direction is Yakamia Creek flowing in AR 5865?
- 13 What is the bearing of Mount Adelaide (AR 6062) from Mount Clarence (AR 5862)?
- 14 What is the straight-line distance between the summit of Mount Clarence (AR 5862) and the summit of Quarantine Hill (AR 6059)?
- 15 What is the width of the Ataturk Entrance at its narrowest point?
- 16 What is the aspect of the slope in AR 5862?
- 17 What is the area of Lake Sappings?
- 18 What is the height of Quarantine Hill (AR 6059)?
- 19 What is the difference in elevation of Mount Clarence and Mount Adelaide?
- 20 Construct the cross-section from the spot height at GR 606608 to the summit of Mount Adelaide (AR 6062). Use a vertical scale of 1 cm = 20 m.
- 21 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 20.
- 22 What is the gradient of the slope between the summit of Mount Clarence and the waterfront of Hanover Bay (GR 580623)?



ACTIVITIES



- 1 Study the Pilbara region map (Figure 3.19a) 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 3.19b) 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?
- 3 Study the Port Hedland topographic map extract on page 115 and then complete the following activities:
 - a Identify the feature of the bio-physical 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?

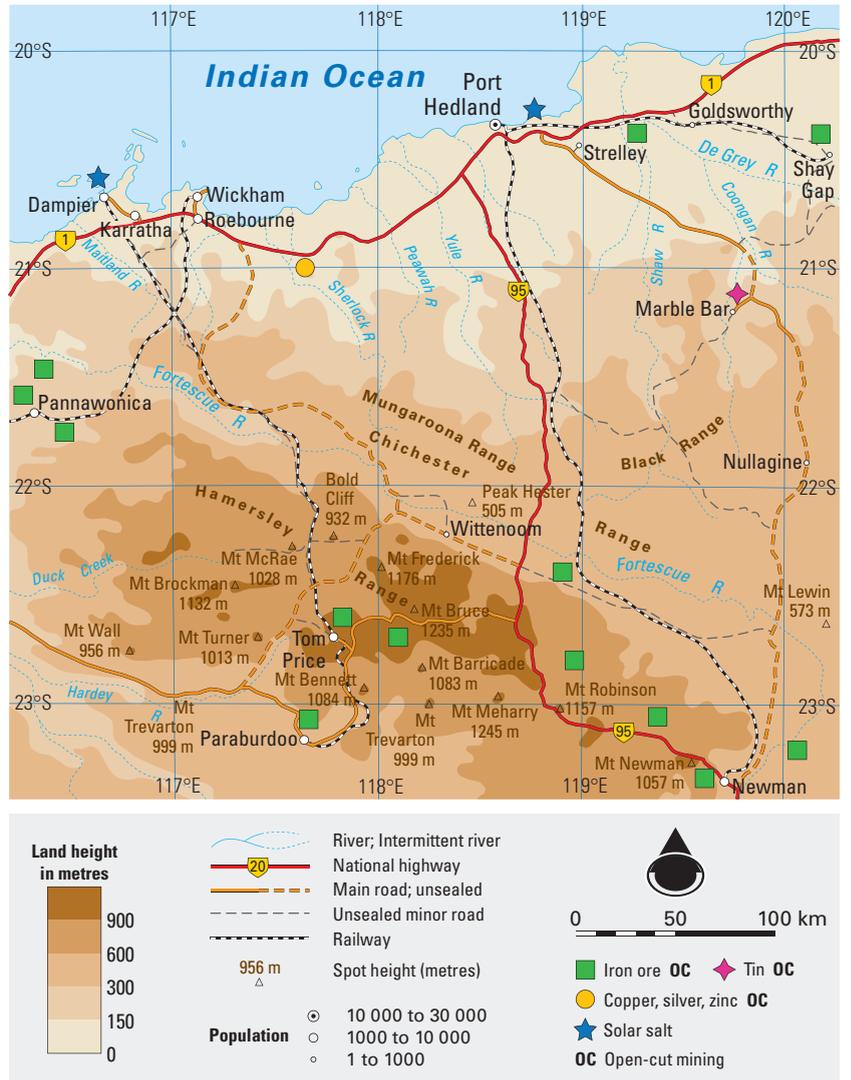


Figure 3.19a The Pilbara region in WA

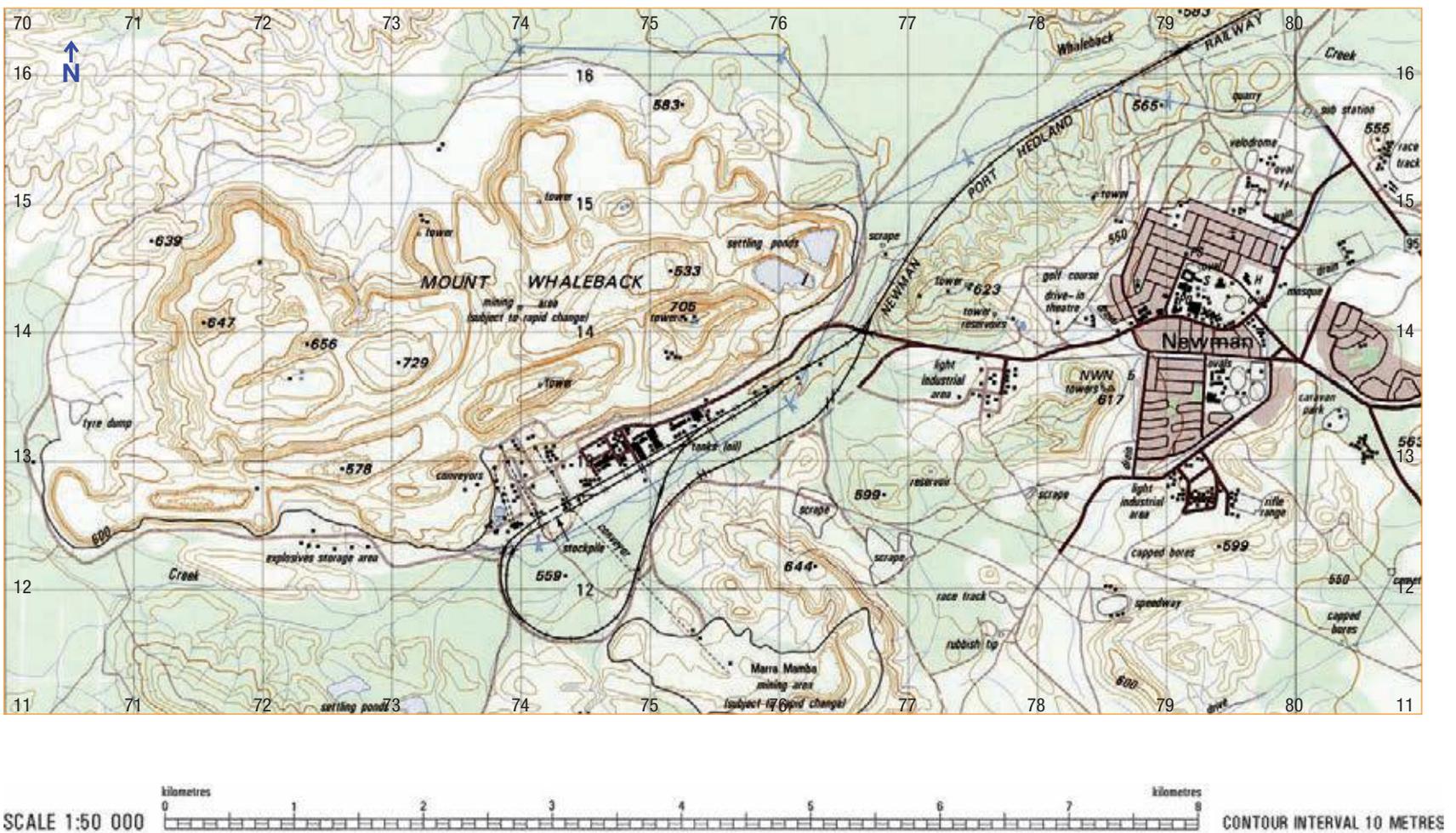
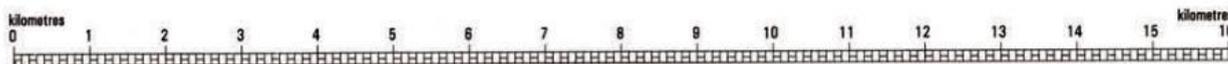


Figure 3.19b Newman topographic map extract

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



SCALE 1:100 000



CONTOUR INTERVAL 20 METRES

Built-up area; Divided highway; Metropolitan route marker ...	Power transmission line ...	Watercourse with flood limits; Area subject to inundation ...
Recreation reserve with oval; Drive-in theatre; Underpass ...	Administrative boundary ...	Swamp; Swamp definite boundary ...
Sealed road two or more lanes; National route marker ...	Mine; Building; Ruin; Church; Windpump; Yard ...	Perennial lake; Watercourse ...
Sealed road one lane; Cutting; Embankment ...	Fence; Horizontal control point; Spot elevation ...	Intermittent lake; Watercourse ...
Unsealed road two or more lanes; Culvert; Causeway ...	Contour with value; Supplementary contour ...	Mainly dry lake; Watercourse ...
Unsealed road one lane; Approximate position (AP) ...	Depression contour; Sand; Distorted surface ...	Tank or small dam; Waterhole ...
Vehicle track; Road bridge; Gate; Stock grid ...	Levae; Sand ridge ...	Saline coastal flat; Intertidal flat; Rock bare or awash ...
Foot track; Foot bridge ...	High cliff; Escarpment ...	Navigation light; Intertidal ledge or reef ...
Multiple track railway; Siding; Station ...	Vegetation; Dense, medium, scattered ...	Exposed wreck; Submerged wreck ...
Single track railway; Light railway ...	Rain forest; Pine ...	Submerged reef; Submerged rock ...
Railway tunnel, bridge, underpass ...	Orchard or vineyard; Line of trees or windbreak ...	Indefinite watercourse; Shoreline; Mangrove swamp ...

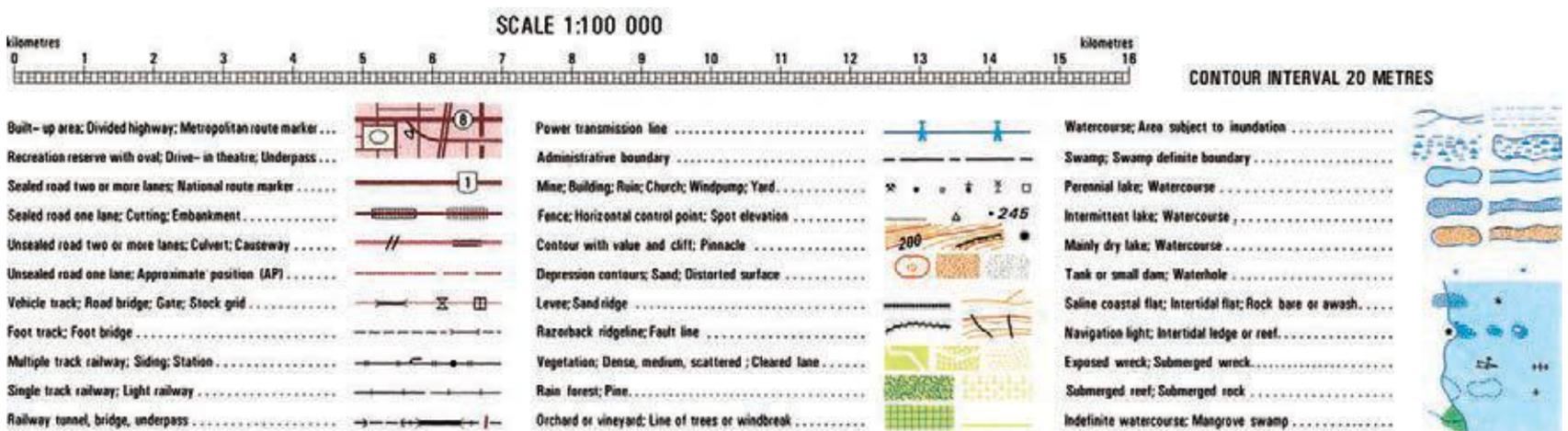


Figure 3.20a Oblique aerial view of the mouth of the Daintree River (World Heritage Area, North Queensland)



Figure 3.20b Oblique aerial photograph of Port Douglas, Queensland

The World Heritage-listed **Daintree** National Park is located in North Queensland 111 km north of Cairns and 56 km from Port Douglas. Daintree National Park consists of two sections – Mossman Gorge and Cape Tribulation. The crystal-clear waters of the Mossman River cascade over granite boulders in Mossman Gorge while Cape Tribulation features rainforest-clad mountains that sweep down to long sandy beaches.



ACTIVITIES

- What is the scale of the map extract?
- What is the contour interval used on the map extract?
- Identify the feature of the biophysical environment located at:
 - GR 382033
 - GR 383997
 - GR 357978
 - GR 255835.
- Identify the feature of the constructed environment located at:
 - GR 287016
 - GR 289036
 - GR 251829
 - GR 309875.
- What river flows into the sea at GR 298823?
- What type of vegetation is found in:
 - AR 2495
 - AR 3197?
- What type of land use is found in AR 2589?
- What is the biophysical feature found in AR 3285?
- What is the direction of Snapper Island (GR 395975) from Dayman Point (GR 310873)?
- In which direction is the Mossman River flowing in AR 2178?
- Estimate the width of the Daintree River in AR 3399.
- Identify the feature of the built environment located 8.2 km to the north-west of Port Douglas (GR 360770).
- What is the bearing of Morey Reef (GR 350778) from Dayman Point (GR 310873)?
- What is the length of the landing ground located to the north of the Daintree River?
- Estimate the distance by road from Dayman Point (GR 310873) to the intersection at GR 267988.
- 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.
- Estimate the density of buildings in AR 2484.
- What is the settlement pattern in AR 3092?
- What is the difference in elevation of Mount Somerset (GR 255835) and Mount Beaufort (GR 280795)?
- What is the local relief experienced on a traverse from the summit of Mount Somerset (GR 255835) to Mount Beaufort (GR 280795)?
- Construct the vegetation transect from GR 200970 to GR 337970.
- Construct a precis map showing the pattern of vegetation on the map extract.
- Describe the nature of the coastline in the area between Port Douglas and the Port of Mossman.
- Study Figure 3.20a and complete the following tasks:
 - What type of photograph is featured?
 - In what direction was the camera facing when the photograph was taken?
 - Construct an annotated photo sketch of Port Douglas.
- What evidence is there that the Daintree River has changed its course?
- Working in groups, brainstorm the attractions of the physical environment that make the Daintree area popular with ecotourists.
- Use Table 3.20a to construct a climate graph for Port Douglas. Then complete the following tasks:
 - Which is the hottest month?
 - Which is the coolest month?
 - What is the average annual range of mean daily maximum temperatures?
 - Which is the wettest month?
 - Which is the driest month?
 - Describe the seasonal distribution of rainfall.
 - Construct a column graph showing the annual distribution of raindays.
- Study Figure 3.20a. Construct a photo sketch of the mouth of the Daintree River. Identify and label the coastal depositional landform features evident in the photograph.
- Study Figure 3.20b. In what direction was the camera pointing when the photograph was taken.

Table 3.20a 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

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





Figure 3.21a Aerial photograph of Noosa

ACTIVITIES



- What is the scale of the map extract?
- What is the contour interval used on the map extract?
- Identify the feature of the biophysical environment located at:
 - GR 118808
 - GR 072798
 - GR 104816
 - GR 115804.
- Identify the feature of the constructed environment located at:
 - GR 079819
 - GR 041804
 - GR 088783
 - GR 053836.
- What river flows into Lake Cooroibah in AR 0386?
- What type of vegetation is found in AR 0187?
- What type of land use is found in GR 056787?
- Name the recreational land use found in AR 0180.
- What is the direction of Lake Weyba from Noosa Head (GR 118821)?
- In which direction is the Noosa River flowing in AR 0387?
- Identify the feature of the biophysical environment located 6.5 km to the north-west of Keuser Island (AR 0779).
- What is the bearing of Noosa Hill (GR 104816) from the drive-in theatre (GR 049789)?
- What is the straight-line distance between Noosa Hill and Seawah Hill (GR 066958)?
- What is the area of Lake Weyba?
- Estimate the density of buildings in AR 0479.
- Estimate the height of the landform feature at GR 065955.
- Estimate the local relief in AR 0695.
- Construct the vegetation transect from GR 000880 to GR 062880.
- What indications are there that much of the land around Noosa Heads is low lying?
- Study the map extract and the aerial photographs of Noosa Heads in 1971 and 2015 (Figures 3.21b and 3.21c). Write a report describing the effects of human activity on the estuary of the Noosa River.
- Working in groups, compile a list of the benefits of the type of human intervention described in Activity 20. 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.
- Describe the nature of the coastal environment between Peregrin Beach (AR 0971) and Teewah (AR 0693).
- Study Figure 3.21a. In what direction was the camera facing when the photograph was taken?
- Study Figures 3.21b and 3.21c. Write a paragraph outlining the changes that have taken place between 1971 and 2015.

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 Cooroibah. 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 the 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



- Working in groups, use the map extract and aerial photographs to evaluate the site's suitability for the proposed development.
- 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.
- 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.
- Determine which point of view you agree with. Write an exposition outlining the arguments you would use to justify your position.
- 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.
- As a class, role-play one of the methods or strategies identified in Activity 5.

Noosa Heads topographic map extract (latitude 26°23'S, longitude 153°06'E)

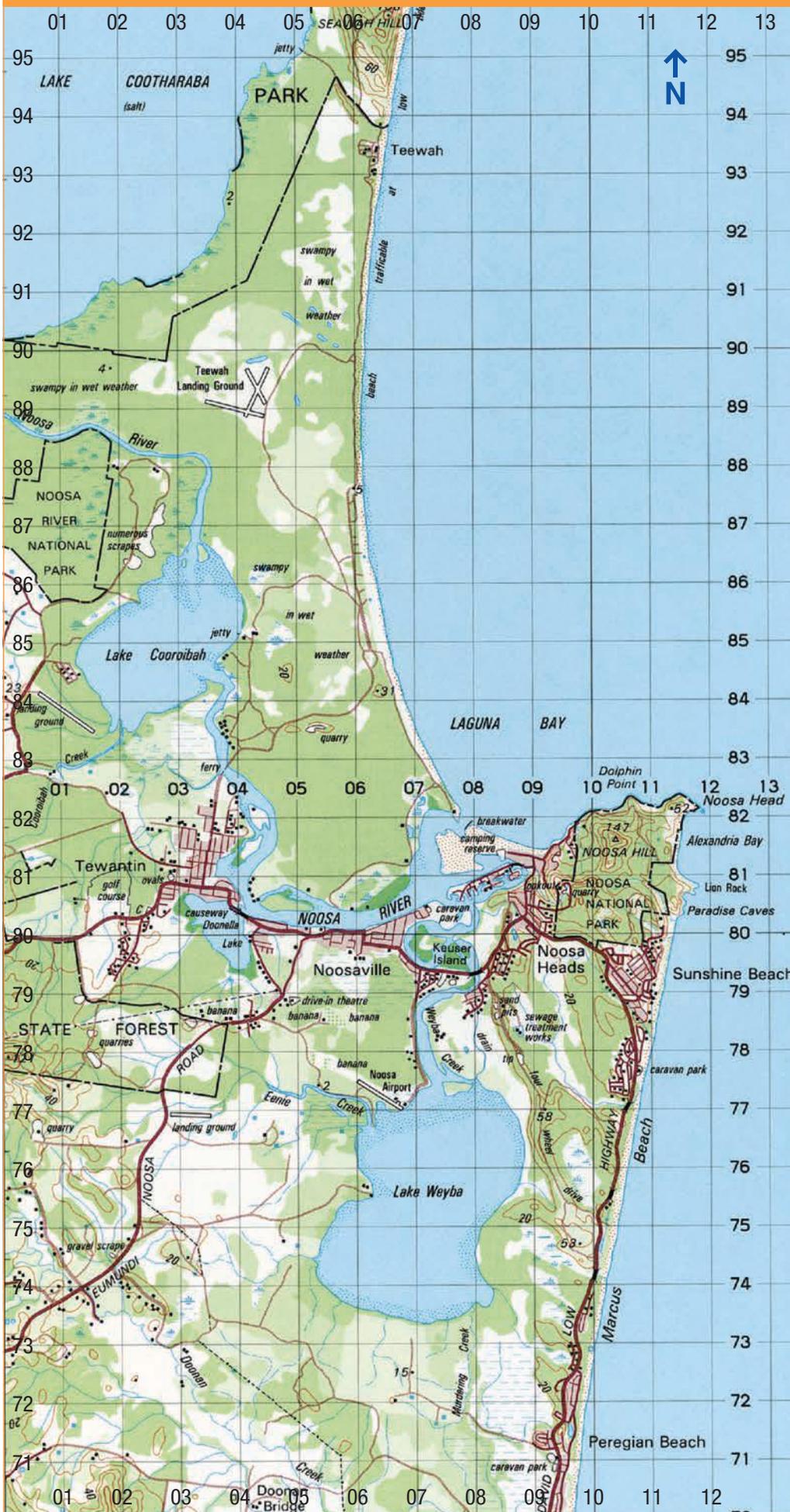


Figure 3.21b Aerial photograph of Noosa Heads, 1971

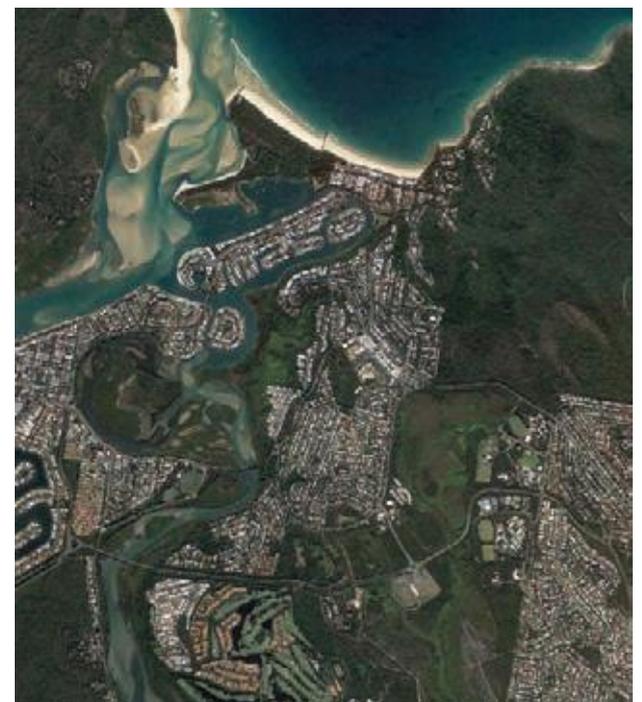


Figure 3.21c Aerial photograph of Noosa Heads, 2015, Google Earth, Image © 2016 Terrametrics, © 2016 Google, Data SIO, NOAA, US Navy, NGA, GEBCO



Built up area; Divided highway; Metropolitan route marker	High voltage transmission line	Mangrove swamp; Area subject to inundation
Recreation reserve with oval; Drive in theatre; Underpass	Fence; Prominent telephone line	Swamp; Swamp definite boundary
Sealed road two or more lanes; National route marker	Mine; Windmill; Church; Building; Yard	Perennial lake; Watercourse
Sealed road one lane; Embankment	Horizontal control point; Spot elevation	Intermittent lake; Watercourse
Unsealed road two or more lanes	Contour with value; Supplementary contour	Mainly dry lake; Watercourse
Unsealed road one lane; Cutting	Depression contour; Sand; Distorted surface	Tank or small dam; Perennial waterhole
Vehicle track; Road bridge; Gate; Stock grid	Levee, bank or sand ridge; Joint or rock fissure	Saline coastal flat; Intertidal flat
Foot track; Foot bridge	High cliff; Escarpment	Navigation light; Intertidal ledge or reef
Multiple track railway; Station	Vegetation: Dense, medium, scattered	Fier; Exposed wreck; Prominent submerged wreck
Single track railway; Light railway	Vegetation distinctive; Distinctive grass	Prominent submerged reef, rock
Railway tunnel, bridge, underpass	Orchard or vineyard; Line of trees or windbreak	Indefinite watercourse, shoreline; Rock bare or awash

Cairns is a major coastal city in Far North Queensland. The town developed into a railhead and major port for exporting sugar cane, gold and other metals, minerals and agricultural products from surrounding coastal areas and the Atherton Tableland region. Today tourism is the city's major industry. It is a gateway to the spectacular Great Barrier Reef.

CHANGE OVER TIME

Topographic maps provide a snapshot of the biophysical, managed and constructed environments of a place at a particular point in time. This topographic map of Cairns was published in 1989. Since then Cairns has experienced rapid urban growth. To view the extent of growth it is often best to compare maps with aerial imagery such as that shown in Figure 3.22a.



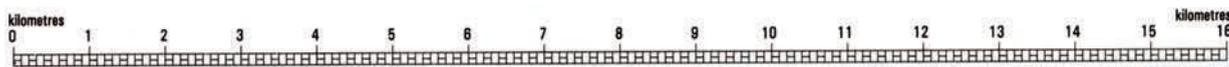
Figure 3.22a Satellite photograph of Cairns, Google Earth, Image © 2016 DigitalGlobe, © 2016 Google, Data SIO, NOAA, US Navy, NGA, GEBCO

ACTIVITIES

- What is the scale of the map extract?
- What is the contour interval used on the map extract?
- Identify the feature of the biophysical environment located at:
 - GR 553383
 - GR 599503
 - GR 608448
 - GR 568270.
- Identify the feature of the constructed environment located at:
 - GR 558362
 - GR 690211
 - GR 671226
 - GR 583466.
- Study Figure 3.22a and the map extract, and complete the following tasks:
 - Identify the features numbered 1–8.
 - Describe the site of Cairns.
 - What restricts the expansion of Cairns to the south-east and west?
 - Describe the relationship between vegetation and topography.
 - How do we know that there are crops in various stages of the growth cycle in the agricultural areas surrounding Cairns?
- What river flows into the sea at AR 6834?
- What type of vegetation is found in AR 7222?
- What type of land use is found in AR 6139?
- Name the biophysical feature found in AR 6142.
- What is the direction of Yorkeys Knob (AR 6341) from Palm Cove (AR 5847)?
- In which direction is the Barron River flowing in AR 6134?
- What is the aspect of the slope in AR 6127?
- What is the bearing of Taylor Point (GR 608448) from Yorkeys Point (GR 637418)?
- What is the straight-line distance between Haycock Island (GR 608496) and the summit of Earl Hill (GR 613426)?
- What is the length of the main runway at Cairns Airport (GR 666328)?
- Estimate the distance by road from Cairns Airport (GR 666328) to Palm Cove (GR 583478).
- 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.
- Estimate the area of Admiralty Island.
- What is the height of the landform feature at GR 748281?
- What is the difference in elevation of Earl Hill (GR 613426) and Red Peak (GR 581365)?
- Estimate the local relief in AR 6142.
- Calculate the gradient of the slope between the spot height at GR 748281 and the building at GR 745267.
- What is the type of settlement pattern found in AR 6828?
- What is the gauge of the railway passing through the Barron Gorge?
- Construct a precis map showing the relationship between landform, settlement and transport infrastructure in the area shown in the map extract.
- Study Figure 3.22a and the map extract. Outline the changes that have taken place in the urban environment of Cairns since the map was published in 1989.



SCALE 1:100 000



CONTOUR INTERVAL 20 METRES

Built-up area; Divided highway; Metropolitan route marker . . .		Power transmission line		Watercourse with flood limits; Area subject to inundation	
Recreation reserve with oval; Drive-in theatre; Underpass		Administrative boundary		Swamp; Swamp definite boundary	
Sealed road two or more lanes; National route marker		Mine; Building; Ruin; Church; Windpump; Yard		Perennial lake; Watercourse	
Sealed road one lane; Cutting; Embankment		Fence; Horizontal control point; Spot elevation		Intermittent lake; Watercourse	
Unsealed road two or more lanes; Culvert; Causeway		Contour with value; Supplementary contour		Mainly dry lake; Watercourse	
Unsealed road one lane; Approximate position (AP)		Depression contour; Sand; Distorted surface		Tank or small dam; Waterhole	
Vehicle track; Road bridge; Gate; Stock grid		Levee; Sand ridge		Saline coastal flat; Intertidal flat; Rock bare or awash	
Foot track; Foot bridge		High cliff; Escarpment		Navigation light; Intertidal ledge or reef	
Multiple track railway; Siding; Station		Vegetation; Dense, medium, scattered		Exposed wreck; Submerged wreck	
Single track railway; Light railway		Rain forest; Pine		Submerged reef; Submerged rock	
Railway tunnel, bridge, underpass		Orchard or vineyard; Line of trees or windbreak		Indefinite watercourse; Shoreline; Mangrove swamp	

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





Figure 3.23a Kata Tjuta (the Olgas)



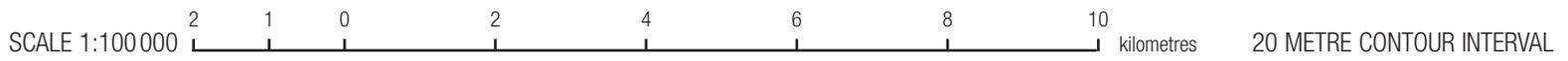
Figure 3.23b Uluru



Figure 3.23c Kata Tjuta (the Olgas) from above, Google Earth, Image © 2016 CNES / Astrium, © 2016 Google



Figure 3.23d Uluru from above, Google Earth, © 2016 Google, Image © 2016 DigitalGlobe



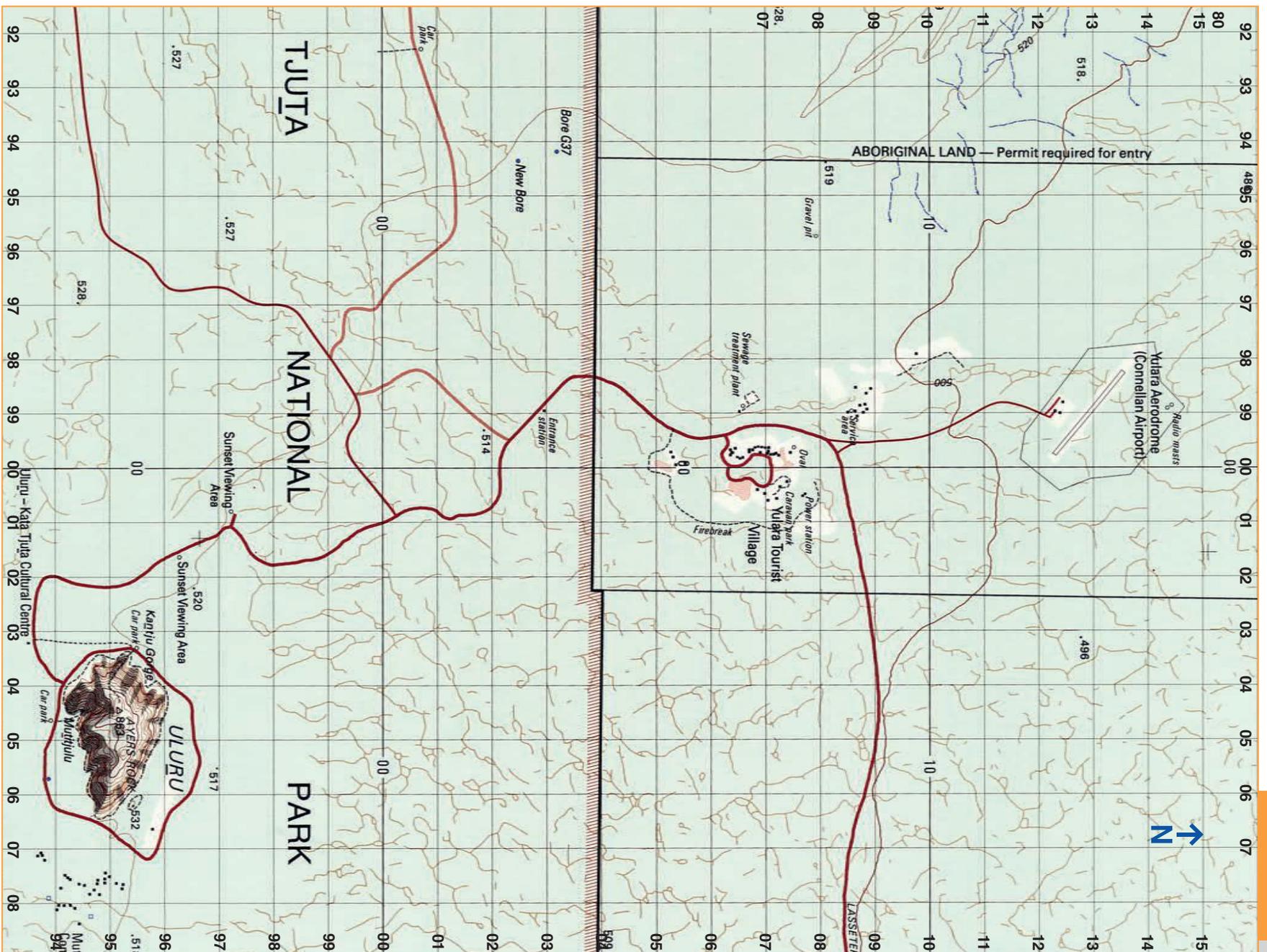
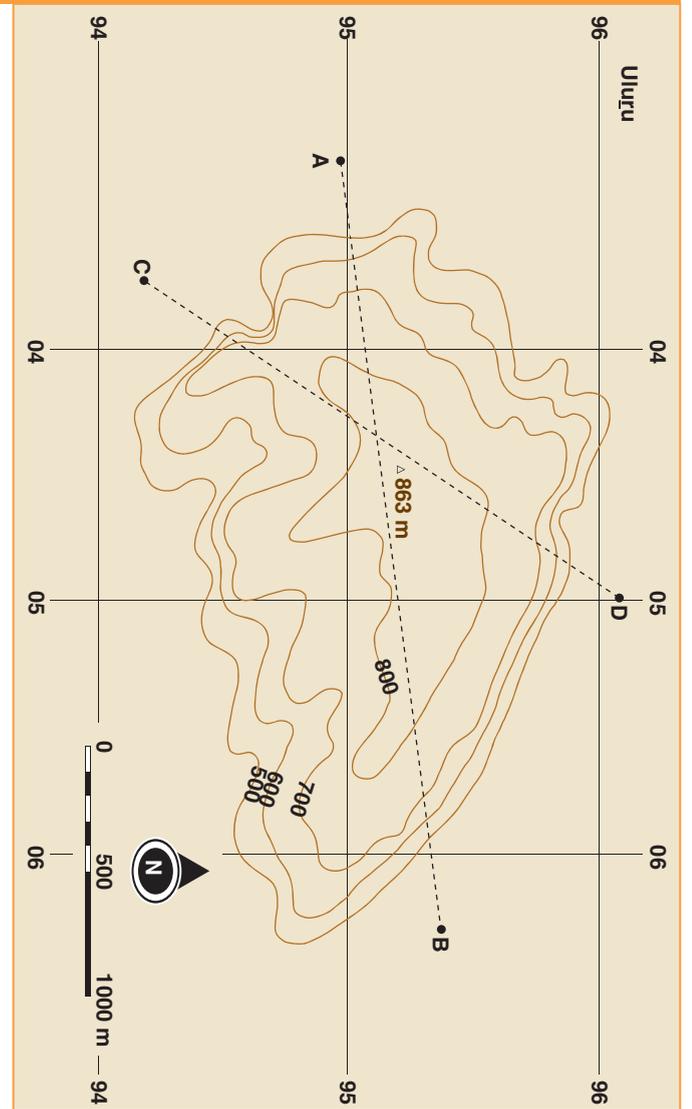
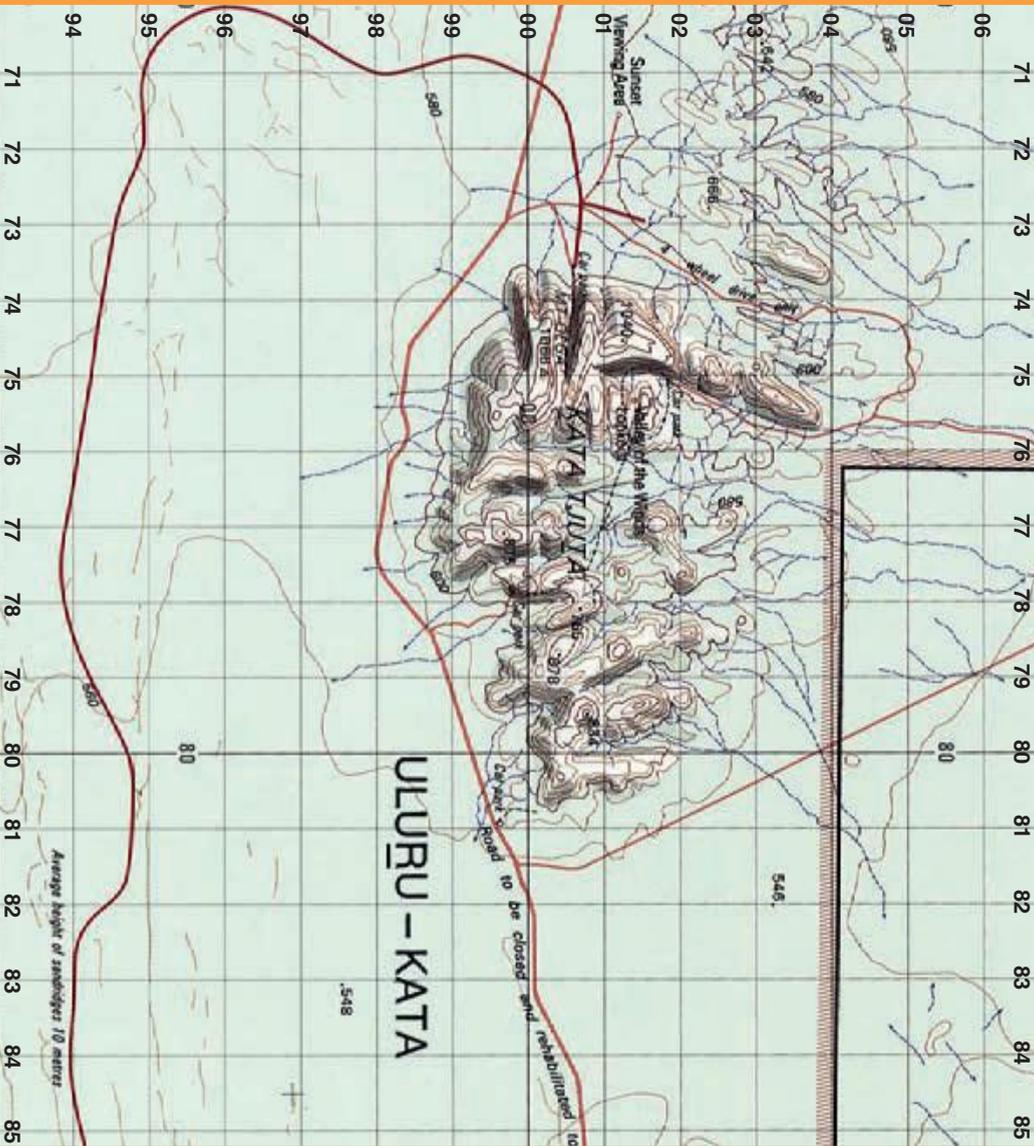
Road two or more lanes: sealed, unsealed; national route marker		Bore or well; tank or small dam		Contour with value; depression contour	
Minor road: sealed, unsealed		Spring; soak or rockhole; waterhole		Sandridge	
Vehicle track; walking track		Mine; windpump; yard		Vegetation: medium, scattered	
Boundaries: National Park; others		Building/s; ruin		Lake: intermittent; mainly dry	
Fence; Built-up area		Trig station; spot height		Stream: intermittent; mainly dry	

Since the Uluru topographic map extract was produced the Yulara Tourist Village has been renamed Ayers Rock Resort and the Yulara Aerodrome has been renamed Ayers Rock Airport.

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 Uluru (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 Uluru (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 Uluru (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 Uluru.
- 17 Estimate the density of buildings in AR 0794.
- 18 What is the height of Uluru?
- 19 What is the height of Mount Olga (GR 750002)?
- 20 What is the difference in elevation of Uluru 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 Uluru 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 Tjuta.
- 26 Study Figures 3.23a and 3.23b. Construct a photo sketch of at least one of these photographs.
- 27 Undertake internet research to investigate the geological history of Uluru and Kata Tjuta.
- 28 Study Figures 3.23c and 3.23d. What do these aerial photographs tell us about the structure of Kata Tjuta and Uluru?





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

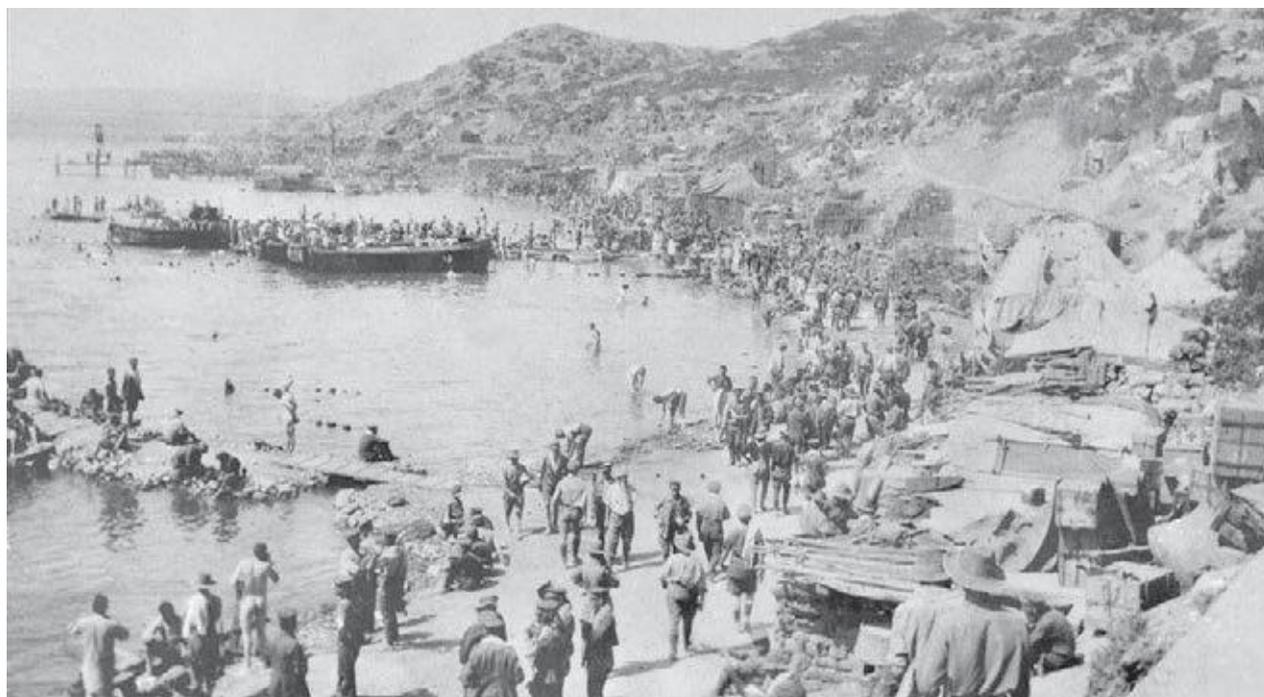


Figure 3.24a Anzac Cove viewed from Hell Spit, 1915. Ari Burnu can be seen in the background. Watson's Pier is towards the top of the photograph.

ordered by their superiors to dig in and wait for further orders. 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 3.24j, page 127). 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 a national identity and was the birth of the Anzac tradition.



Figure 3.24b Anzac Cove, 1915. This is a hand-coloured photograph.



Figure 3.24c Anzac Cove, 2016. Ari Burnu can be seen in the background.



Figure 3.24d 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 3.24e North Beach viewed from Ari Burnu, 2000

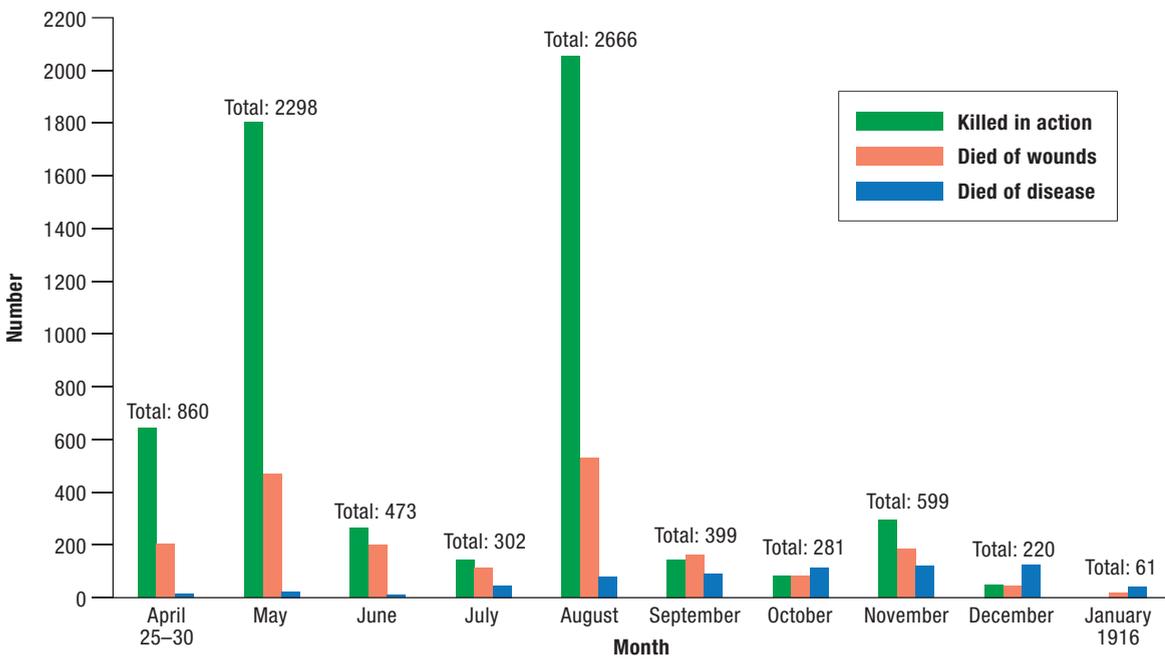


Figure 3.24f Australians killed at Gallipoli, 25 April 1915 to 8 January 1916

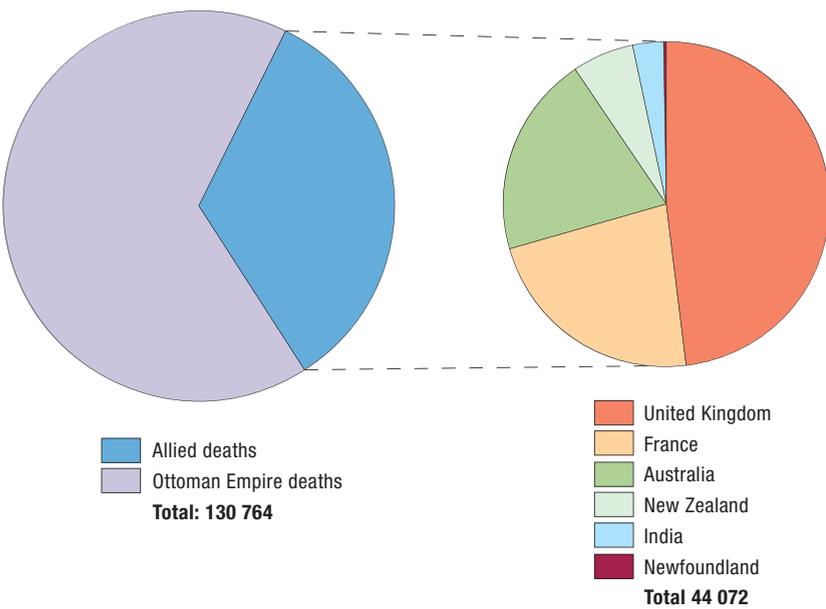


Figure 3.24g Gallipoli casualties

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, lies North Beach. Further north lies 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' (Yuksektepe). This is a weathered pinnacle from which the ground falls steeply away into deep, narrow gullies.

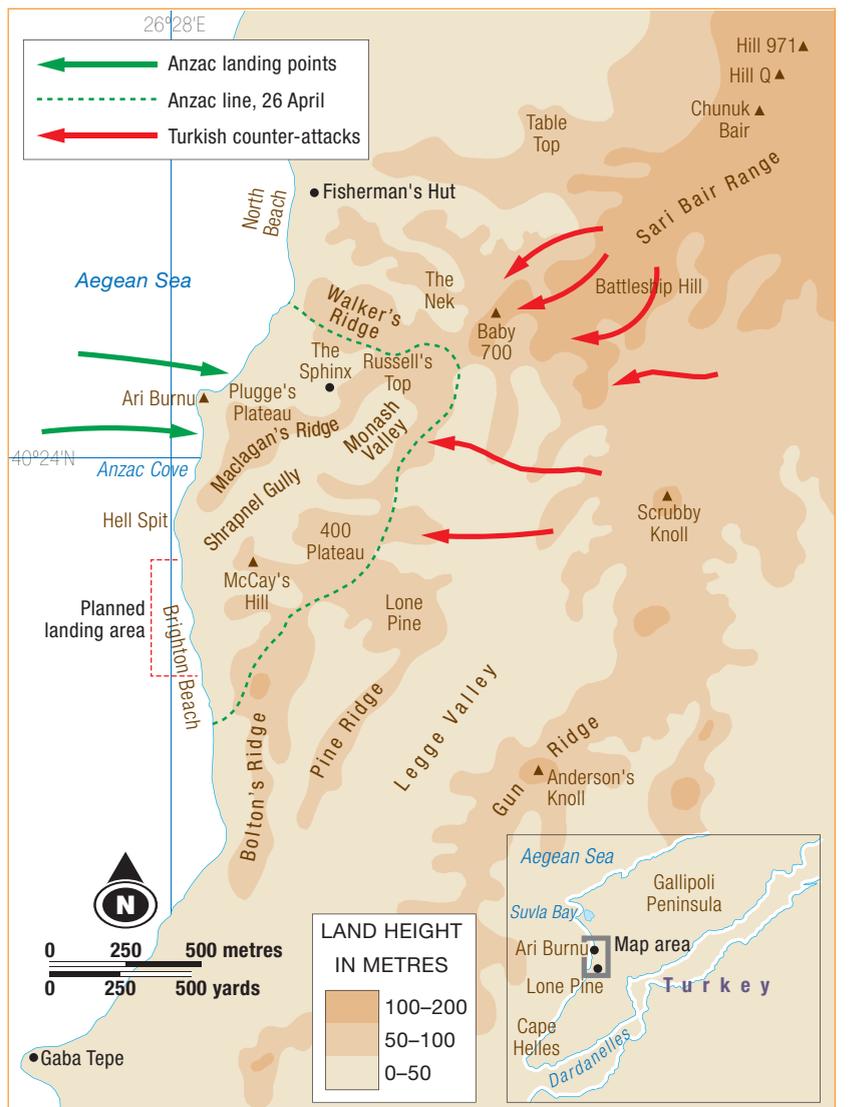


Figure 3.24h Territory occupied by Anzac troops on 25-26 April 1915

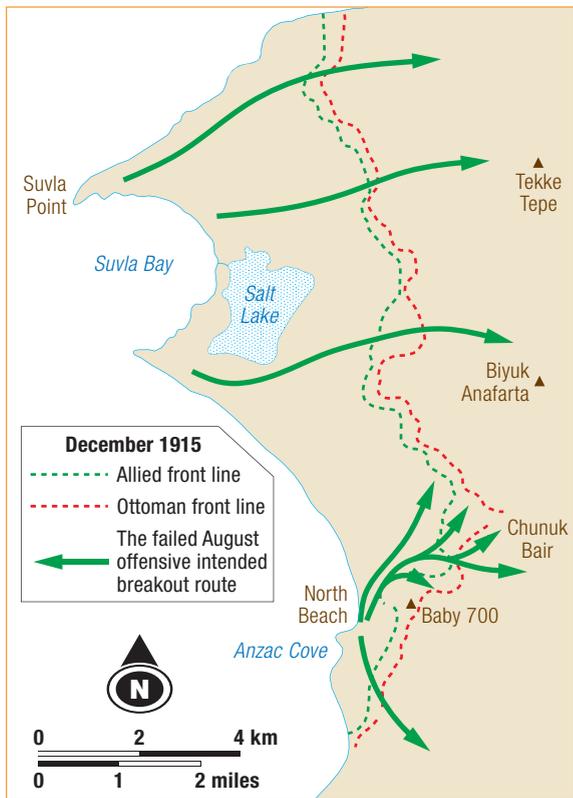


Figure 3.24j The front line at Gallipoli, August–December 1915



Figure 3.24k Turkish map of the Anzac encampment at Gallipoli, 1916

TURKISH MAP OF ANZAC ENCAMPMENT, 2016

The map shown in Figure 3.24k was drawn for the Turkish Mapping Directorate after the evacuation of the Allies from Gallipoli in December 1915 and January 1916. Place names were printed in Ottoman Turkish, with English translations added later.

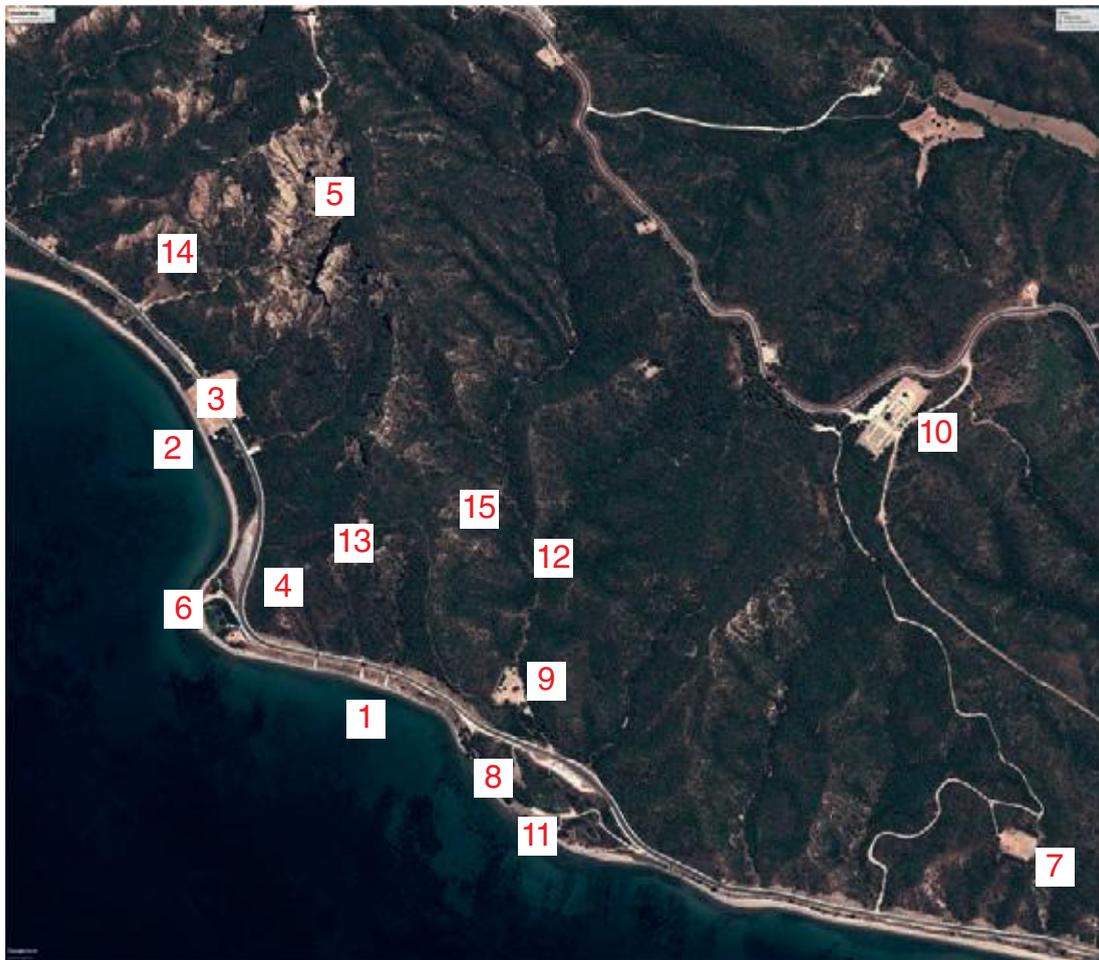
Above Ari Burnu you can see the piers built on North Beach. At the end of the first pier (called Williams Pier by the Anzacs) the ship called *The Milo* can

be seen. 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.



Figure 3.24l Oblique aerial photograph of Ari Burnu Cemetery with Anzac Cove in the background



- 1 Anzac Cove
- 2 North Beach
- 3 Anzac memorial and dawn service site
- 4 Ari Burnu
- 5 The Sphinx
- 6 Ari Burnu Cemetery
- 7 Shell Green Cemetery
- 8 Beach Cemetery
- 9 Shrapnel Gully Cemetery
- 10 Lone Pine memorial
- 11 Hell Spit
- 12 Shrapnel Gully
- 13 Plugge's Plateau
- 14 Walker's Ridge
- 15 Maclagan's Ridge

Figure 3.24m Satellite photograph of Gallipoli, Google Earth © 2016

ACTIVITIES



- 1 Read the text 'The Gallipoli campaign' (page 124) and study Figures 3.24h and 3.24i (pages 125 and 126) and then complete the following tasks:
 - a Locate the following landform features on Figure 3.24j. 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 3.24h:
 - i Fisherman's Hut
 - ii Biyuk Anafarta.
- 2 Study the photographs of Anzac Cove (Figures 3.24a to 3.24c, page 124) 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 3.24a and 3.24b.
- 3 Study Figure 3.24i (page 126) 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 3.24d and 3.24e (page 125) 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.
- 5 Study Figures 3.24f and 3.24g (page 125) 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 in a?
 - 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 3.24h (page 125) 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 Figure 3.24i (page 126) 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.
- 8 Study Figure 3.24m and then complete the following tasks:
 - a Write a paragraph describing the landscape of Anzac Cove and the surrounding area.
 - b Based on your observations, explain why North Beach, rather than Anzac Cove, was selected for the annual Anzac Dawn Service.
- 9 Study Figure 3.24m. Locate the following locations, each of which holds an important place in the history of the Gallipoli Campaign. Try locating them on Figure 3.24j (page 127).
 - a Plugge's Plateau
 - b The Sphinx
 - c Walker's Ridge
 - d Ari Burnu
 - e Shrapnel Gully
 - f Maclagan's Ridge.

SECTION 4 New Zealand

New Zealand

4.1

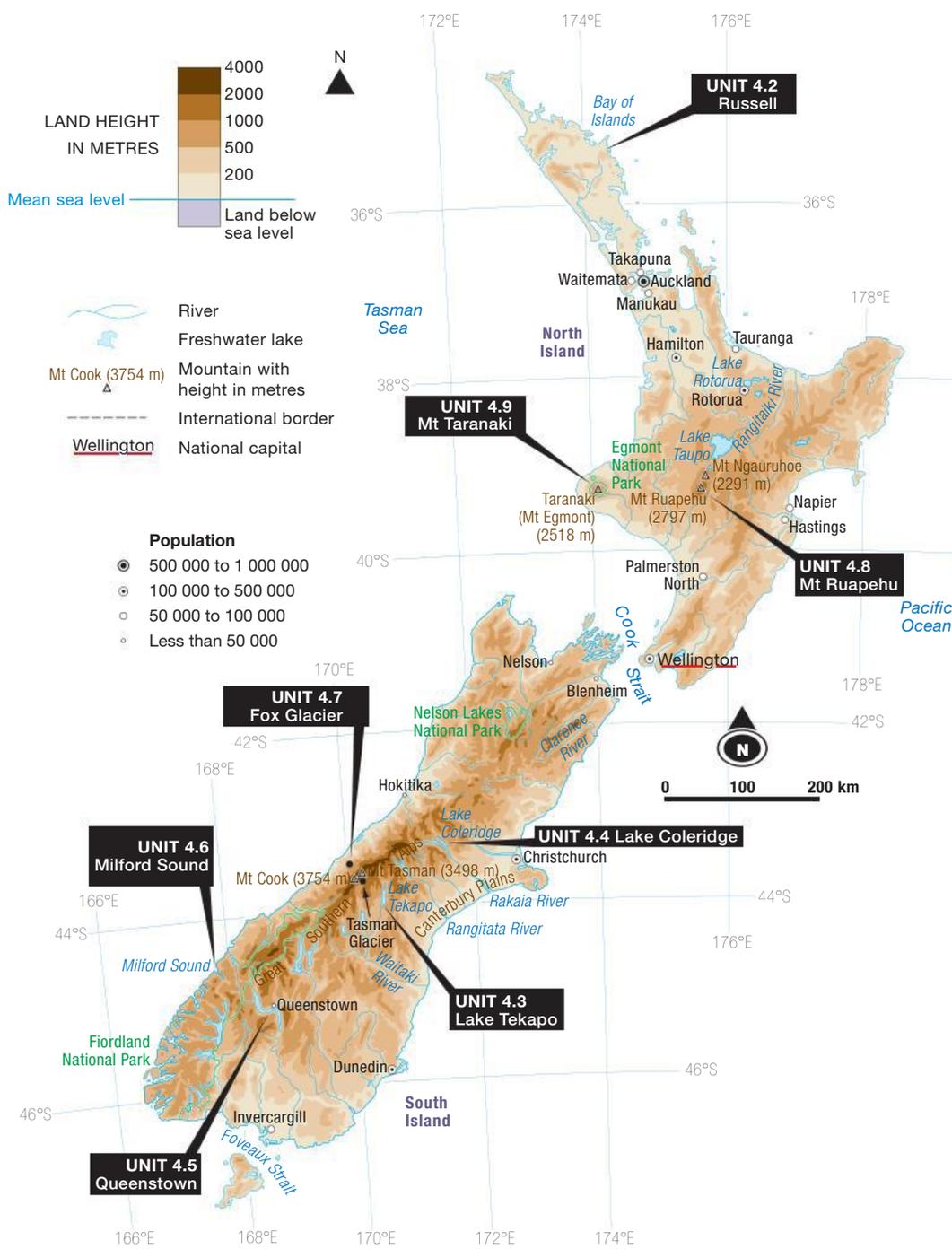


Figure 4.1b Russell, North Island, New Zealand



Figure 4.1c Lake Coleridge



Figure 4.1d Lake Tekapo

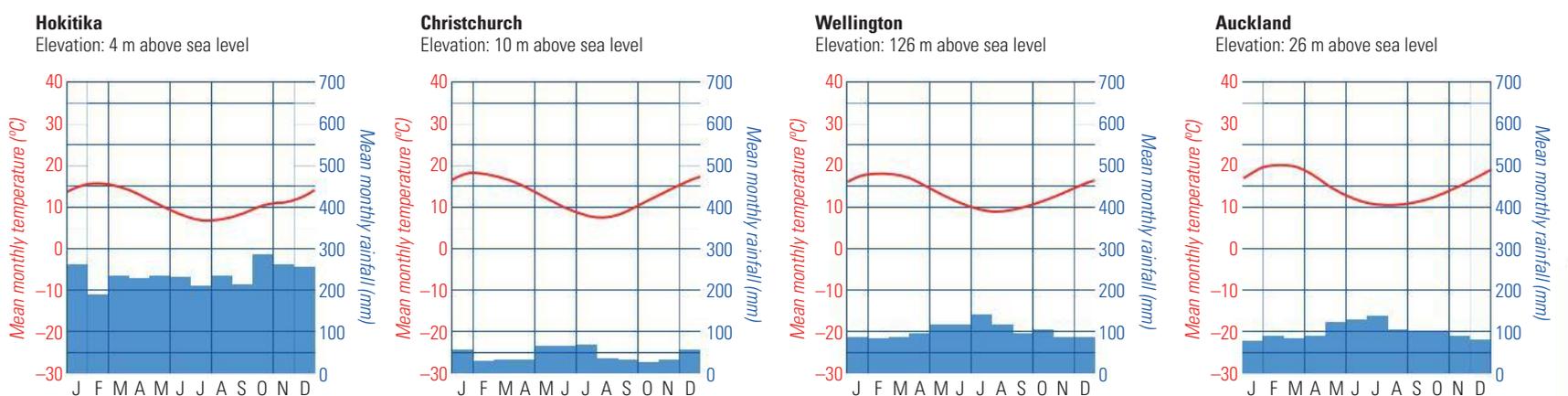


Figure 4.1a New Zealand: physical features and climate graphs

Climate

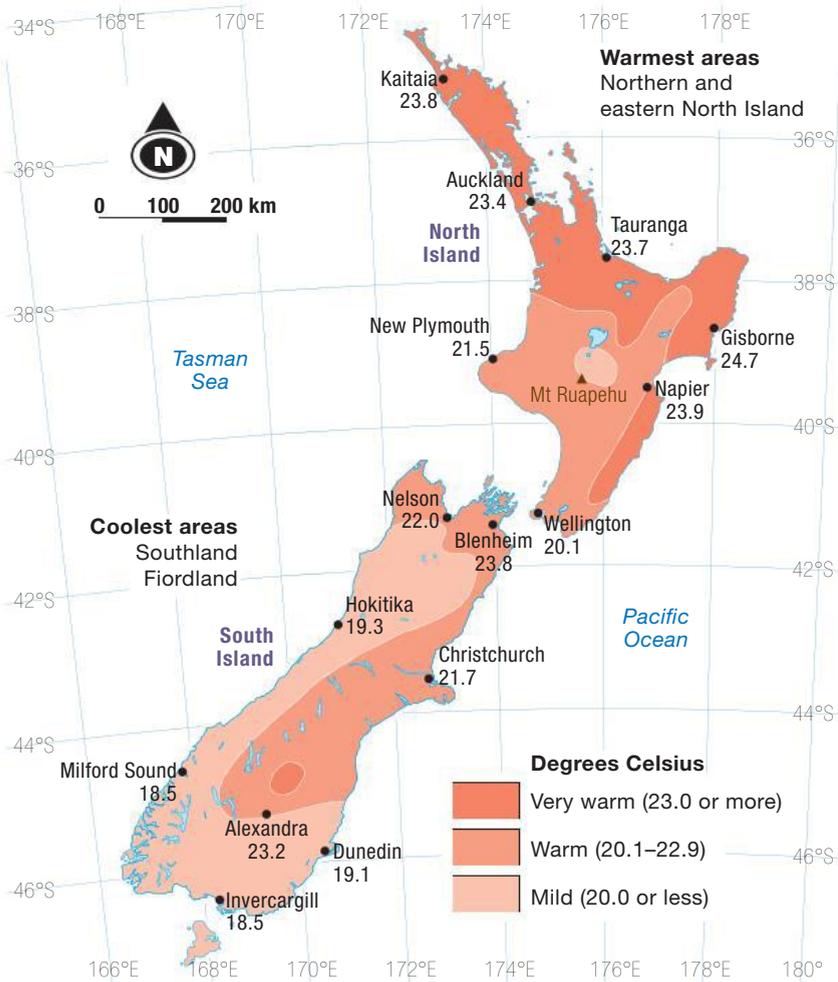


Figure 4.1e Maximum temperature (midsummer daily average)

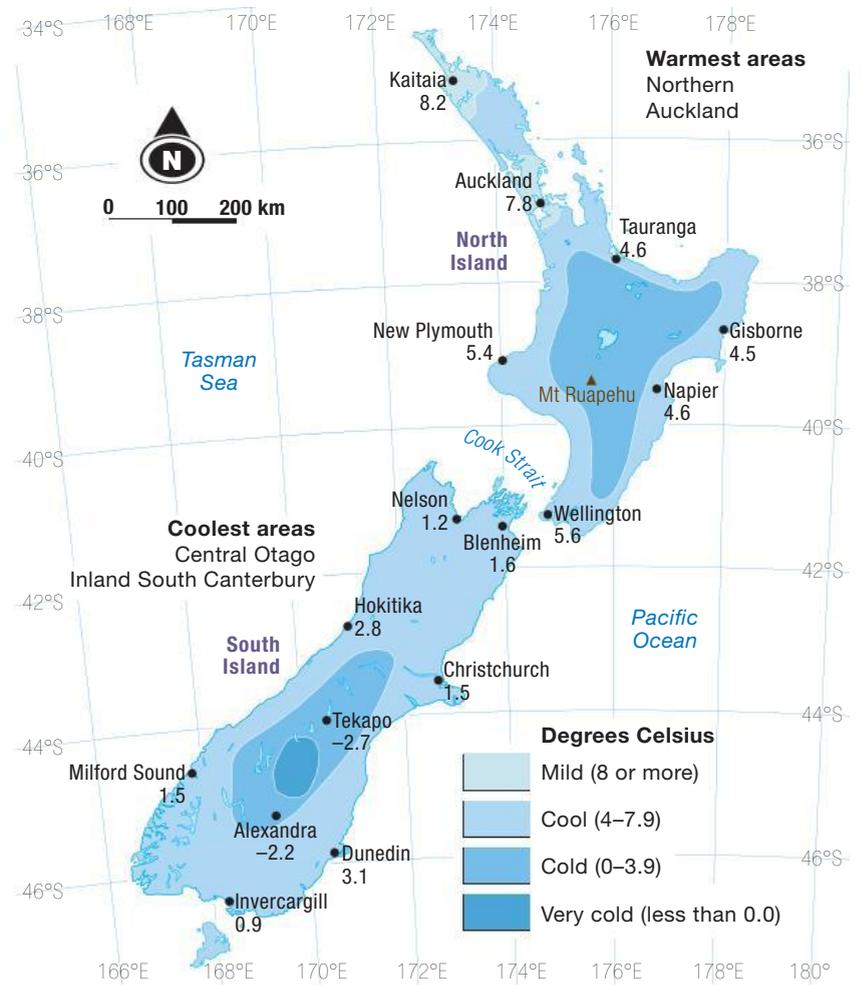


Figure 4.1f Minimum temperature (midwinter daily average)

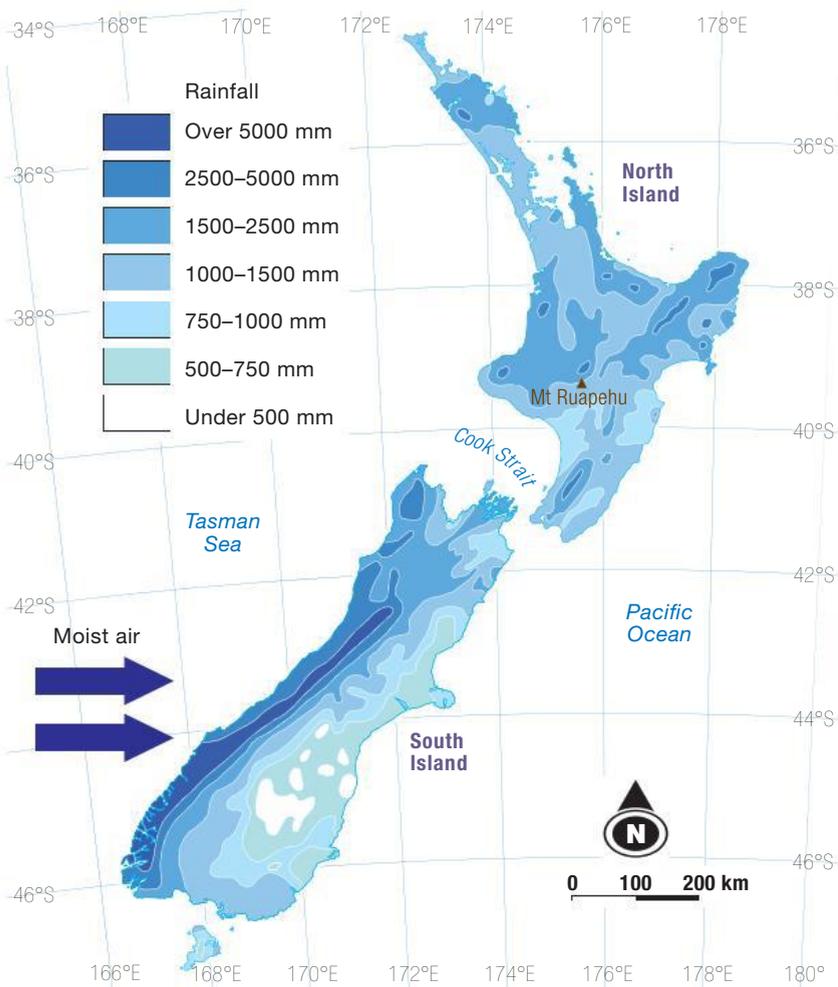


Figure 4.1g Annual average rainfall

ACTIVITIES

- Study an atlas map of New Zealand and then complete the following tasks:
 - What is the capital city of New Zealand?
 - What is New Zealand's largest city?
 - List the New Zealand cities with a population greater than 100 000.
 - What strait separates the North Island from the South Island?
 - Name the highest peak on the South Island.
 - Name the highest peak on the North Island.
 - What mountain range runs the length of the South Island?
 - Name the feature of the physical environment located at the following latitudes and longitudes:
 - 39°18'S, 174°05'E
 - 43°28'S, 170°10'E
 - 43°33'S, 170°10'E
 - 44°41'S, 167°55'E
 - 46°30'S, 168°00'E
 - 39°18'S, 175°34'E.
 - Name the urban centre located at each of the following latitudes and longitudes:
 - 38°09'S, 176°15'E
 - 46°25'S, 168°21'E
 - 45°02'S, 168°40'E
 - 45°53'S, 170°31'E
 - 36°52'S, 174°45'E
 - 41°17'S, 174°47'E.
 - What is the straight-line distance between:
 - Auckland and Wellington
 - Dunedin and Auckland?
- What is the direction of:
 - Wellington from Christchurch
 - Queenstown from Christchurch
 - Nelson from Wellington
 - Rotorua from Auckland?
- Study the climate graphs in Figure 4.1a (page 129) and then answer the following questions.
 - Which station has:
 - the highest mean monthly temperature
 - the lowest mean monthly temperature
 - the highest annual rainfall
 - the lowest annual rainfall?
 - What is the annual temperature range of the following:
 - Auckland
 - Christchurch
 - Wellington
 - Hokitika?
- Study Figures 4.1e to 4.1g and then complete the following tasks.
 - What parts of New Zealand have midsummer daily average temperatures of more than 23.0°C (very warm)?
 - What parts of New Zealand have midwinter daily average temperatures below 0°C (very cold)?
 - Explain the pattern of average temperature on New Zealand's South Island.
- Compare Figure 4.1a (page 129) and the map showing the annual distribution of rainfall (Figure 4.1g). Explain the annual distribution of rainfall.





SCALE 1:50 000

THE VERTICAL INTERVAL BETWEEN THE CONTOURS IS 20 METRES



Russell, the settlement after which this map has been named, was the first permanent European settlement and seaport in New Zealand. Nearby are the towns of Paihia and Waitangi. All are located in New Zealand's scenic Bay of Islands.

Waitangi is best known for being the location where the Treaty of Waitangi was first signed on 6 February 1840. It is also the place where the Declaration of Independence of New Zealand was signed five years prior, on 28 October 1835.

ACTIVITIES

- | | | |
|---|---|---|
| <p>1 What is the scale of the map extract?</p> <p>2 What is the contour interval used on the map extract?</p> <p>3 Identify the feature of the biophysical environment located at:
a GR 016997
b GR 002949
c GR 993973
d GR 054004.</p> <p>4 Identify the feature of the constructed environment located at:
a GR 983973
b GR 985969
c GR 069998.</p> | <p>5 What is the area reference of Russell township?</p> <p>6 What type of economic activity is found in AR 0394?</p> <p>7 Name the type of vegetation found in AR 9796.</p> <p>8 What is the direction of Tikitikioure (AR 0594) from Russell (AR 0297)?</p> <p>9 What is the bearing of Tikitikioure (AR 0594) from Oturori Rock (GR 042987)?</p> <p>10 What is the bearing of Captain Cook's Anchorage (AR 0699) from Hermione Rock (AR 9997)?</p> | <p>11 What is the straight-line distance between Tapeka Point (GR 021996) and Captain Cook's Anchorage (GR 069998)?</p> <p>12 What is the length of the ferry run between Paihia (GR 993953) and Russell (GR 020974)?</p> <p>13 What is the area of Motuarohia Island?</p> <p>14 What is the density of buildings in AR 9794?</p> <p>15 What is the difference in elevation of Tikitikioure (AR 0594) and Malki Hill (AR 0297)?</p> |
|---|---|---|



4.3 Lake Tekapo topographic map extract



ACTIVITIES

- What is the scale of the Lake Tekapo topographic map extract?
- What is the contour interval used on the Lake Tekapo topographic map extract?
- Identify the feature of the biophysical environment located at the following grid references:
 - GR 045309
 - GR 970320
 - GR 013319
 - GR 965275.
- Identify the feature of the constructed environment located at the following grid references:
 - GR 979235
 - GR 967266
 - GR 973288
 - GR 026277.
- Identify the productive activity taking place in AR 9623.
- State the type of vegetation found at GR 000240.
- Estimate the area of the following features:
 - Lake McGregor
 - Motuariki Island.
- What is the density of buildings in AR 9626?
- What is the straight-line distance between the summit of Mt John (AR 9626) and the summit of Mt Hay (AR 0430)?
- What is the water surface height, or elevation, of:
 - Lake Tekapo
 - Roys Lagoon?
- What is the difference in elevation of Mt Hay (AR 0430) and Wee McGregor (AR 0631)?
- What is the local relief experienced in a traverse from the summit of Mt Hay (AR 0430) to the summit of Wee McGregor (AR 0631)?
- What is the aspect of the slope in AR 0423?
- What is the bearing of Mt John (AR 9626) from Mt Hay (AR 0430)?
- Construct a cross-section from the summit of Mt Hay (AR 0430) to the summit of Wee McGregor (AR 0631) using a vertical scale of 1 cm = 100 m.
- Calculate the vertical exaggeration of the cross-section drawn in Activity 15.
- Calculate the gradient of the slope between the spot height in AR 0523 and GR 045240.





ACTIVITIES

- 1 Identify the feature of the biophysical environment located at:
 - a GR 870993
 - b GR 839030
 - c GR 850065.
- 2 Identify the feature of the constructed environment located at:
 - a GR 772012
 - b GR 823001
 - c GR 855998.
- 3 What is the grid reference of Lake Coleridge power station?
- 4 Name the type of vegetation found at GR 825038.
- 5 What waterway flows into Lake Coleridge at GR 815047?
- 6 What is the direction of Round Hill (AR 8207) from Peak Hill (AR 7702)?
- 7 In what direction is Ryton River flowing in AR 8107?
- 8 What is the bearing of Round Hill (AR 8207) from Laings Hill (GR 850065)?
- 9 What is the aspect of the slope in AR 8606?
- 10 Estimate the straight-line distance between the summit of Peak Hill (AR 7702) and the summit of Mt Barker (GR 870993).
- 11 What is the length of the Lake Coleridge power station hydro-electricity tunnels and pipelines?
- 12 What is the density of buildings in AR 8599?
- 13 What is the elevation of Lake Coleridge?
- 14 Estimate the height of the following landform features:
 - a GR 862014
 - b GR 829027.
- 15 What is the difference in elevation of Peak Hill (AR 7702) and Mt Barker (GR 870993)?
- 16 Estimate the local relief experienced on a traverse from the summit of Carriage Drive (AR 8007) to the summit of Round Hill (AR 8207).
- 17 Construct the cross-section from point 1 to point 2 using a vertical scale of 1 cm = 200 m.
- 18 Calculate the vertical exaggeration used for the cross-section drawn in Activity 17.
- 19 What is the gradient of the slope between the summit of Peak Hill (AR 7702) and the water's edge at GR 785037?



Queenstown is a resort town in the south-west of New Zealand's South Island. It is built around an inlet called Queenstown Bay on Lake Wakatipu, a waterway formed by glacial processes.

The town is especially popular with winter sports enthusiasts. Some of New Zealand's most popular ski resorts are nearby.



Figure 4.5a Photograph of Queenstown

ACTIVITIES

- 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 GR 545069
 - b GR 645089
 - c GR 603097
 - d GR 637077.
- 4 Identify the feature of the constructed environment located at the following grid references:
 - a GR 573049
 - b GR 594031
 - c GR 638051
 - d GR 644058.
- 5 What type of vegetation is found in AR 5705?
- 6 Name the two rivers that merge in AR 6606.
- 7 What creek flows into the lake at GR 537013?
- 8 In what direction is the Shotover River flowing in AR 6209?
- 9 What is the direction of Ferry Hill (AR 6408) from central Queenstown?
- 10 What is the aspect of the slope in AR 6005?
- 11 What is the bearing of Ferry Hill (GR 645089) from Peninsula Hill (GR 632036)?
- 12 What is the bearing of Queenstown Hill (GR 605071) from Peninsula Hill (GR 632036)?
- 13 What is the straight-line distance between the summit of Queenstown Hill (GR 605071) and Peninsula Hill (AR 632036)?
- 14 What is the length of the Skyline Gondola (AR 5704)?
- 15 Estimate the area of Lake Johnson.
- 16 What is the elevation of Lake Wakatipu?
- 17 Construct the cross-section from the summit of Queenstown Hill (GR 605071) to the summit of Peninsula Hill (GR 632036) using a vertical scale of 1:200 m.
- 18 Calculate the vertical exaggeration of the cross-section from Queenstown Hill (GR 605071) to the summit of Peninsula Hill (GR 632036).
- 19 What is the gradient of the slope between the summit of Queenstown Hill (GR 605071) and the shoreline of Lake Wakatipu at GR 615055?
- 20 What is the gradient of the slope between the summit of Peninsula Hill (GR 632036) and the bridge at GR 638050?
- 21 Is Arthurs Point (GR 588088) visible from the summit of Peninsula Hill (AR 6303)? Justify your answer.
- 22 Study Figure 4.5a. In what direction was the camera facing when the photograph was taken?
- 23 Study Figure 4.5b. Identify the features numbered 1–6.

<p>RELIEF FEATURES¹</p> <p>Index contour Intermediate contours Perennial snow and ice contours Supplementary contour Depression contours Shallow depression, small depression or shaft Beaconed trig station (with trig identification code) Elevation in metres Cliff, terrace, slip Rock outcrops Stopbank, cutting Embankment or causeway Saddle, cave Alpine features Moraine Moraine wall Scree</p> <p>WATER FEATURES</p> <p>Coastal rocks Shoal or reef Sand and mud Sand Shingle Swamp Boat ramp Breakwater, wharf, jetty Slipway Marine farm, seawall Dam, floodgate, weir Waterfall, rapids Cold spring, hot spring Fumarole, geothermal bore Watercourse, drain Canal: large, small Stream disappearing into ground</p> <p>VEGETATION FEATURES</p> <p>Native forest Exotic coniferous forest Exotic non-coniferous forest Scrub Scattered scrub Shelter belt Trees Orchard or vineyard or plantation Mangroves</p>	<p>ROADS AND TRACKS¹</p> <p>State highway Four lanes or more Two lanes (includes passing lanes) Narrow road Vehicle track Foot track Closed track (see warning note below) Paved route, track connector sealed road surface metalled unmetalled Tunnel, tunnel under road Bridge: two lanes, one lane Ford Gate, locked gate, cattlestop Footbridge, cableway, walkway</p> <p>RAILWAYS</p> <p>Double or multiple track Single track Railway station, yard or siding Bridge, tunnel Level crossing Road over railway Railway over road Tramway or bush railway</p> <p>MISCELLANEOUS</p> <p>Residential area Large buildings Isolated building Homestead, stockyard Glasshouse or greenhouse Church, cemetery, grave Training track Golf course, helicopter Historic Māori pā, redoubt, monument, plaque or signpost Reservoir covered, reservoir uncovered, tank Mast, tower, wind machine or wind turbine Shipwreck, lighthouse, beacon Fence (selection only) Pipeline above ground Pipeline underground Clashed water race Power line on pylons (actual positions) Power line on poles (away from roads) Telephone line (away from roads) Industrial cableway Mine: underground, opencast Buried gas pipeline</p>
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Figure 4.5b Aerial photograph of Queenstown







Figure 4.6a Milford Sound



Figure 4.6b Milford Sound settlement and airport



Figure 4.6c Oblique aerial photograph of Milford Sound

Milford Sound is located in New Zealand's Fiordland National Park. The 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. Milford Sound is the most famous (and most frequently visited) of these fiords.

ACTIVITIES



- Construct a photo sketch of Figure 4.6a.
- Undertake research. Investigate the geographical processes responsible for the landscape of New Zealand's Fiordland.
- What is the scale of the map extract?
- What is the contour interval used on the map extract?
- Identify the feature of the biophysical environment located at:
 - GR 977417
 - GR 957456
 - GR 027315
 - GR 997423.
- Identify the feature of the constructed environment located at:
 - GR 008405
 - GR 959396
 - GR 988405
 - GR 957456.
- What is the area reference of Milford Sound Airport?
- Name the type of biophysical feature found in AR 9441.
- Name the type of drainage pattern evident in the north-east quadrant of the map.
- On what waterway is Camp Owen Falls (AR 9439) located?
- What tributary joins the Cleddau River in AR0039?
- What river flows into Milford Sound at GR 975416?
- What is the direction of Sheerdown Peak (AR 9937) from Mt Phillips (AR 9441)?
- In what direction is the Bowen River flowing in AR 9843?
- What is the bearing of Mt Phillips (GR 943413) from Barren Peak (GR 997422)?
- What is the straight-line distance between Barren Peak (GR 997422) and Sheerdown Peak (AR 9937)?
- What is the distance by road from the Homer Tunnel exit to Milford Sound?
- What is the length of the Tubuko Valley Track?
- What is the length of Milford Sound Airport's runway?
- What is the length of the road tunnel in the south-east quadrant of the map?
- What is the aspect of the slope in AR 9531?
- What is the elevation of the historic suspension bridge in AR 0137?
- What is the difference in elevation of Access Peak (AR 9733) and Mt Ada (AR 9434)?
- What is the elevation of the surface of Lake Ada?
- What is the gradient of the slope from the summit of Cascade Peak (AR 9744) to the shoreline of Milford Sound at GR 967445?
- Study Figure 4.6b. In which direction was the camera facing when this photograph was taken?

SCALE 1:50 000

THE VERTICAL INTERVAL BETWEEN THE CONTOURS IS 20 METRES



Milford Sound topographic map extract (Milford Sound: latitude 44°41'S, longitude 167°47'E)





Figure 4.7a Fox Glacier base



Figure 4.7b Fox Glacier upper section

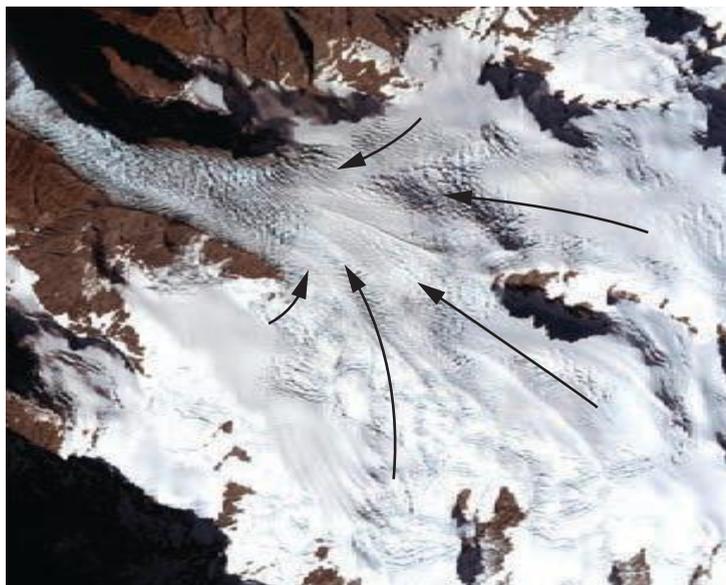
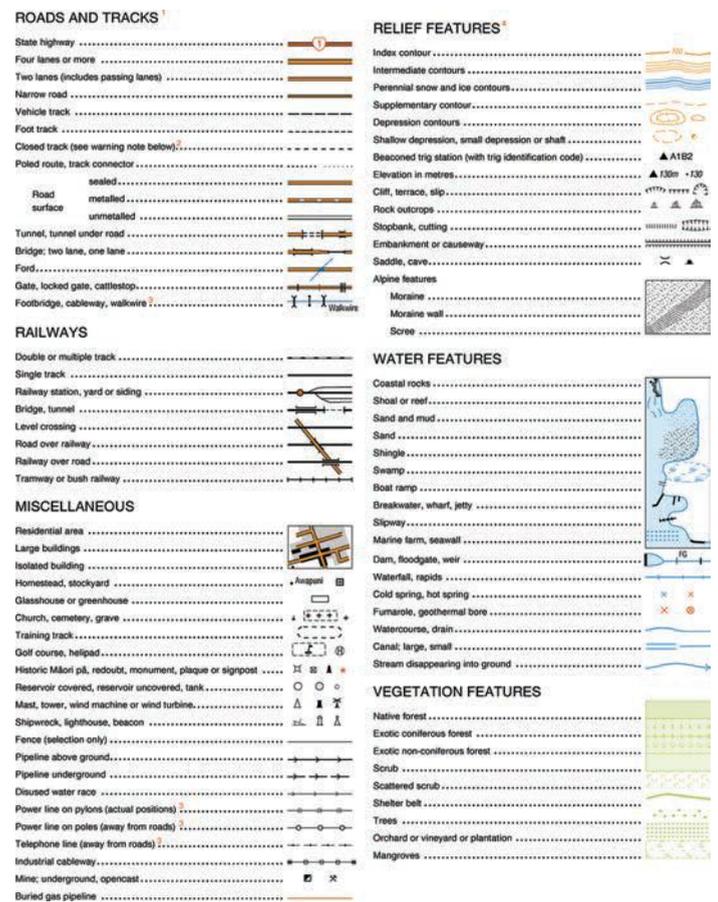


Figure 4.7c Aerial photograph of Fox Glacier

SCALE 1:50 000

THE VERTICAL INTERVAL BETWEEN THE CONTOURS IS 20 METRES



Fox Glacier is a 13-km-long glacier located on the west coast of New Zealand's South Island. The glacier flows down 2600 m on its journey from the Southern Alps. During the last ice age, the glacier reached the present coastline.

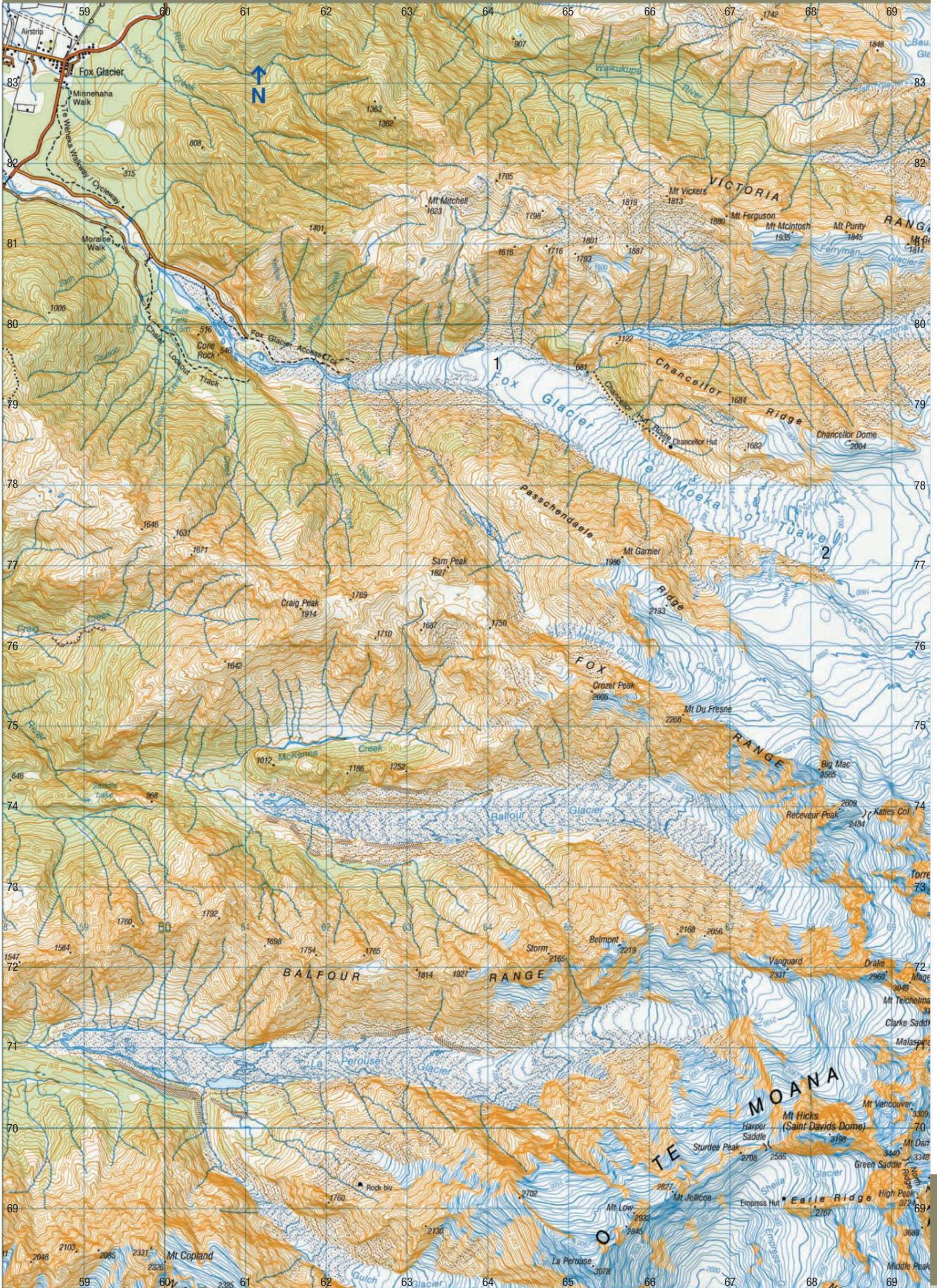
While the Fox Glacier has been retreating for most of the past century, it advanced between 1985 and 2009. In 2006 the average rate of advance was about a metre a week. Since 2009 there has been a significant retreat. Between January 2014 and January 2015 the glacier retreated around 300 m.

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 600799
 - b GR 685785
 - c GR 658758
 - d GR 638797.
- 4 Identify the feature of the constructed environment located at:
 - a GR 676691
 - b GR 598808
 - c GR 663785
 - d GR 594810.
- 5 Identify the landform features in AR 6070.
- 6 Name the two ridges that line each side of Fox Glacier.
- 7 What is the grid reference of the base of the Fox Glacier?
- 8 Name the waterway flowing into the lake in AR 6379.
- 9 What is the general direction of flow of the glaciers shown on the Fox Glacier topographic map extract?
- 10 What is the direction of flow of Boyd Creek in AR 6377?
- 11 What is the direction of Chancellor Dome (AR 6878) from Mt Mitchell (AR 6381)?
- 12 What is the bearing of Mt Mitchell (AR 6381) from Chancellor Dome (AR 6878)?
- 13 What is the aspect of the slope in AR 6178?
- 14 What is the distance by road from the intersection in Fox Glacier (GR 587833) to the beginning of the Fox Glacier Access Track (GR 610798)?
- 15 What is the straight-line distance between the base of Fox Glacier (GR 623793) to GR 685775 via GR 645795?
- 16 What is the average gradient of Fox Glacier from the base of the glacier (GR 623793) to GR 685775 via GR 645795?
- 17 State the area references of the flattest sections of Fox Glacier (i.e. the sections with the gentlest gradient).
- 18 What is the difference in elevation of Chancellor Dome (AR 6878) and Mt Garnier (AR 6577)?
- 19 What is the elevation of Empress Hut (AR 6769)?
- 20 Construct the cross-section from point 1 to point 2 using a vertical scale of 1 cm = 200 m.
- 21 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 20.
- 22 Draw a photo sketch of either Figure 4.7a or 4.7b.



Fox Glacier topographic map extract (Fox Glacier: latitude 43°27'S, longitude 170°1'E)



Mt Ruapehu (often known as simply 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: Taurangi (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 4.8b.)

The North Island's major ski fields and its only glaciers are on the slopes of Mt Ruapehu.

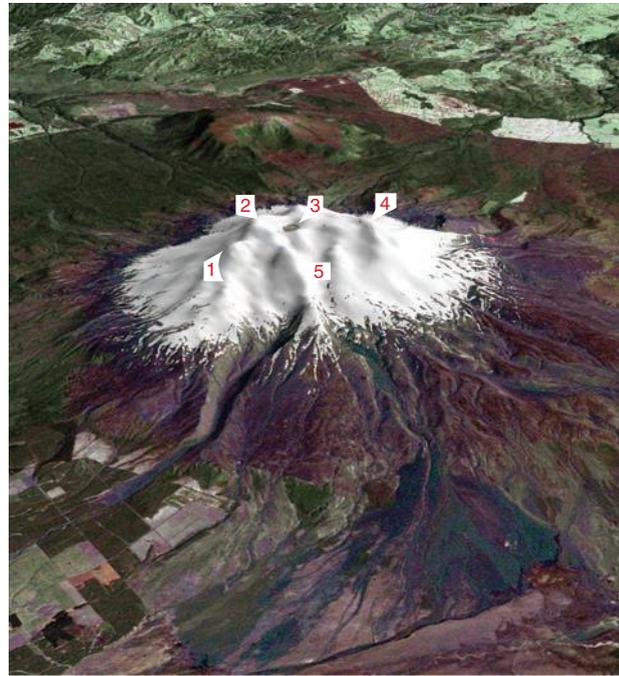


Figure 4.8a Enhanced-colour image of Mt Ruapehu, facing north-west

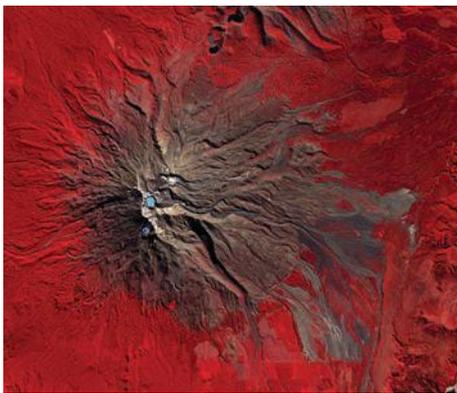


Figure 4.8b False-colour satellite image of Mt Ruapehu. It is one of the most active volcanoes in New Zealand. The last major eruption was in 1995.



Figure 4.8c Ash cloud erupting from Mt Ruapehu

ROADS AND TRACKS ¹	WATER FEATURES
State highway	Waterfall, rigid
Four lanes or more	Cold spring, hot spring
Two lanes (includes passing lanes)	Fumarole, geothermal loop
Narrow road	Watercourse, draft
Vehicle track	Canal, large, small
Foot track	Stream disappearing into ground
Closed track (see warning note below)	
Pointed route, track connector	
Road surface	
sealed	
unsealed	
Tunnel, tunnel under road	
Bridge, two lane, one lane	
Ford	
Gate, locked gate, cattlestop	
Footbridge, catwalkway, walkway	
RAILWAYS	VEGETATION FEATURES
Double or multiple track	Native forest
Single track	Exotic coniferous forest
Railway station, yard or siding	Exotic non-coniferous forest
Bridge, tunnel	Scrub
Level crossing	Scattered scrub
Road over railway	Shelter belt
Railway over road	Trees
Tramway or bush railway	Orchard or vineyard or plantation
	Mangroves
MISCELLANEOUS	
Residential area	
Large buildings	
Isolated building	
Homestead, stockyard	
Glasshouse or greenhouse	
Church, cemetery, grave	
Training track	
Golf course, helipad	
Historic Māori pā, redoubt, monument, plaque or signpost	
Reservoir covered, reservoir uncovered, tank	
Mast, tower, wind machine or wind turbine	
Shipwreck, lighthouse, beacon	
Fence (detection only)	
Pipeline above ground	
Pipeline underground	
Disused water race	
Power line on pylons (actual positions)	
Power line on poles (away from roads)	
Telephone line (away from roads)	
Industrial cableway	
Mine, underground, opencast	
Buried gas pipeline	
RELIEF FEATURES ¹	
Index contour	
Intermediate contour	
Perennial snow and ice contours	
Supplementary contour	
Depression contours	
Shallow depression, small depression or shaft	
Beaconed trig station (with trig identification code)	
Elevation in metres	
Cliff, terrace, slip	
Rock outcrops	
Scarpbank, cutting	
Embankment or causeway	
Saddle, cave	
Alpine features	
Moraine	
Moraine wall	
Scree	

SCALE 1:50 000

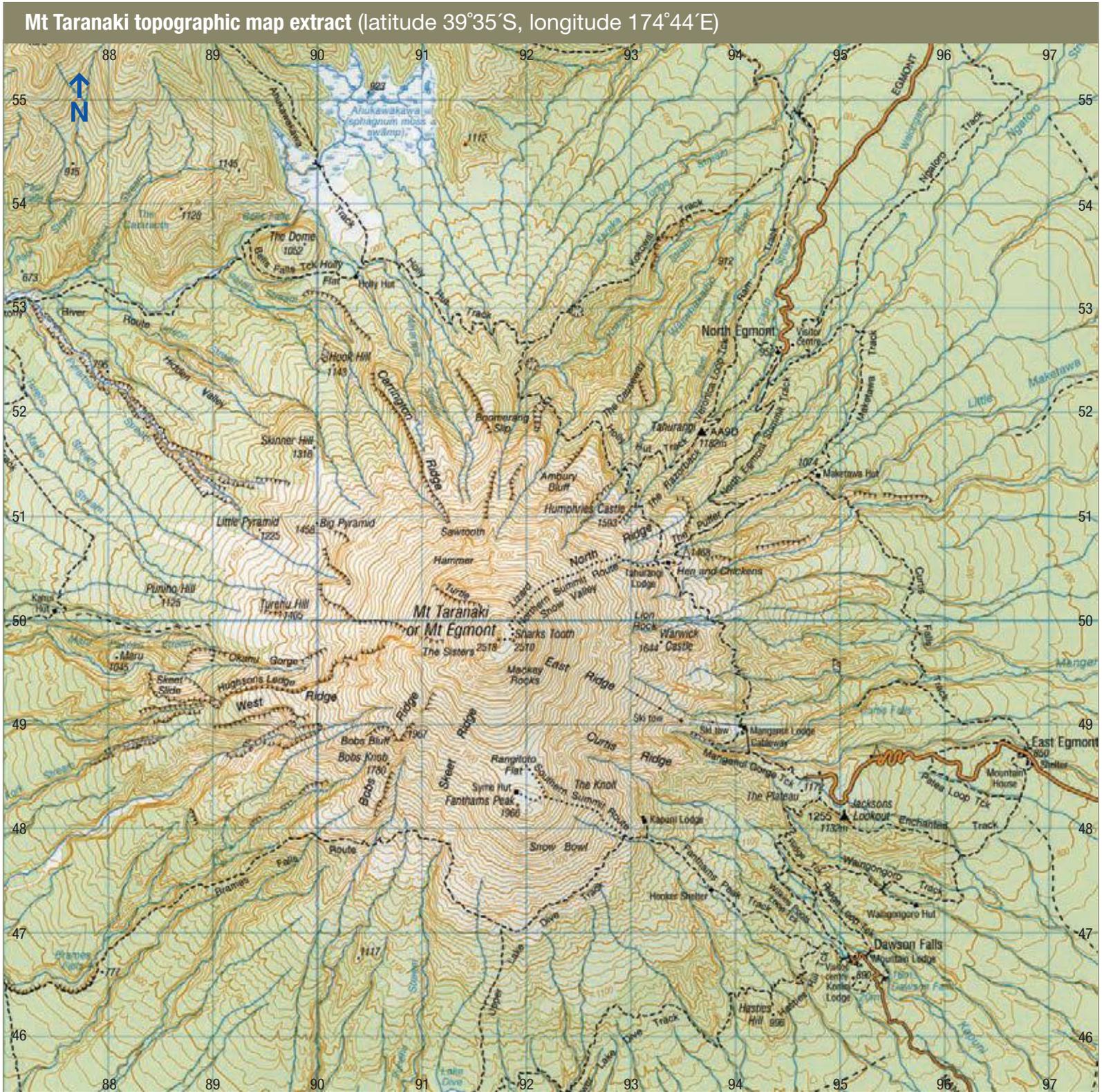
THE VERTICAL INTERVAL BETWEEN THE CONTOURS IS 20 METRES



ACTIVITIES

- What is the scale of the map extract?
- What is the contour interval used on the map extract?
- Study Figure 4.8a and the map extract. Identify the topographic features labelled 1–5.
- Identify the feature of the biophysical environment located at:
 - GR 215488
 - GR 206495
 - GR 214471
 - GR 225500
 - GR 184565.
- Identify the feature of the constructed environment located at:
 - GR 173538
 - GR 255471
 - GR 247448
 - GR 263466.
- What is the area reference of Iwikau Village?
- Name the type of biophysical feature found in AR 1855.
- Name the type of land use found in AR 2051.
- On what waterways is the Punaruku Falls (AR 1856) located?
- What is the direction of the Tukino Skifield (AR 1947) from the Whakapapa Skifield (AR 2051)?
- What tributary joins Whakapapanui Stream in AR 1956?
- In what direction is Tawhainui Stream flowing in AR 1954?
- What is the bearing of Girdlestone Peak (AR 2147) from Cathedral Rocks (GR 219497)?
- What is the bearing of Paretetaitonga (AR 2049) from Girdlestone Peak (AR 2147)?
- What is the aspect of the slope in AR 1950?
- What is the straight-line distance between Paretetaitonga (AR 2049) and Girdlestone Peak (AR 2147)?
- What is the length of the ski lift in AR2051?
- What is the area of the Summit Plateau?
- What is the area of Crater Lake?
- What is the height of Pyramid Peak (AR 2148)?
- What is the difference in elevation of Taurangi (GR 210480) and Girdlestone Peak (AR 2147)?
- Estimate the local relief experienced on a traverse from the summit of Paretetaitonga (AR 2049) to the summit of the Dome (AR 2149).
- Construct the cross-section from GR 180510 to the summit of Paretetaitonga at GR 207495. Use a vertical scale of 1 cm = 200 m.
- Calculate the vertical exaggeration of the cross-section that you constructed in Activity 23.
- What is the gradient of the slope in the cross-section that you constructed in Activity 23?
- Construct the cross-section from GR 170480 to Taurangi (GR 210470). Use a vertical scale of 1 cm = 100 m.
- Calculate the vertical exaggeration of the cross-section you constructed in Activity 26.
- What is the gradient of the slope in the cross-section you constructed in Activity 26?





SCALE 1:50 000

THE VERTICAL INTERVAL BETWEEN THE CONTOURS IS 20 METRES



Mt Taranaki is an active volcano on the west coast of New Zealand's North Island. The 2518-m-high mountain is one of the most symmetrical volcanic cones in the world. There is a secondary cone, Fanthams Peak (1966 m), just to the south of the summit.

Figure 4.9a Mt Taranaki

ACTIVITIES

- 1 Identify the feature of the biophysical environment located at:
 - a GR 898537
 - b GR 878467
 - c GR 919484
 - d GR 918485.
- 2 Identify the feature of the constructed environment located at:
 - a GR 951481
 - b GR 945527
 - c GR 952467
 - d GR 875501.
- 3 Name the types of drainage pattern evident on the Mt Taranaki topographic map extract.
- 4 Name the type of vegetation found at GR 9054.
- 5 What is the aspect of the slope in AR 9247?
- 6 What is the area of Ahukawakawa (sphagnum moss swamp)?
- 7 In what direction is Maero Stream flowing in AR 8751?
- 8 What is the direction of The Dome (AR 8953) from the summit of Mt Taranaki (AR 9149)?
- 9 What is the bearing of Warwick Castle (GR 933498) from The Dome (GR 899537)?
- 10 What is the straight-line distance between Warwick Castle (GR 933498) and The Dome (GR 899537)?
- 11 Construct the cross-section from the summit of Mt Taranaki (AR 9149) to GR 870510. Use a vertical scale of 1 cm = 200 m.
- 12 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 11.
- 13 What is the gradient of the slope from the summit of Mt Taranaki (AR 9149) to the spot height in AR 8849?



SECTION 5

South America

South America

5.1



ACTIVITIES



- Name the capital city of the following countries:
 - Peru
 - Argentina
 - Brazil
 - Colombia.
- Name the countries that have the following cities as their capital:
 - Santiago
 - Caracas
 - Montevideo
 - La Paz.
- Name the major river system draining the northern half of South America.
- Name the mountain range running the length of South America's west coast.
- What is the straight-line distance between:
 - Lima and Buenos Aires
 - Santiago and Caracas?
- What is the direction of:
 - Buenos Aires from Lima
 - Brasilia from Santiago?
- Name the feature of the physical environment located at the following latitudes and longitudes:
 - 32°40' S, 70°10' W
 - 9°08' S, 77°36' W.
- Name the urban centres located at the following latitudes and longitudes:
 - 23°33' S, 46°39' W
 - 34°55' S, 56°10' W
 - 16°30' S, 68°10' W
 - 22°55' S, 43°17' W.



Figure 5.1b Incan woman in traditional dress selling hand-woven rugs to tourists in Peru's Sacred Valley of the Incas



Figure 5.2a Cuzco, Peru, was once the capital of the Inca Empire.

Cuzco: city of the Incas

Cuzco (see Figure 5.2a), in southern Peru, was once the capital of the Inca Empire (1197–1572). The city sits in a valley (see Figure 5.2b), with the snow-capped Andes Mountains to its north. The river running across the top of Figure 5.2b 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 5.2c) 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 5.2b Topographic image of Cuzco, produced by a NASA satellite in July 2006

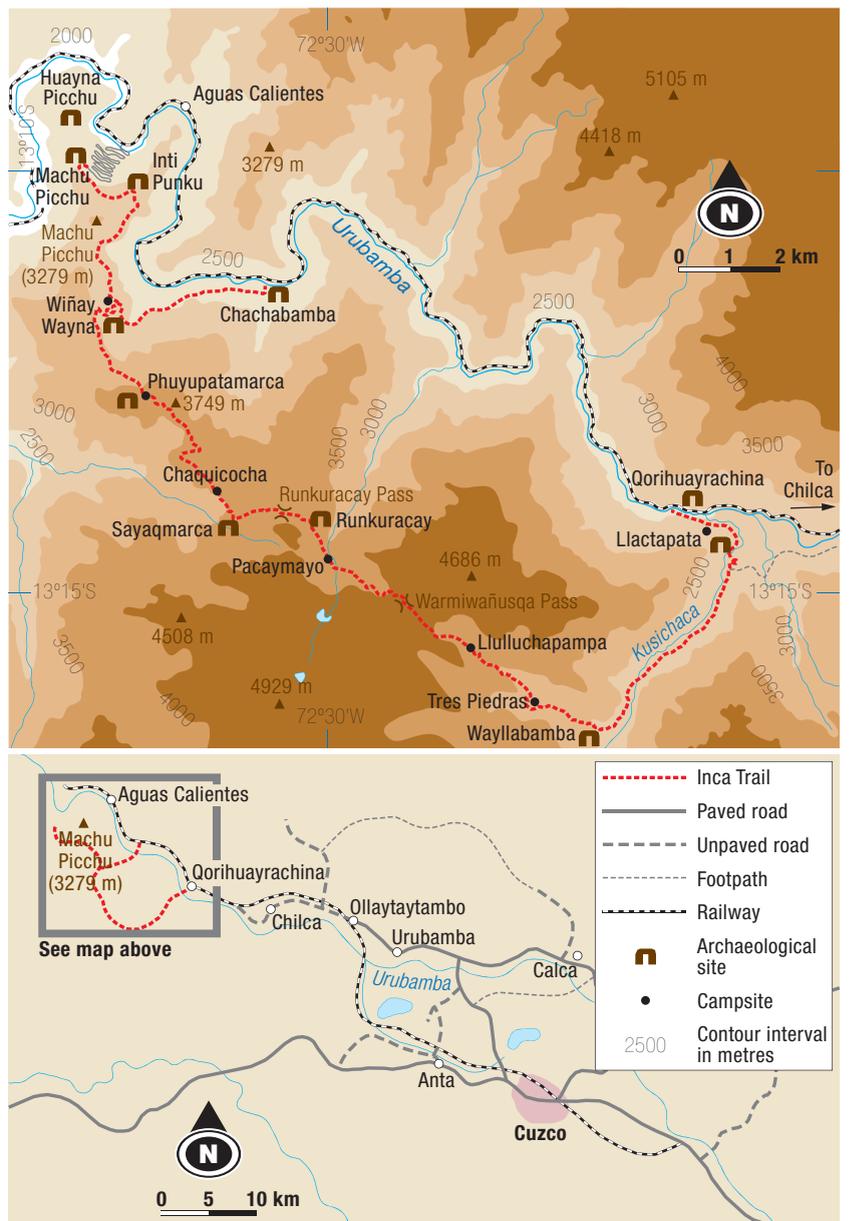
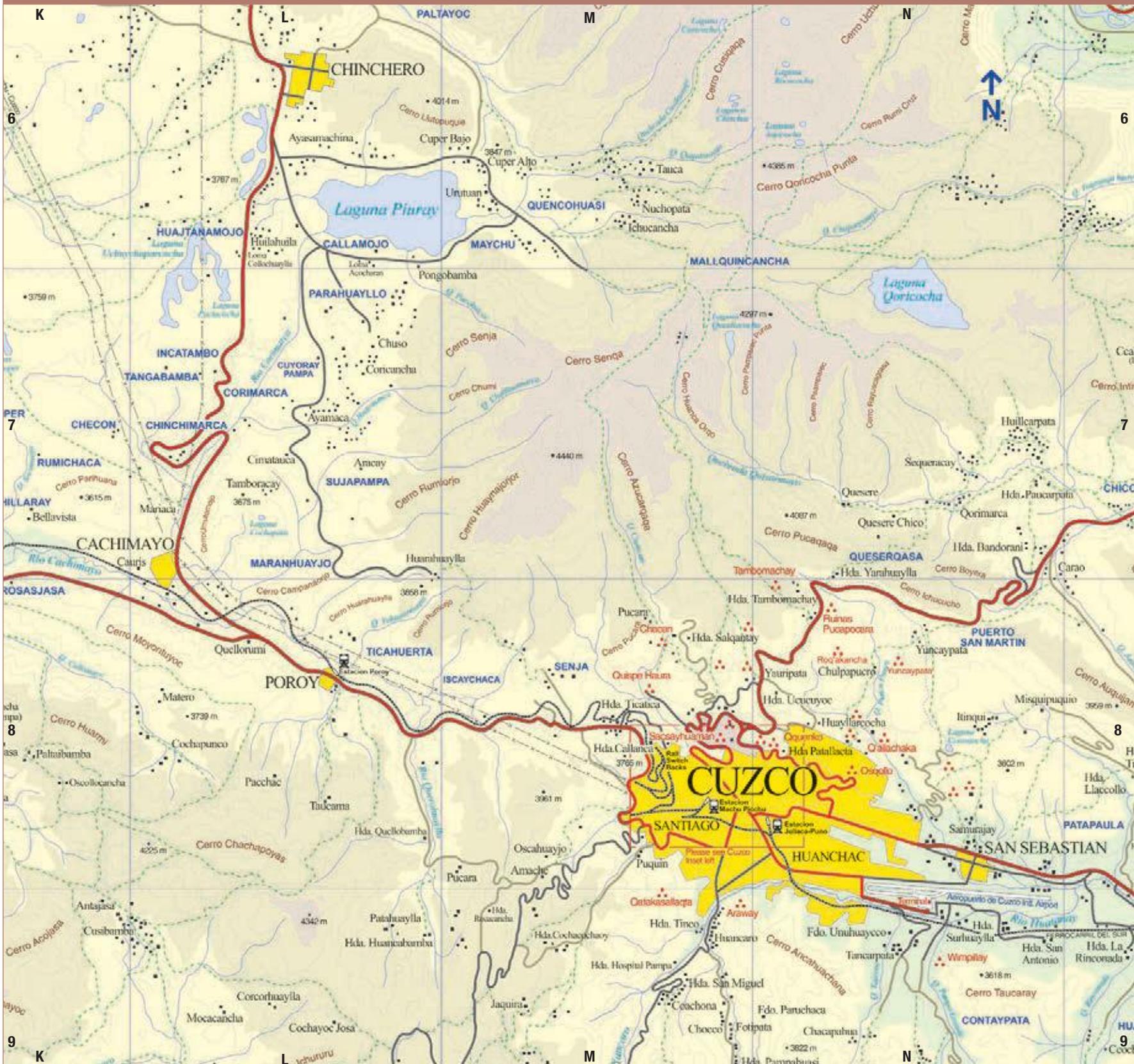


Figure 5.2c The Inca Trail

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
- Inca Trail / Camino Inca
- Paved Major Highway
- Main Road (hard surface)
- Dirt Road
- Dirt Track (not reliable) & Hiking
- Settlements / Villages
- Towns / Cities
- Area Names
- Accommodation / Camping
- Ruins / Bus Stop
- Rivers / Aqueducts
- Power Corridor
- Glaciated Peak (Nevedo)

Scale / Escala 1:110,000
Contour lines show every 100 m

Please note some abbreviations:
Hda. Hacienda (village)
Q. Quebrada (creek)
Lag. Laguna (lake)
Co. Cerro (mountain)
Nev. Nevado (glaciated peak)

ACTIVITIES

- 1 Study Figures 5.2a and 5.2b. Describe the physical setting (the site) of Cuzco.
- 2 Study Figure 5.2a. 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 5.2b.
- 4 Study Figure 5.2b and the topographic map extract. Identify the features of the biophysical environment labelled 1–3.
- 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 features are Cerro Pamparec Punta and Cerro Paamparec in N7?
 - j What is the area of Laguna Piuray?



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 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 5.3a was taken?
- 31 Construct a photo sketch of Figure 5.3a.

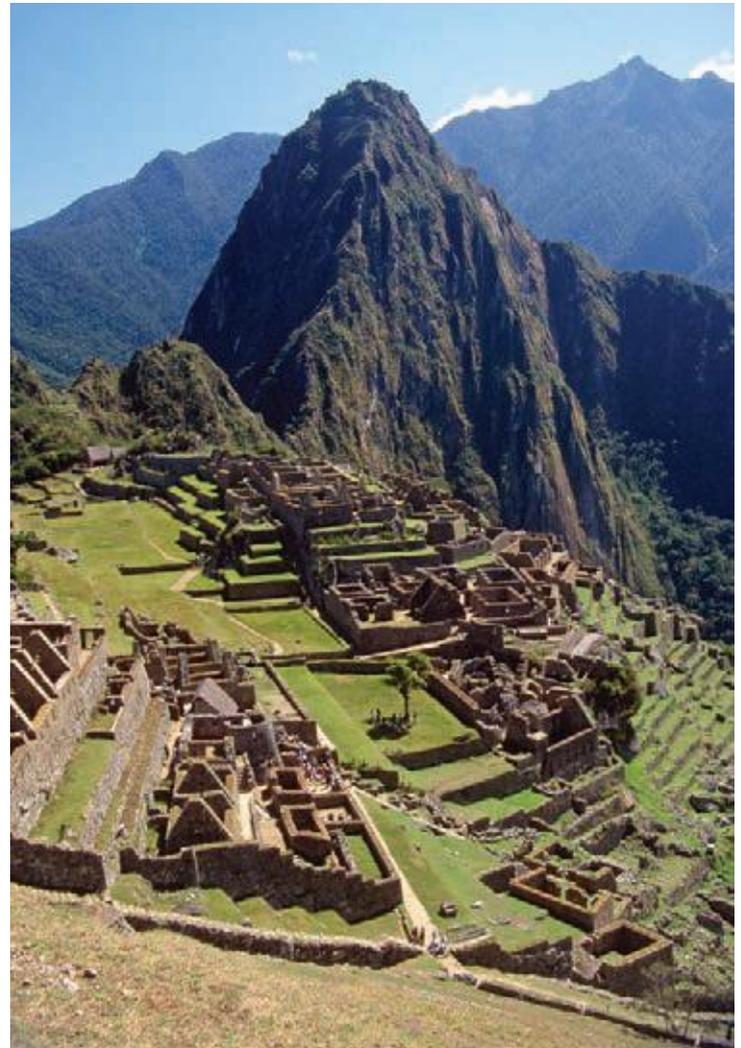


Figure 5.3a Machu Picchu

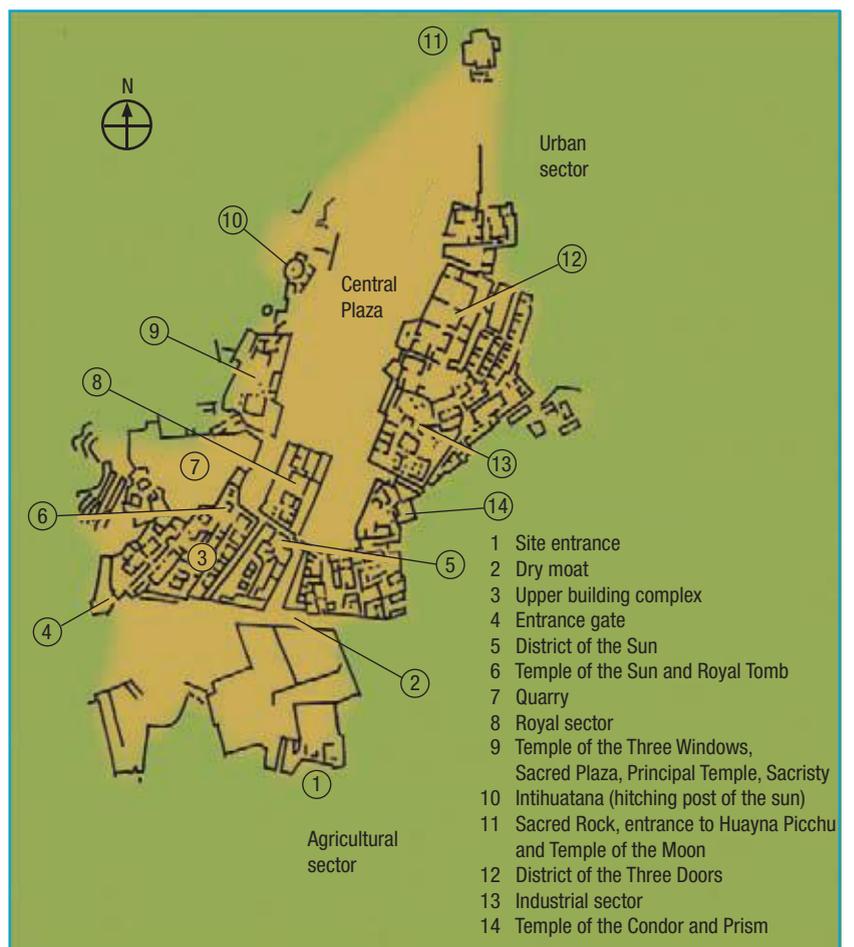
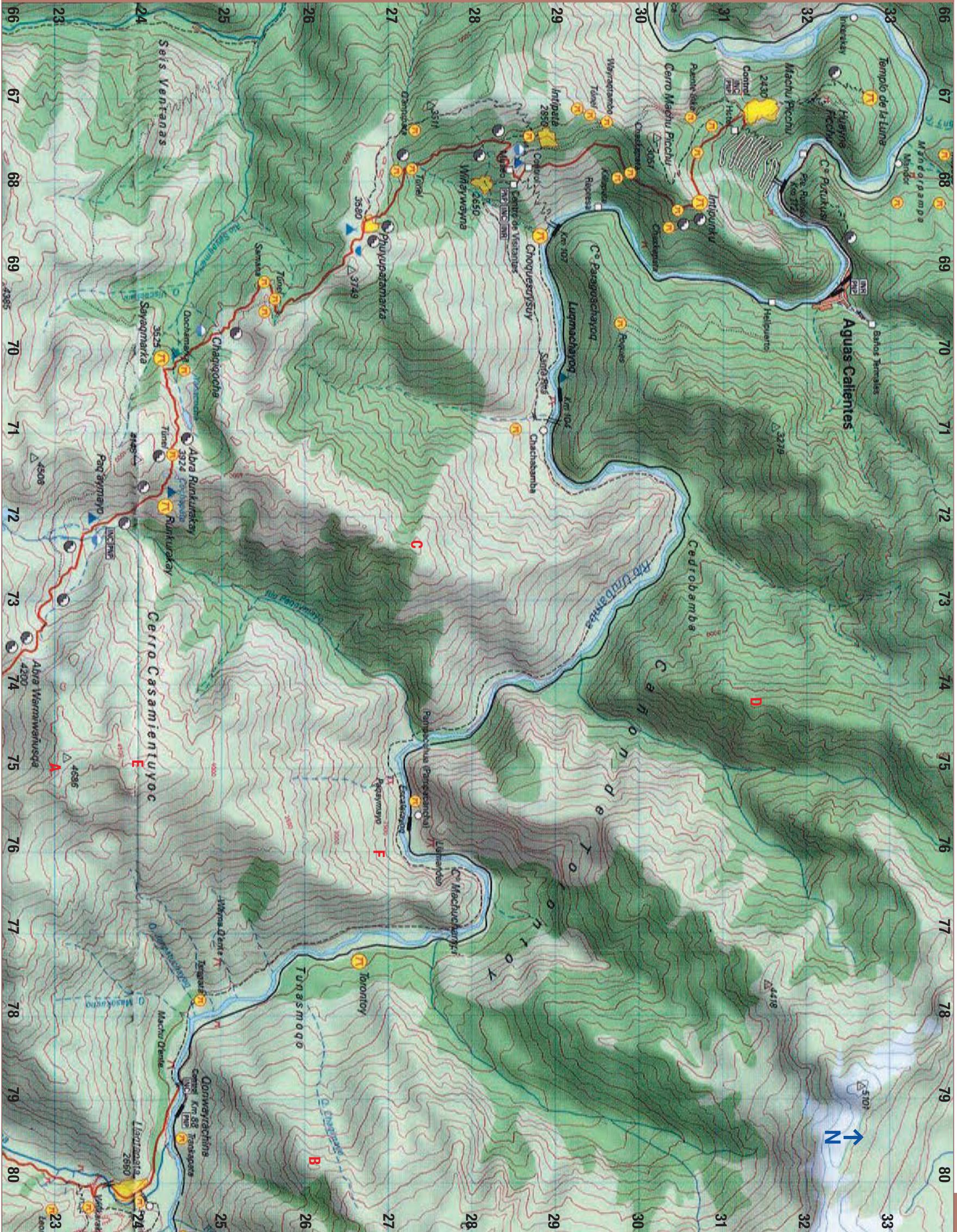


Figure 5.3b Map of Machu Picchu

Leyenda / Legend :

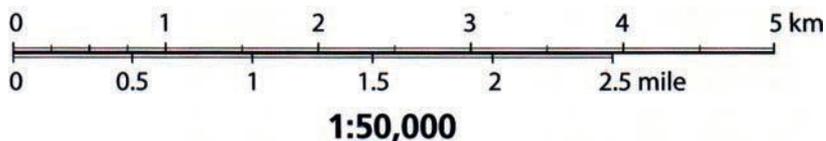
	Camino Inka / Inca Trail		escala scale 1 : 50,000		equidistancia contour interval 100m
	Callejón / Road		UTM 18		convergencia meridiana meridian convergence 0°35'
	Camino / Trail		WGS 84		
	Sendero / Path				
	Ferrocarril, Estación / Railway Station		Policía Nacional / National Police		Instituto Nacional de Cultura / National Institute of Culture
	Ruina / Ruin		Instituto Nacional de Cultura / National Institute of Culture		Instituto Nacional de Recursos Naturales / National Institute of Natural Resources
	Andenes, Gradás / Terraces, Stairway		otros servicios / other services		Lugar de campamento / Camping site
			Serv. Higiénico: rústico - equipado / Toilets: basic - equipped		

0 1 2 km



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.



Contour Interval 25 m

Symbol Key:

2002 Zona Reservada/ 2002 Reserved Zone*		Trailhead, GPS Point	
Primary Circuit Route		Transportation: Regular, Irregular	
Other Path		Mine, Abandoned Mine	
Minor Path		Town / Village, Hamlet	
Rough Road		Miscellaneous Building, Telephone	
Primary Road		Spot height, Named Summit	
River, Stream		Thermal Springs, Pass/Col	
Intermittent Stream		Lodging, Campsite	
Lake, Wetland		Major Moraine	

Lexicon:

Abbreviation, *Spanish, English, (Quechua)*
Qda., *Quebrada, Stream*
Rio, *River*
Lag., *Laguna, Lake, (Cocha)*

Nvd., *Nevado, Snowy Summit*
Co., *Cerro, Rocky Summit*
Gl., *Glacial, Glacier*
Coll/Punta, *Pass*
Pampa, *Grazing Zone*



Figure 5.4a Lake Carhuacocha and the Cordillera Huayhuash, Peru



Figure 5.4b The Cordillera Huayhuash pictured from the International Space Station

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 5.4a. Label the principal landform features of the landscape.
- 22 In which direction was the camera facing when the photograph in Figure 5.4a was taken?
- 23 Study Figure 5.4b and the map extract. Identify the features 1–3.





Figure 5.5a Satellite photograph of Cuzco, Google Earth © 2016 Google, Image © 2016 DigitalGlobe



Figure 5.5b Satellite photograph of Machu Picchu, Google Earth © 2016 Google, Image © DigitalGlobe, Image © 2016 CNEW / Astrium

ACTIVITIES



- 1 Study the Cuzco topographic map extract (page 145) and Figure 5.5a and complete the following tasks:
 - a Locate the following features on the satellite photograph of Cuzco and surrounds:
 - i Laguna (Lake) Piuray
 - ii Laguna Qoricocha
 - iii Cachimayo
 - iv Aeropuerto de Cuzco International Airport.
 - b Describe the relationship between the urban area of Cuzco and the region's topography.
 - c Describe the location and extent of urban expansion that has occurred since the map of Cuzco was published.
 - d Describe the nature of the vegetation in the area surrounding Cuzco. What does this suggest about the climate experienced in the region?
- 2 Study the Machu Picchu topographic map extract (page 147) and Figure 5.5b and complete the following tasks:
 - a Locate the following features on the satellite photograph of Machu Picchu:
 - i Aguas Calientes
 - ii Machu Picchu historical site
 - iii Rio Urubamba
 - iv Huayna Picchu
 - v Machu Picchu access road.
 - b Describe the topography of the area shown in the satellite photograph of Machu Picchu.
 - c Identify the principal erosional process responsible for shaping the landscape shown.
 - d Describe the nature of the vegetation evident in the satellite image. Speculate why it might be different from the vegetation surrounding Cuzco.
- 3 Study the Cordillera Huayhuash topographic map extract (page 149) and Figure 5.5c and complete the following tasks:
 - a Locate the following features on the satellite photograph of the Cordillera Huayhuash:
 - i Solteracocha
 - ii Carhuacocha
 - iii Lag. Gangrajanca
 - iv Yerupaja Sur
 - v Mituraju.
 - b Describe the nature of the landscape shown in the satellite photograph.
 - c Identify the principal erosional process responsible for shaping the landscape shown.



Figure 5.5c Satellite photograph of Cordillera Huayhuash, Google Earth, Image © 2016 CNES / Astrium, © 2016 Google

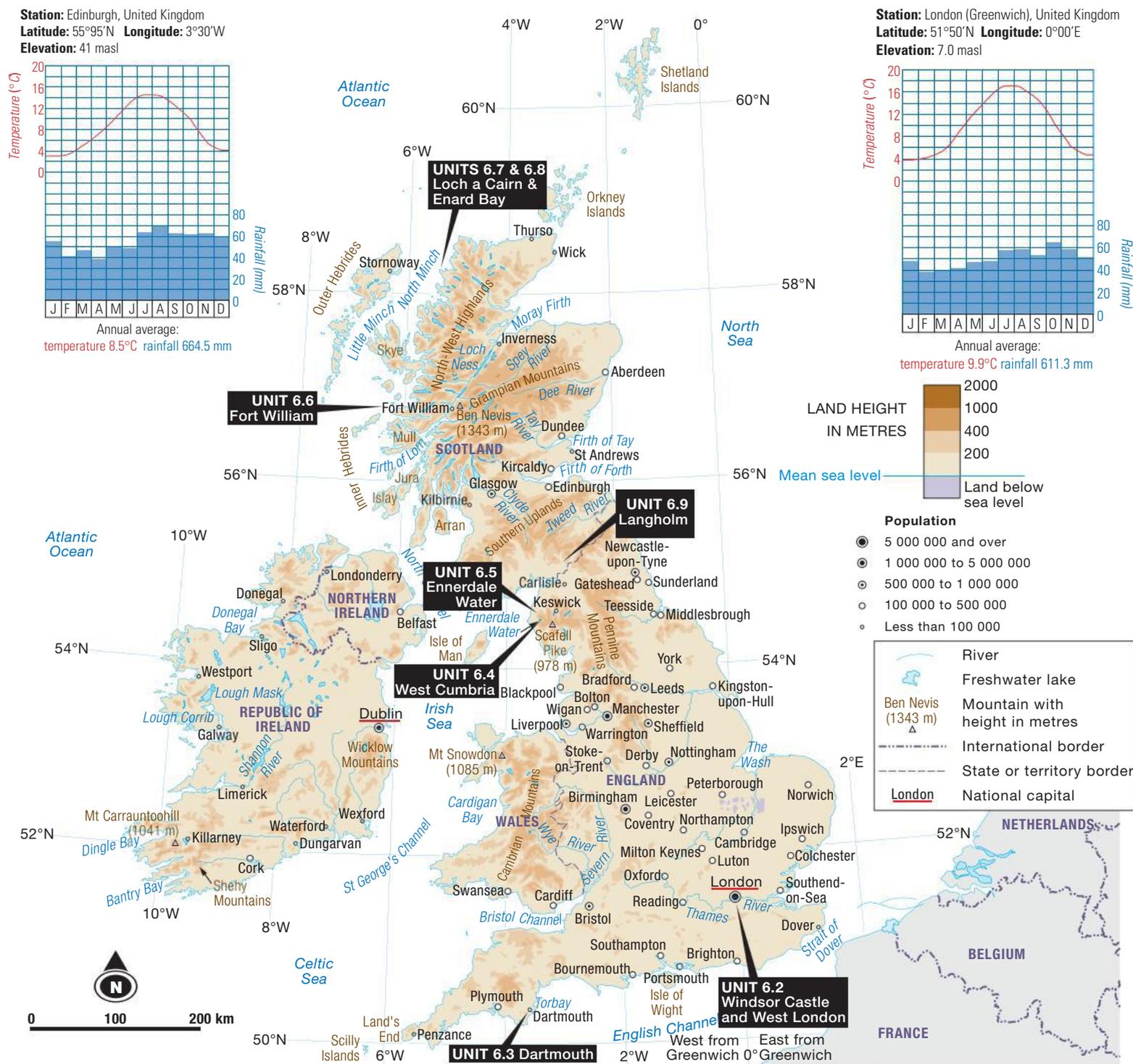


Figure 6.1a United Kingdom (England, Wales, Scotland and Northern Ireland) and the Republic of Ireland: physical features

ACTIVITIES

- What is the latitude and longitude of the following physical features:
 - Lough Mask (Republic of Ireland)
 - Mt Carrauntoohill (Republic of Ireland)
 - Isle of Wight (England)
 - Scafell Pike (England)
 - Ben Nevis (Scotland)?
- What cities are located at the following latitudes and longitudes:
 - 55°57'N, 3°01'W
 - 50°48'N, 1°05'W
 - 51°30'N, 0°10'W
 - 52°30'N, 1°50'W?
- What is the name of the waterway separating Ireland from England and Wales?
- What is the name of the waterway separating the United Kingdom from Northern France?
- What is the capital city of the Republic of Ireland?
- What is the direction of the Strait of Dover from London?
- What is the direction of Dublin from London?
- What is the straight-line distance between:
 - Dublin and London
 - Edinburgh and London?
- Name the mountain range located in Wales.
- Name the mountain range to the north-west of Edinburgh.
- Name the mountains in the north of England.
- Name the highest mountain in the United Kingdom.
- Name three cities with a population of more than 1 million in the United Kingdom.
- Name the river on which London is located.
- Study the climate graphs of London and Edinburgh and then complete the following tasks:
 - What is the range of average monthly temperatures experienced by London and Edinburgh?
 - Which months receive the most rainfall in both London and Edinburgh?
 - Describe the seasonal distribution of rainfall in both London and Edinburgh.

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. Historic 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 late Queen Mother.

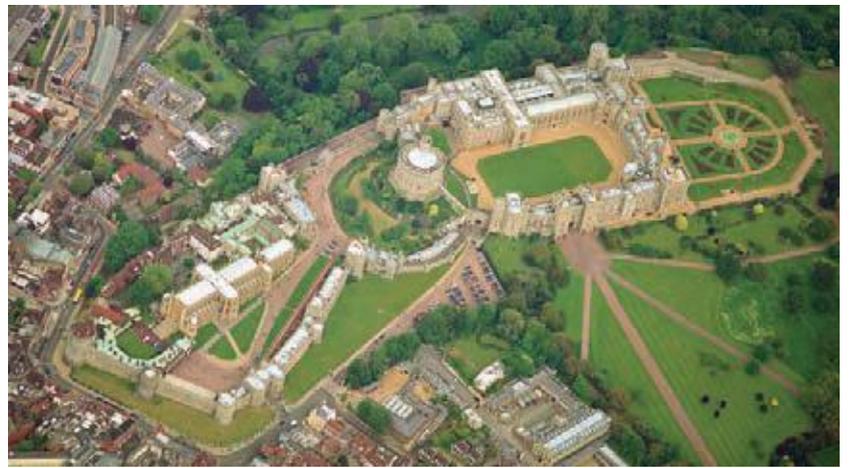
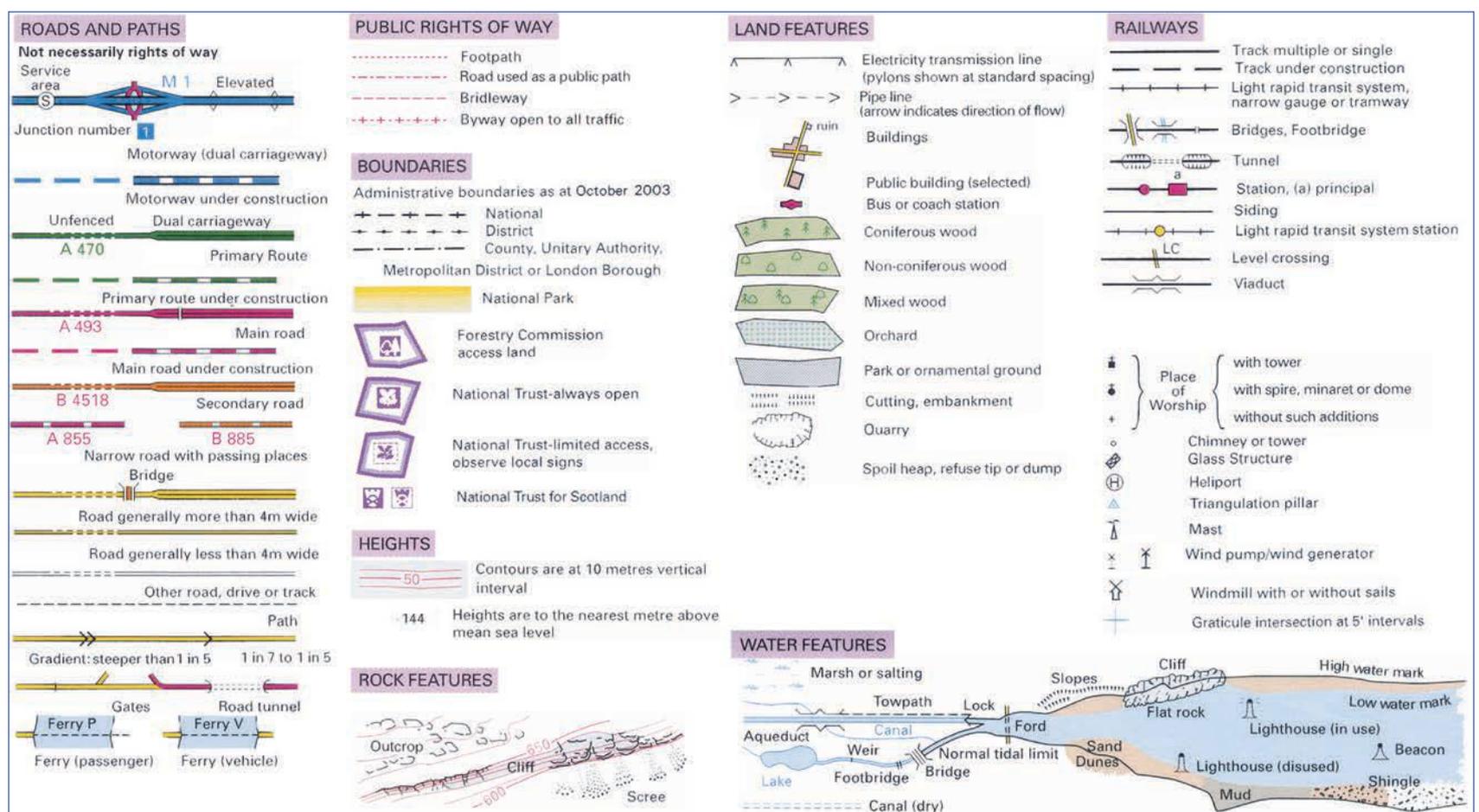


Figure 6.2a Windsor Castle



ACTIVITIES

- What is the scale of the map extract?
- What is the contour interval used on the map extract?
- Identify the feature of the biophysical environment located at:
 - GR 975689
 - GR 000729
 - GR 997757
 - GR 026677.
- Identify the feature of the constructed environment located at:
 - GR 969720
 - GR 967774
 - GR 977761
 - GR 975759
 - GR 966682
 - GR 967769.
- Identify the historical feature that is located at:
 - GR 973739
 - GR 992746
 - GR 004727
 - GR 968778.
- What is the grid reference of Windsor Castle?
- Name the type of vegetation found in AR 9569.
- Name the type of land use found in AR 0478.
- What waterway flows into the Thames River at GR 019720?
- What two rivers merge at GR 977778?
- What two motorways intersect in AR 0478?
- What primary route joins the M25 in AR 0272?
- What is the direction of Windsor Castle (GR 970770) from Magna Carta Island (AR 9973)?
- What is the direction of the King George VI Reservoir from The Queen Mother Reservoir?
- What is the bearing of the statue (AR 9672) from Windsor Castle (GR 970770)?
- Estimate the distance by road from the motorway junction at AR 0167 to the motorway junction at AR 0478.
- 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.
- What is the length of The Long Walk from Windsor Castle (GR 9790770) to the intersection at GR 967729?
- Estimate the area of:
 - Wraysbury Reservoir
 - King George VI Reservoir.
- Estimate the elevation of the memorial at GR 997728.
- Estimate the elevation of the statue at GR 967729.
- Using Google Earth, explore the area surrounding Windsor Castle. Locate Windsor Castle and the features you have identified in the above activities.
- Investigate the historical importance of Runnymede and the Magna Carta.





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Figure 6.3a Google Earth image of Dartmouth and surrounds, Google Earth, Image © Getmapping plc, © 2016 Google, Image © 2016 TerraMetrics



Dartmouth is a tourist destination set on the western bank of the estuary of the River Dart, which is a long narrow tidal ria that runs inland as far as Totnes.

Dartmouth was of strategic importance as a deep-water port for sailing vessels. Two fortified castles – Dartmouth Castle and Kingswear Castle – protected the narrow mouth of the Dart.

Dartmouth was once an important port for the Royal Navy. Warfleet Creek, close to Dartmouth Castle, was named for the vast fleets which often assembled there.

The town is still home to the Royal Navy's officer training college (Britannia Royal Naval College), where all officers of the Royal Navy and many foreign naval officers are trained.

ACTIVITIES

Refer to the legend on page 152 to complete the following tasks:

- 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 GR 919497
 - b GR 888496
 - c GR 858556
 - d GR 919507.
- 4 Identify the feature of the constructed environment located at the following grid references:
 - a GR 946567
 - b GR 897563
 - c GR 876521.
- 5 Identify the historical feature located at the following grid references:
 - a GR 801606
 - b GR 888537
 - c GR 892504.
- 6 Identify the recreational activity available in the following area references:
 - a AR 9056
 - b AR 8759.
- 7 Estimate the height of the landform feature located at the following grid references:
 - a GR 839536
 - b GR 828559
 - c GR 869538.
- 8 Calculate the gradient of the slope from the spot height at GR 798559 to the road intersection at GR 808563. What is the aspect of this slope?
- 9 What is the aspect of the slope in AR 8753?
- 10 Name three tributaries of the River Dart.
- 11 State the number of vehicle ferries that cross the River Dart.
- 12 What type of road connects Kingswear (AR 8851) to Higher Brixham (AR 9255)?
- 13 What type of agricultural land use is found near the village of Aish (GR 843589)?
- 14 What is the direction of:
 - a Paignton from Berry Head
 - b Dartmouth from Brixham?
- 15 What is the direction of flow of the River Wash in AR 8055?
- 16 Estimate the length of the Breakwater in the north-east quadrant of the map extract.
- 17 What is the distance by road from the bus station (GR 923561) to the Totnes roundabout (GR 808605)?
- 18 Calculate how long it would take for a bus to travel from the bus station (GR 923561) to the Totnes roundabout (GR 808605) at a constant speed of 30 km/h.
- 19 Estimate the distance by rail from Kingswear Station (GR 882511) to Churston Station (GR 894563).
- 20 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
- 21 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.
- 22 What evidence is there that tourism is an industry in the area covered by the map extract?
- 23 What evidence is there that Dartmouth was once an important naval facility?
- 24 How might the local topography have favoured the location of a naval facility at the mouth of the River Dart?
- 25 Study Figure 6.3a and the map extract. Locate the following features on the satellite image of Dartmouth and surrounds:
 - a River Dart
 - b Dartmouth
 - c Totnes
 - d Paignton
 - e Berry Head (AR 9456)
 - f Scabbacombe Head (AR 9251)
 - g Dartmouth Marina (AR 8851)
 - h Old Mill Creek (AR 8652)
 - i Britannia Royal Naval College (GR 875520)
 - j St Mary's Bay (AR 9355).







Figure 6.4a Bassenthwaite Lake and Derwent Water, © 2016 Google, © Infoterra Ltd & Bluesky

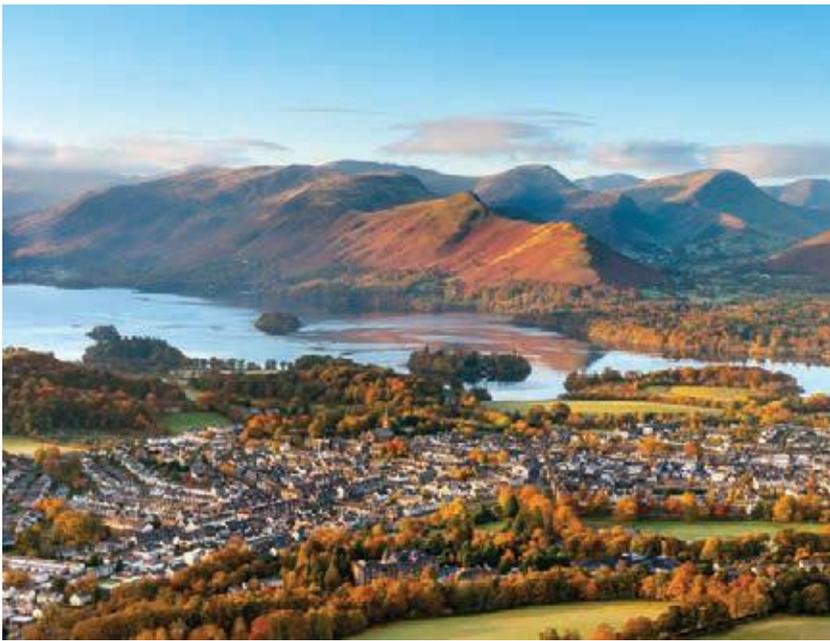


Figure 6.4b Keswick and Derwent Water, West Cumbria



ACTIVITIES

Refer to the legend on page 152 to complete the following tasks.

- 1 What is the scale of the West Cumbria 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.

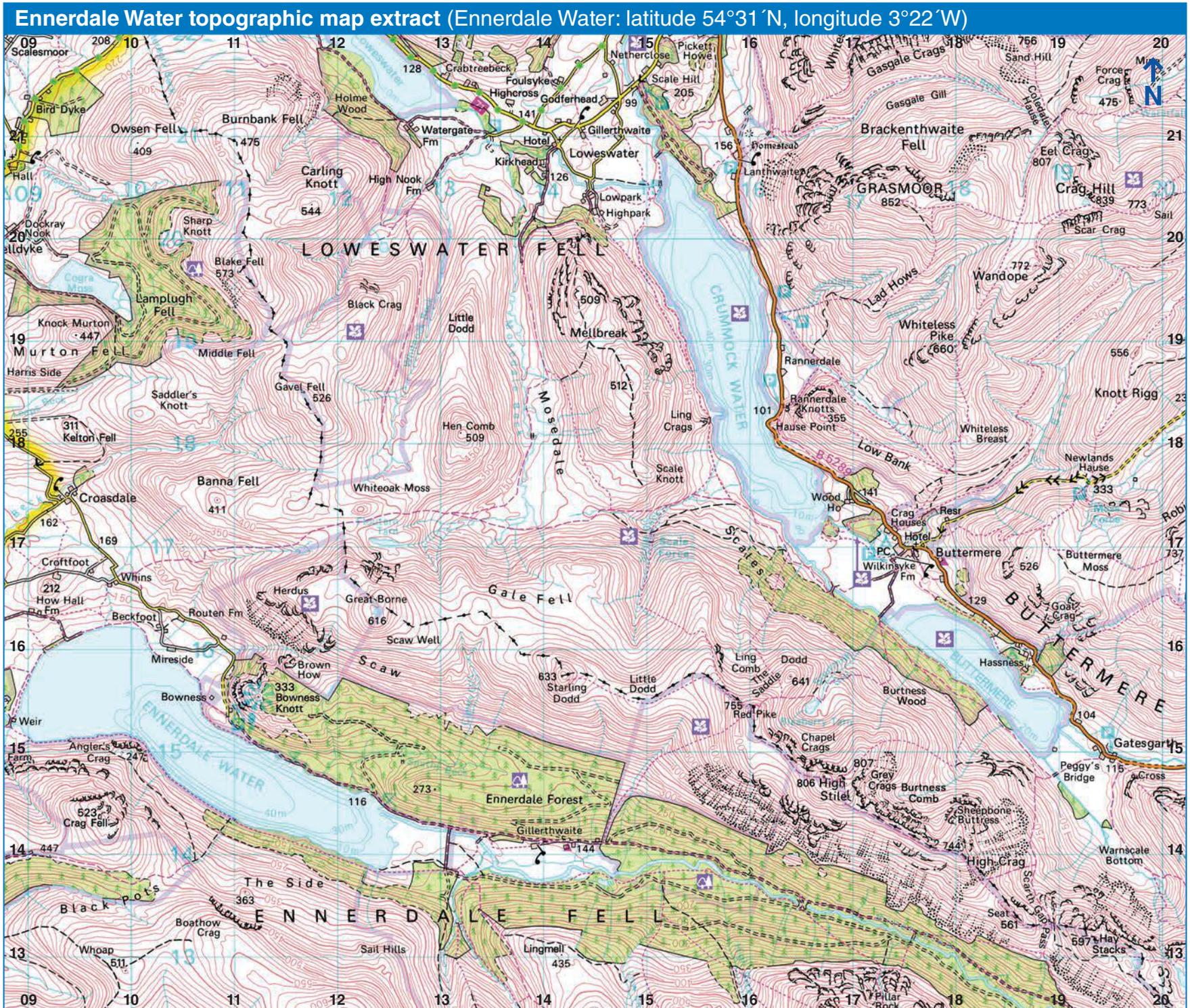
Study Figure 6.4b. Compare it with the West Cumbria topographic map extract and complete the following tasks:

- 31 Construct a line drawing of the area shown in the photograph.
- 32 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).
- 33 What is the direction in which the camera was facing when the photograph was taken?
- 34 Name the physical processes responsible for the development of this landscape.
- 35 State whether the area shown is predominantly characteristic of the biophysical or constructed environment.
- 36 Study Figure 6.4a and the West Cumbria topographic map extract. Locate the following features on Figure 6.4a:
a Derwent Water
b Bassenthwaite Lake
c River Derwent
d Keswick
e Lord's Ireland
f St Herbert's Ireland
g Lonscale Fell
h Braithwaite.



West Cumbria topographic map extract (Keswick: latitude 54°35' N, longitude 3°10' W)





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1 0 1 2 3 4
SCALE 1:50 000 KILOMETRES

ACTIVITIES

Refer to the legend on page 152 to complete the following tasks:

- What is the scale of the Ennerdale Water topographic map extract?
- What is the contour interval of the Ennerdale Water topographic map extract?
- Identify the feature of the biophysical environment located at the following grid references:

a	166154	b	132181
c	096197	d	156183.
- Identify the feature of the constructed environment located at the following grid references:

a	194149	b	176170
c	127211	d	088154.
- Name the type of biophysical features found in AR 1714.
- Name the type of vegetation found in AR 1314.
- What rivers flow into Crummock Water in AR 1619?
- What is the straight-line distance between Banna Fell (GR 108175) and Hen Comb (GR 132181)?
- Estimate the area of Buttermere.
- What is the direction of Crummock Water from Ennerdale Water?
- In what direction is Mosedale Beck flowing in AR 1318?
- What is the bearing of Hen Comb (GR 132181) from Banna Fell (GR 108175)?
- What is the aspect of the slope in AR 1317?
- What is the depth of Ennerdale Water?
- Estimate the height of the landform features at the following grid references:

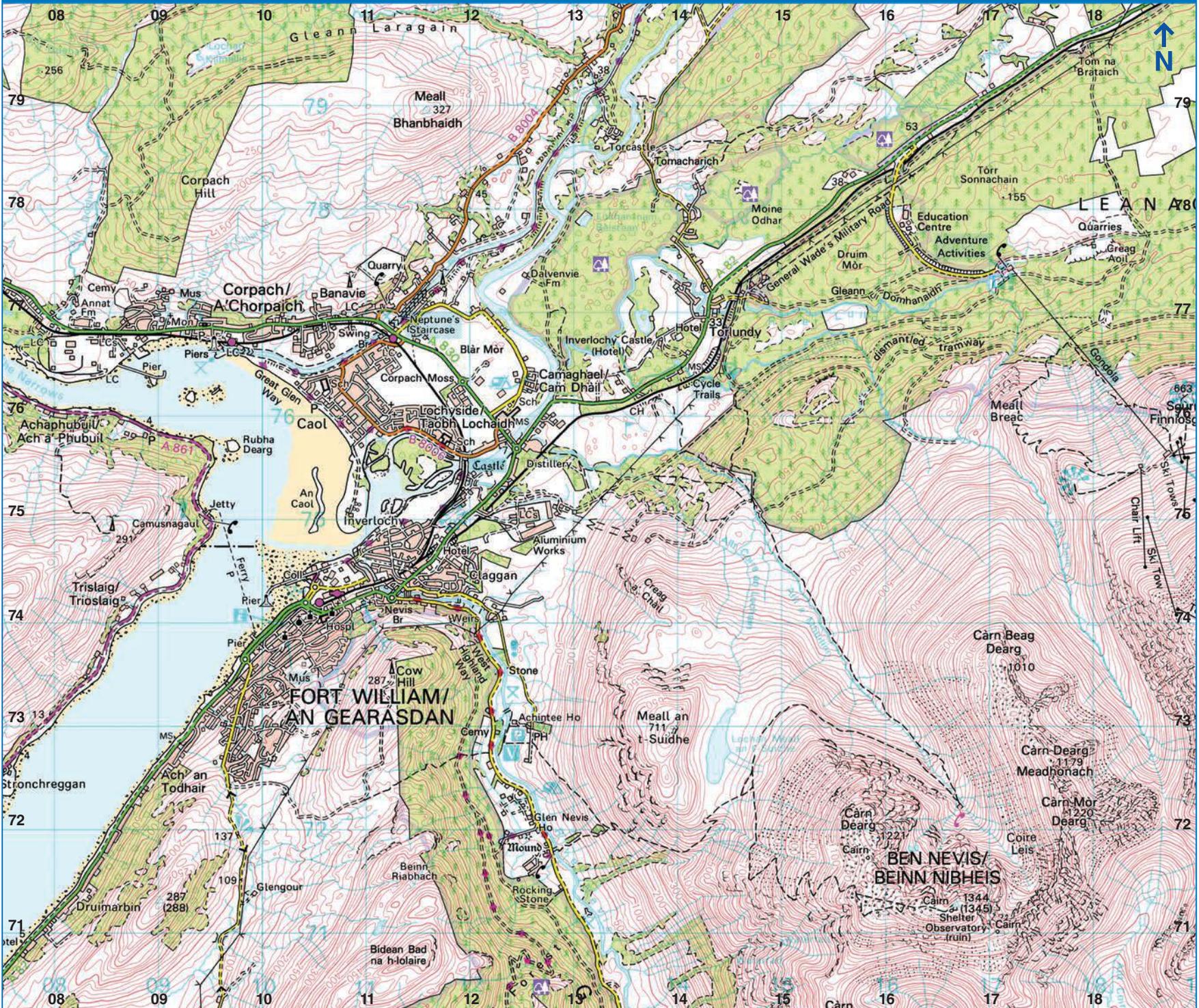
a	GR 117174
b	GR 121189.
- Study Figure 6.5a. In what direction was the photographer facing when the image was captured?



Figure 6.5a Buttermere



Fort William topographic map extract (Fort William: latitude 56°49'N, longitude 4°48'W)



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ACTIVITIES

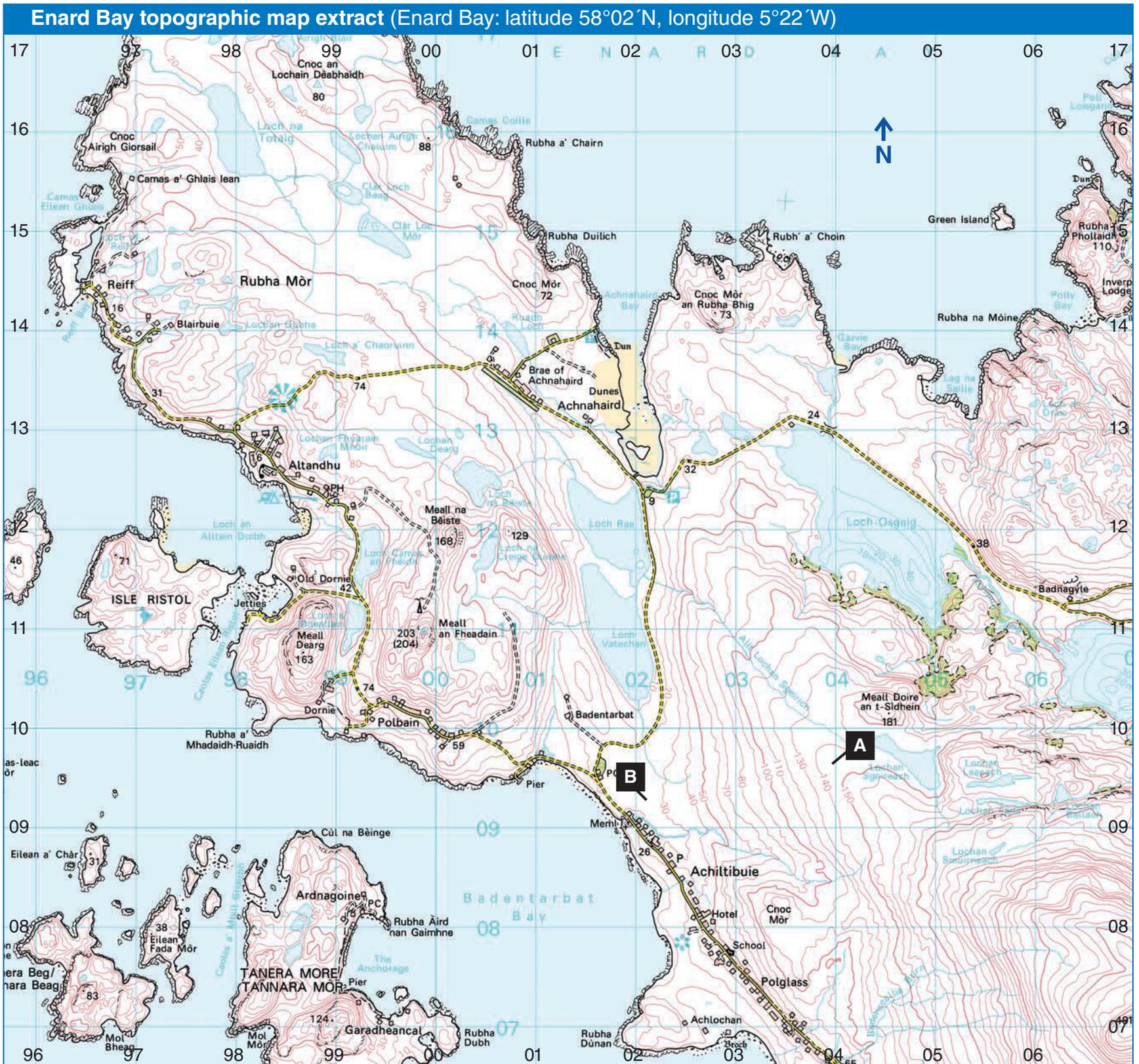


Refer to the legend on page 152 to complete the following tasks.

- 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.
- 14 Study Figure 6.6a and the map extract. Identify the features labelled 1–5.



Figure 6.6a Satellite photograph of Fort William, © 2016 Google, Image © 2016 DigitalGlobe, Image © 2016 Getmapping plc



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Scale 1:50 000

ACTIVITIES

Refer to the legend on page 152 to complete the following tasks.

- 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.

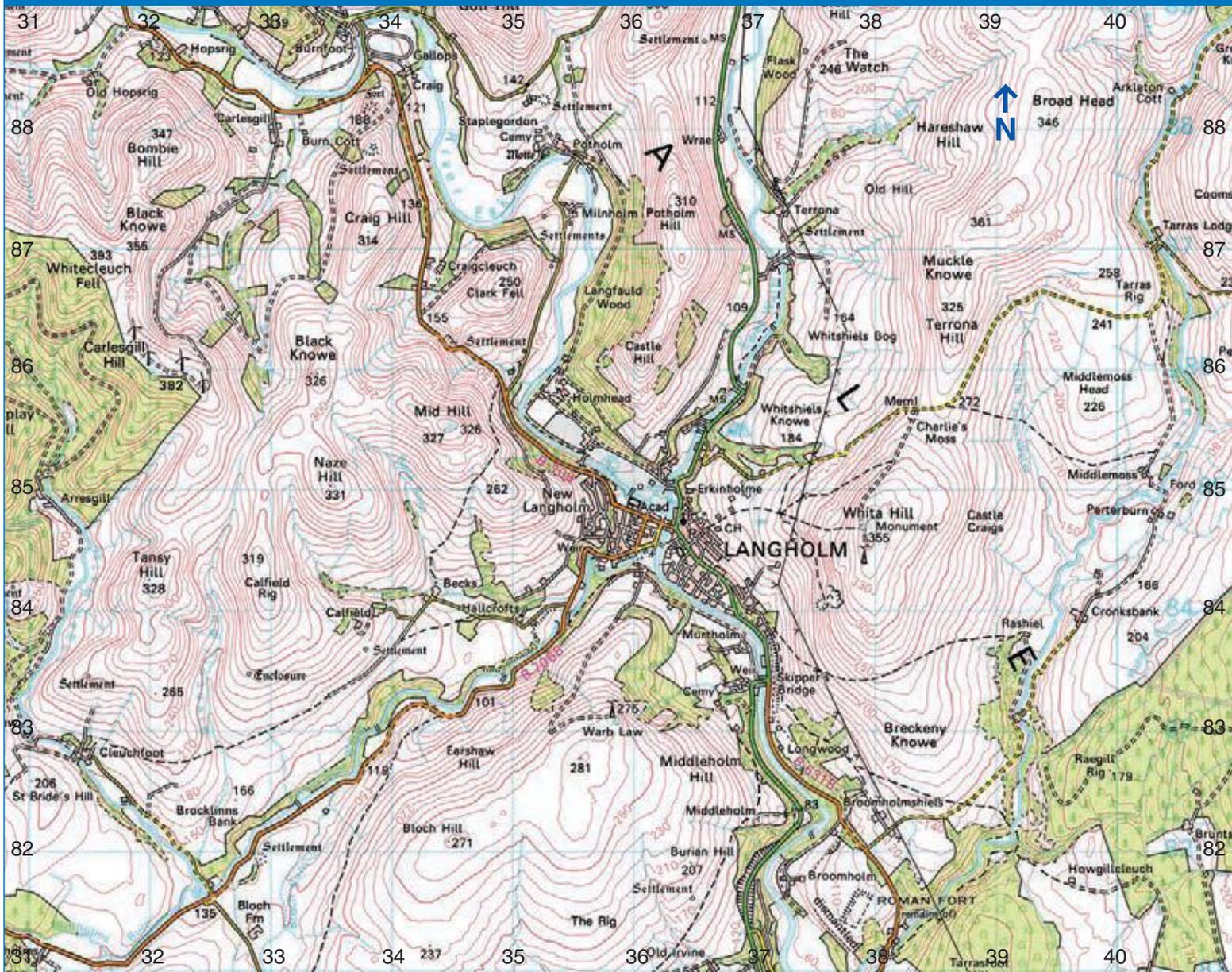
- 4 What type of depositional landform feature is centred on GR 983113?
- 5 What settlement pattern is evident in the south-east quadrant of the map?
- 6 What water body flows into the sea at Gavie Bay in AR 0413?
- 7 What is the direction of flow of Allt Lochan Sgeirich in AR 0310?
- 8 What is the direction 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 an Lochain deabhaidh (GR 988165)?
- 12 What is the local relief on Tanera More in the south-west quadrant of the map?

- 13 What is the approximate area of Tanera More in the south-west quadrant of the map?
- 14 What is the depth of Loch Osgaig at GR 048115?
- 15 Identify the principal geomorphological processes responsible for the landforms of the Enard Bay topographic map extract.



Langholm topographic map extract (latitude 55°15'N, longitude 2°59'W)



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Scale 1:50 000

Langholm, a small town on the River Esk in Scotland, has long been home to the woollen milling trade. At one stage there were 22 mills in the town. Since then there

has been some consolidation and closure of mills but many people still earn their living in the trade.

ACTIVITIES

Refer to the legend on page 152 to complete the following tasks.

- 1 What is the contour interval used on the map extract?
- 2 Identify the feature of the biophysical environment located at:
 - a GR 379847
 - b GR 335850
 - c GR 376841.
- 3 Identify the feature of the constructed environment located at:
 - a GR 373869
 - b GR 379845
 - c GR 362852.
- 4 Name the type of land use found in AR 3185.
- 5 Name the waterways flowing into the River Esk in AR 3684.
- 6 In what direction is Tarras Water flowing in AR 3982?
- 7 What is the direction of the Whita Hill (AR 3784) from the monument at AR 3583?
- 8 What is the bearing of Whita Hill (AR 3784) from the summit of Clark Fell (GR 348867)?
- 9 What is the straight-line distance between the summit of Tansy Hill (GR 320844) and Bloch Hill (AR 3482)?
- 10 What is the distance by road from the bridge at GR 366856 and Skipper's Bridge at GR 371835?
- 11 What is the aspect of the slope in AR 3482?
- 12 What is the elevation of the historic 'enclosure' at GR 328835?
- 13 What is the difference in elevation of Tansy Hill (GR 320844) and Skipper's Bridge at GR 371835?
- 14 Construct the cross-section from Tansy Hill (GR 320844) to the summit of Skipper's Bridge at GR 371835 using a vertical scale of 1 cm = 100 m.
- 15 Study Figure 6.9a and the map extract. Locate the following features: Langholm township, Ewes Water, River Esk and Skipper's Bridge.
- 16 Describe the nature of the biophysical, managed and constructed environments evident in the area surrounding Langholm.



Figure 6.9a Langholm, Scotland, © 2016 Google, Image © 2016 Getmapping plc



Figure 7.1a Canada and the United States: physical features

ACTIVITIES

- 1 Name the capital cities of Canada and 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
- 12 Name five cities with a population greater than 5 million.
- 13 Name three Canadian cities with a population greater than 1 000 000 but less than 5 000 000.
- 14 What is the direction of:

a New York from Washington, DC	f Texas
b San Francisco from Austin, Texas?	h Hawaii.
- 15 In what US state would you find the following tourist attractions:

a the Grand Canyon	c Yosemite National Park
b Yellowstone National Park	d Niagara Falls
- 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	c Vancouver
b Washington, DC	d Montreal?





Figure 7.2a Oblique aerial photograph of central Vancouver

Vancouver, British Columbia, has a population of 2.3 million people and is the third-largest Canadian city. It also ranks as one of the world's most 'liveable' cities.

The city occupies a most spectacular coastal setting and features a mountain backdrop. The North Shore Mountains dominate the cityscape as does Stanley Park. At 404.9 ha it is North America's largest urban park.

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).

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 each of the following grid references:
 - a GR 911604
 - b GR 944704
 - c GR 899614
 - d GR 915609
 - e GR 955558.
- 4 Identify the feature of the constructed environment located at the following grid references:
 - a GR 919582
 - b GR 917668
 - c GR 919675
 - d GR 900637.
- 5 Identify the land use in AR 9860.
- 6 What river flows into Vancouver Harbour in AR 8963?
- 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 9063?
- 10 What is the direction of Prospect Point (AR 8962) from Brockton Point (AR 9160)?
- 11 What is the bearing of Elsie Point (GR 8958) from Brockton Point (AR 9160)?
- 12 What is the length of the Grouse Mountain cable car from GR 928688 to GR 939697?
- 13 What is the elevation of the landform feature at GR 987703?
- 14 What is the density of buildings in AR 9468?
- 15 Identify the recreational facility located in the following area references:
 - a AR 8960
 - b AR 9060.
- 16 What is the area of Stanley Park?
- 17 Estimate the area of Lost Lagoon (AR 8960).
- 18 What is the aspect of the slope in AR 9368?
- 19 What is the general aspect of North Vancouver?
- 20 What is the gradient of the slope from the summit of Grouse Mountain to Vancouver Harbour's shoreline at GR 950614?
- 21 In what general direction was the camera facing when Figure 7.2a was taken?
- 22 Using Figure 7.2b locate the features of the physical and human environments identified in Activities 3–4.

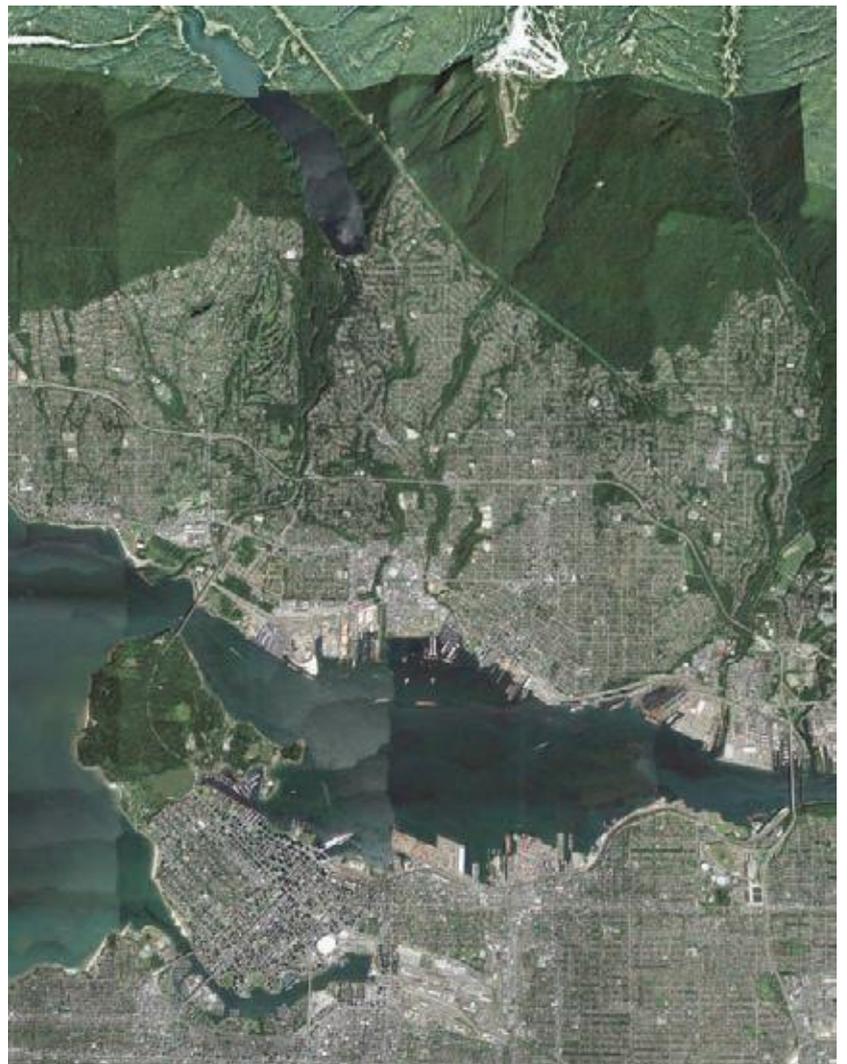


Figure 7.2b Satellite photograph of Vancouver, Google Earth, Image © 2016 DigitalGlobe, © 2016 Google, Image © Province of British Columbia



Vancouver topographic map extract (Vancouver: latitude 49°13'N, longitude 123°06'W)





Figure 7.3a Snug Cove ferry terminal and marina

Bowen Island, British Columbia, is an island in Howe Sound. The island is approximately 6 km wide by 12 km long. At its closest point it is just 3 km west

of the mainland. There is a regular ferry service to the island from Horseshoe Bay. The island is a popular vacation home location for British Columbians.



Figure 7.3b Horseshoe Bay

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 763679
 - b GR 775740
 - c GR 716694
 - d GR 803696
 - e GR 733690
 - f GR 800654.
- 4 Identify the feature of the constructed environment located at:
 - a GR 733754
 - b GR 804672
 - c GR 752699
 - d GR 798683.
- 5 What is the area reference of Passage Island?
- 6 Name the types of vegetation found in AR 7471.
- 7 On what waterway is Honeymoon Lake (AR 7472) located?
- 8 What waterway flows into Snug Cove in AR 7569?
- 9 What is the direction of Horseshoe Bay (AR 8069) from Snug Cove (AR 7669)?
- 10 In what direction is Lee Creek flowing in AR 7366?
- 11 What is the bearing of:
 - a Hope Point (AR 7375) from Finisterre Island navigation light (GR 776740)
 - b Crebe Islets (GR 880654) from Mount Gardner (GR 717694)?
- 12 What is the straight-line distance between Hope Point (AR 7375) and Finisterre Island navigation light (GR 776740)?
- 13 What is the length of the ferry route from Snug Cove (GR 760697) to Horseshoe Bay (GR 803693)?
- 14 What is the aspect of the slope in AR 7468?
- 15 What is the area of Bowyer Island?
- 16 What is the density of buildings in AR 7471?
- 17 What is the height of:
 - a Mount Gardiner (GR 717694)
 - b Mount Collins (AR 7572)?
- 18 What is the elevation of the surface of Killarney Lake?
- 19 Estimate the local relief experienced on a traverse from the summit of Mount Gardiner (AR 7169) to the summit of the hill in AR 7367.
- 20 Construct the cross-section from the summit of Mount Gardiner (GR 7169) to the summit of Mount Collins at GR 758726. Use a vertical scale of 1 cm = 100 m.
- 21 Calculate the vertical exaggeration of the cross-section that you constructed in Activity 20.
- 22 What is the gradient of the slope between the summit of Mount Gardiner (GR 717694) to the point where the creek flows into the sea in AR 7070?
- 23 What is the gradient of Warwick Creek (AR 7466)?
- 24 Study Figure 7.3b and the map extract. Identify the features labelled 1–6.
- 25 In what direction was the camera facing when the image in Figure 7.3b was taken?
- 26 Study Figure 7.3c and the map extract. Identify the features labelled 1–5.



Figure 7.3c Snug Cove

CONTOUR INTERVAL 20 METRES





Figure 7.4a Oblique aerial photograph of Nanaimo, Vancouver Island

Nanaimo is a small city on British Columbia's Vancouver Island. Nanaimo began as a Hudson Bay Co. trading post in the early 19th century. The discovery of coal led to the city becoming known for

the export of coal. Today, Nanaimo is a popular tourist destination. The city's ferry terminal is an important transport link for those travelling between Vancouver Island and the mainland.

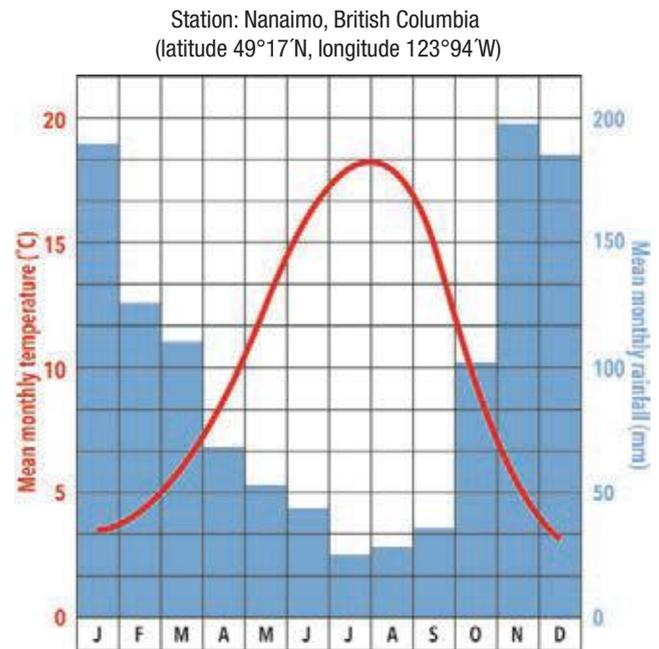


Figure 7.4b Nanaimo's waterfront

ACTIVITIES

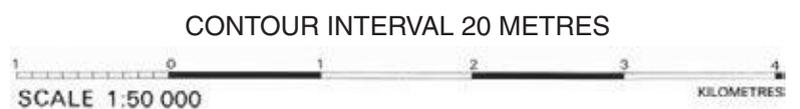


- 1 What is the scale of the map extract?
- 2 What is the contour interval used on the map extract?
- 3 Identify the feature of the biophysical environment located at:
 - a GR 326530
 - b GR 378498
 - c GR 308530
 - d GR 281531.
- 4 Identify the feature of the constructed environment located at:
 - a GR 374432
 - b GR 291442
 - c GR 324494
 - d GR 283503.
- 5 What is the area reference of Five Finger Island?
- 6 Name the type of biophysical feature found in AR 3342.
- 7 Name the type of land use found in AR 3245.
- 8 Name the type of vegetation found in AR 3442.
- 9 What river flows into Nanaimo Harbour at GR 314470?
- 10 What is the direction of Snake Island (AR 3551) from Five Finger Island (AR 3353)?
- 11 In what direction is Millstone Creek flowing in AR 2847?
- 12 What is the bearing of Horswell Rock (AR 3151) from the navigation light on Snake Island (GR 352520)?
- 13 What is the length of the ferry route from Nanaimo (GR 319465) to Descanso Bay (GR 374475)?
- 14 What is the length of the ferry route from Nanaimo to Protection Island?
- 15 What is the aspect of the slope in AR 2953?
- 16 What is the area of Newcastle Island?
- 17 What is the density of buildings in AR 3747?
- 18 What is the height of the hill at GR 294529?
- 19 What is the height of the hill at GR 284452?
- 20 What is the elevation of the surface of Westwood Lake (AR 2745)?
- 21 What is the gradient of the slope between GR 294529 and the shoreline at GR 298535?
- 22 List the main economic activities found in and around Nanaimo.
- 23 Study Figure 7.4a and the map extract. Locate the following features in the photograph: Newcastle Island, Protection Island, Newcastle Passage, Mark Bay, Departure Bay and Jesse Island.
- 24 Study the climate graph of Nanaimo in Figure 7.4c 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 precipitation.



	J	F	M	A	M	J	J	A	S	O	N	D	Year
Av. max. (°C)	6.9	8.5	11.0	14.1	17.7	20.8	23.9	24.3	20.9	14.6	9.3	6.3	14.8
Av. min. (°C)	0.1	0.0	1.7	3.9	7.2	10.3	12.3	12.1	8.9	5.2	1.8	-0.2	5.3
Daily mean (°C)	3.5	4.3	6.3	9.0	12.5	15.6	18.1	18.2	14.9	9.9	5.6	3.1	10.1
Precip. (mm)	187.9	126.0	113.0	67.4	54.3	43.4	25.4	28.4	35.8	102.2	197.2	184.3	1165.4

Figure 7.4c Climate data for Nanaimo, British Columbia



Nanaimo topographic map extract (Nanaimo: latitude 49°17'N, longitude 123°94'W)

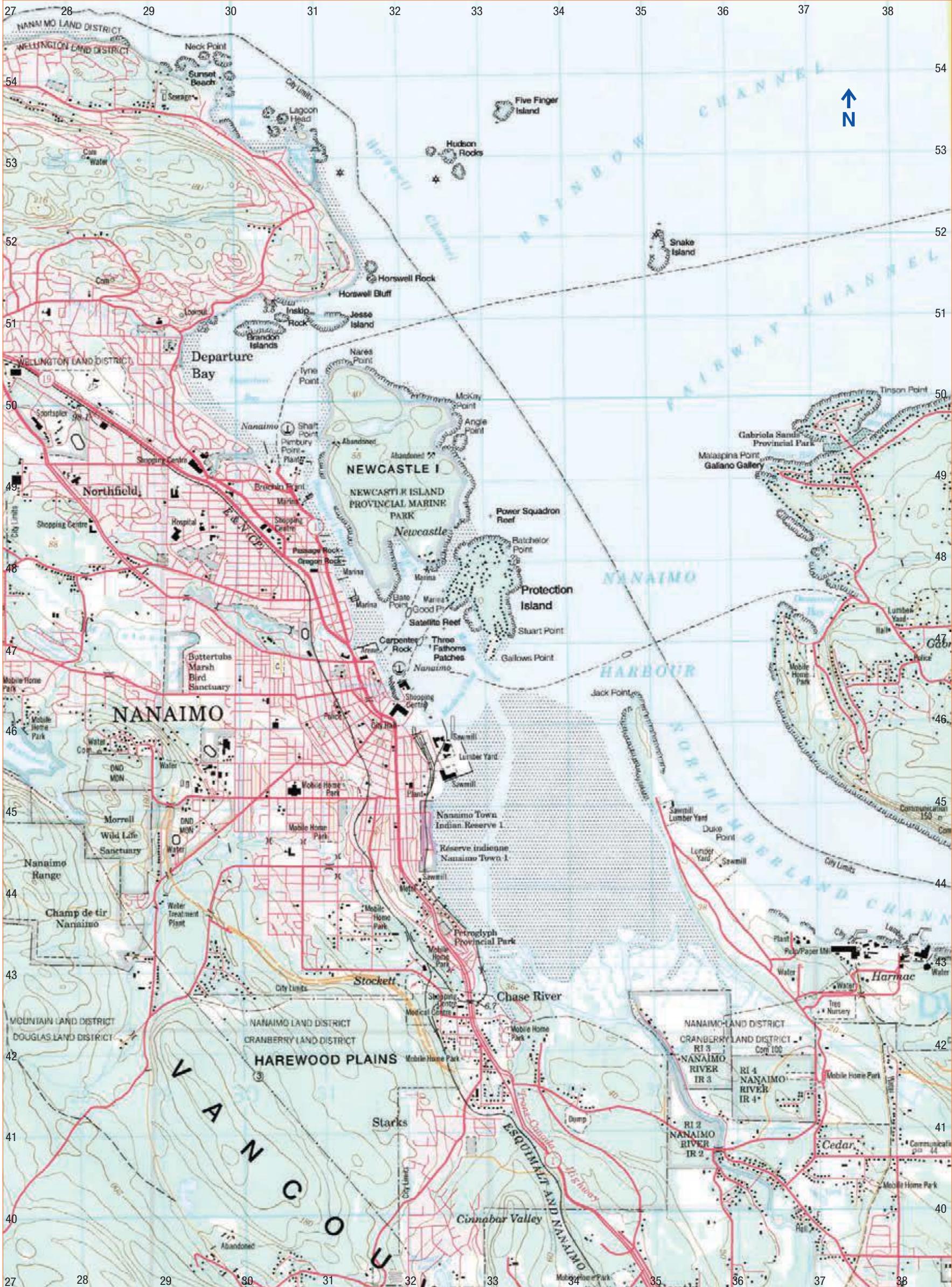




Figure 7.5a Blackcomb and Whistler mountains

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 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?
- 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 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.
- 30 Study Figure 7.5b and the map extract. Locate the following features: Green Lake, Lost Lake, Whistler Golf Course, Chateau Whistler Golf Course, Upper Village, Whistler Village, and the Alpine Meadows residential area.

Whistler is one of the world's leading winter sports resorts. Over 2 million people visit Whistler each year, primarily for skiing and snowboarding and, in summer, mountain bike riding, golfing and hiking.

Whistler is located approximately 125 km 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.

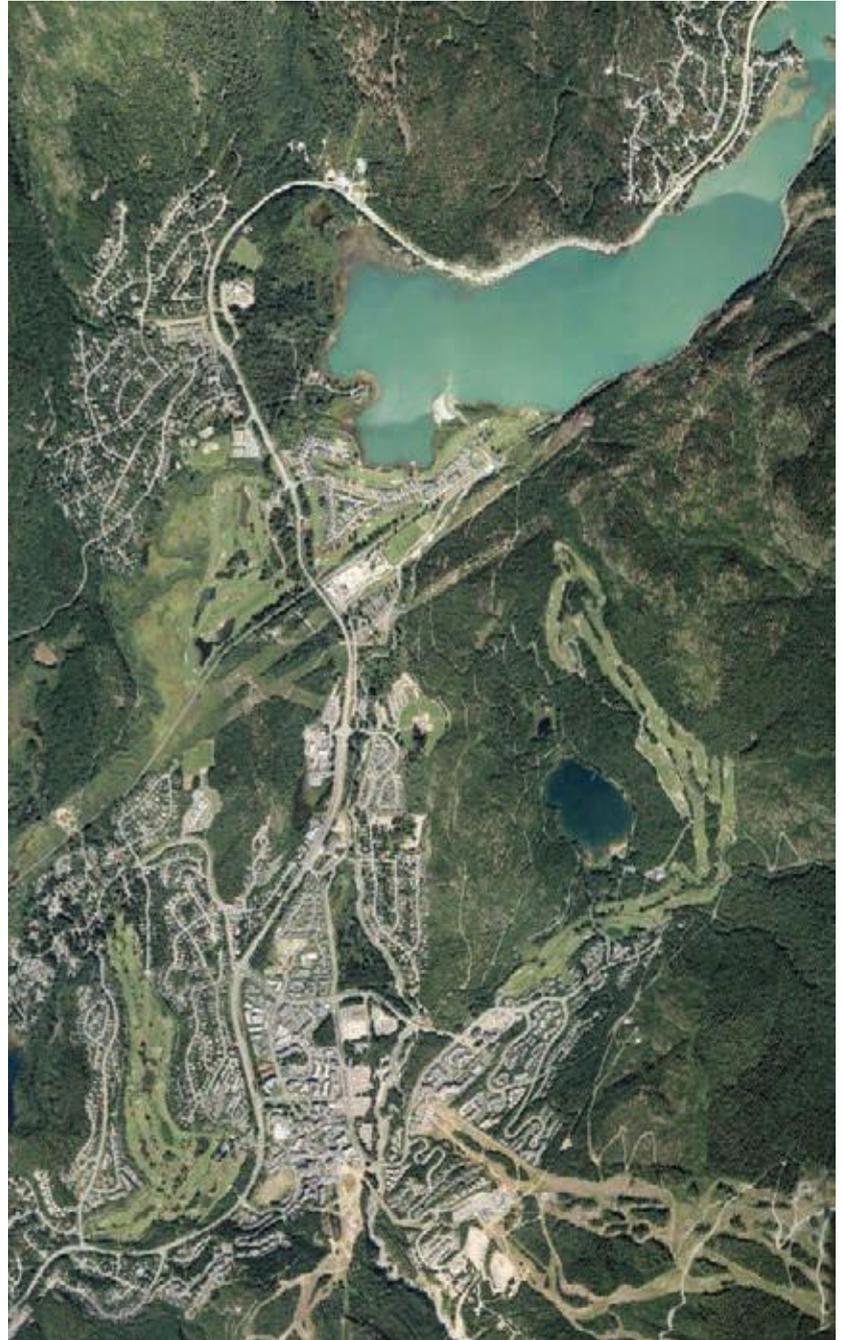
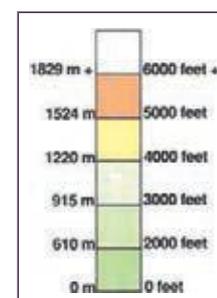
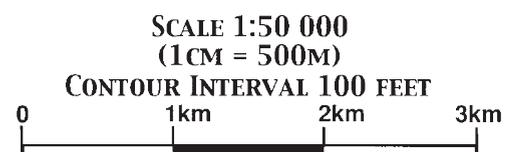


Figure 7.5b Whistler Village, Google Earth, Image © 2016 DigitalGlobe, © 2016 Google



Whistler topographic map extract (Whistler: latitude 49°58'N, longitude 123°09'W)

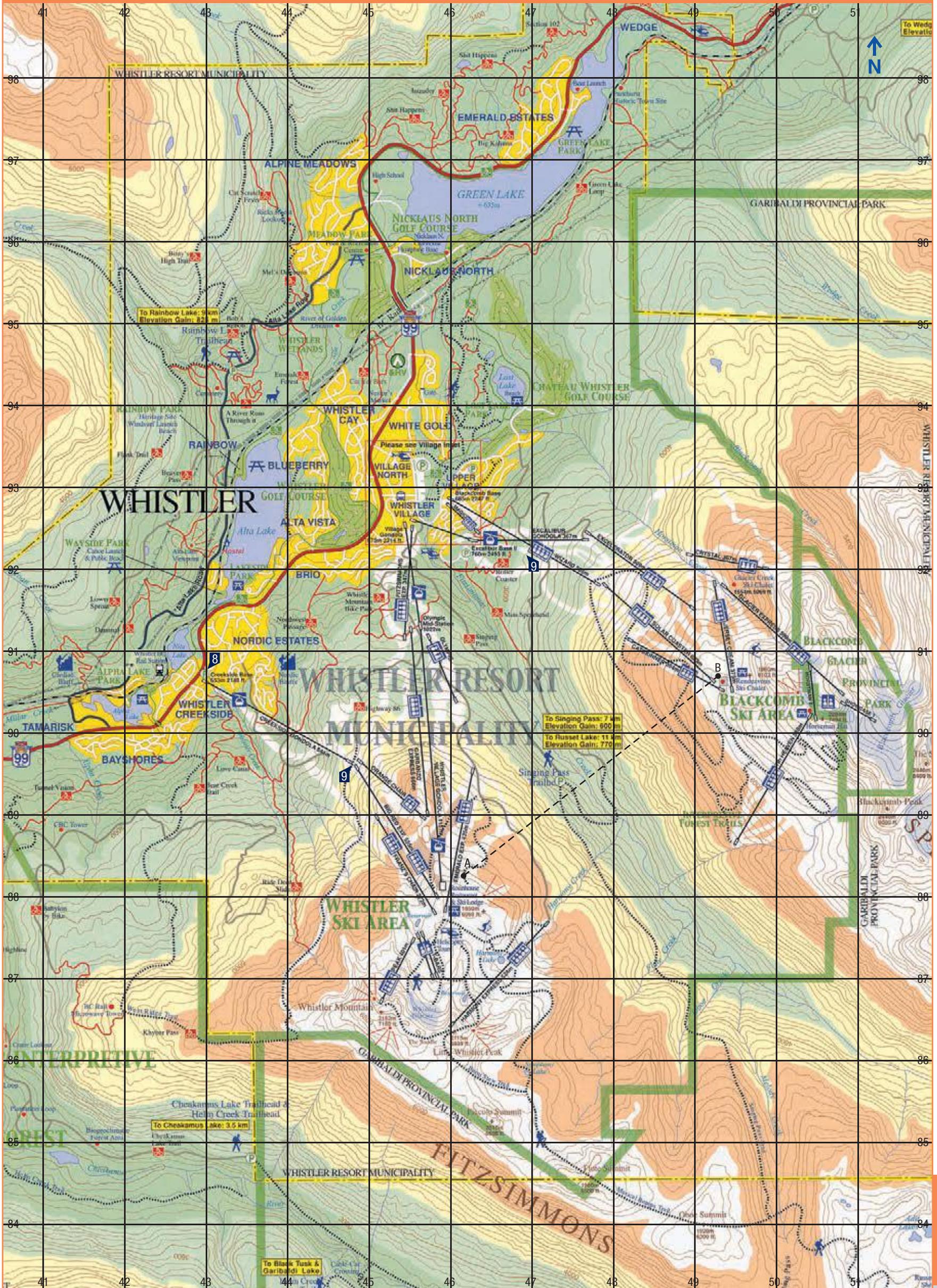




Figure 7.6a Moraine Lake



Figure 7.6b Agnes Lake



Figure 7.6c Banff Springs Hotel, Banff



Figure 7.6d Lake Louise and the Chateau Lake Louise

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 233726
 - b GR 267765
 - c GR 323717
 - d GR 351743.
- 4 Identify the feature of the constructed environment located at:
 - a GR 249723
 - b GR 276721
 - c GR 313665
 - d GR 244721.
- 5 What is the grid reference of Castle Junction?
- 6 What biophysical feature is found in AR 3568?
- 7 What type of recreational land use is found in AR 2872?
- 8 What is the name of the creek flowing from Kaufmann Lake in AR 2768?
- 9 What is the name of the tributary that joins the Bow River at GR 327683?
- 10 What is the direction of Lake Louise (AR 2872) from Banff (AR 3666)?
- 11 In what direction does Bow River flow in AR 2970?
- 12 Study Figure 7.6d. In which direction was the camera facing when this photograph was taken?
- 13 What is the bearing of Mount Brett (AR 3366) from Panther Mountain (AR 3574)?
- 14 What is the aspect of the slope in AR 3769?
- 15 What is the straight-line distance from Castle Junction (AR 3168) to Lake Louise (AR 2872)?
- 16 What is the straight-line distance from the summit of Mount Brett (AR 3366) to the summit of Panther Mountain (AR 3574)?
- 17 Estimate the area of Bonnet Glacier (AR 3172).
- 18 Estimate the height of the following landform features:
 - a Pulsatilla Mountain (GR 309714)
 - b Mt Cory (GR 348674)
 - c Lake Louise (GR 274719).
- 19 Estimate the height of the camping ground at GR 331694.
- 20 What is the difference in elevation of Mount Brett (AR 3366) and Panther Mountain (AR 3574)?
- 21 Identify the principal agents of erosion responsible for the landforms featured on the map extract.
- 22 Describe the relationship between transport and topography on the map extract.
- 23 Construct a precis map showing the relationship between topography and transport on the map extract.
- 24 Study Figures 7.6a–d. Using grid and area references, locate each of these features on the Banff Springs topographic map extract.

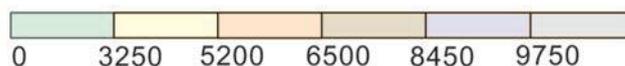
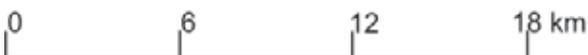


Banff National Park is Canada's oldest national park and one of the world's great scenic wonders. The park covers 6641 km² of mountainous terrain, with numerous glaciers, ice fields and dense coniferous forest. Some of the most famous sights include Lake Louise and Moraine Lake. The main commercial centre of the park is the town of Banff in the Bow River valley.

Multi-lane Highway	
Major Roads (paved)	
Secondary Roads (paved)	
Main Gravel Roads	
Trails	
Railway	
Accommodation	
Airstrip / Airport	
Camp / Recreation Sites	
Fishing	
Information	
Parking	
Point of Interest	
Rest / Picnic Area	
R V Park	
Ski Area	
Waterfall	
View Point	
Provincial Boundary	
Indian Reserve	
Parks	
Glacier/Icefield	

Scale 1 : 300 000

Contour interval 650 feet



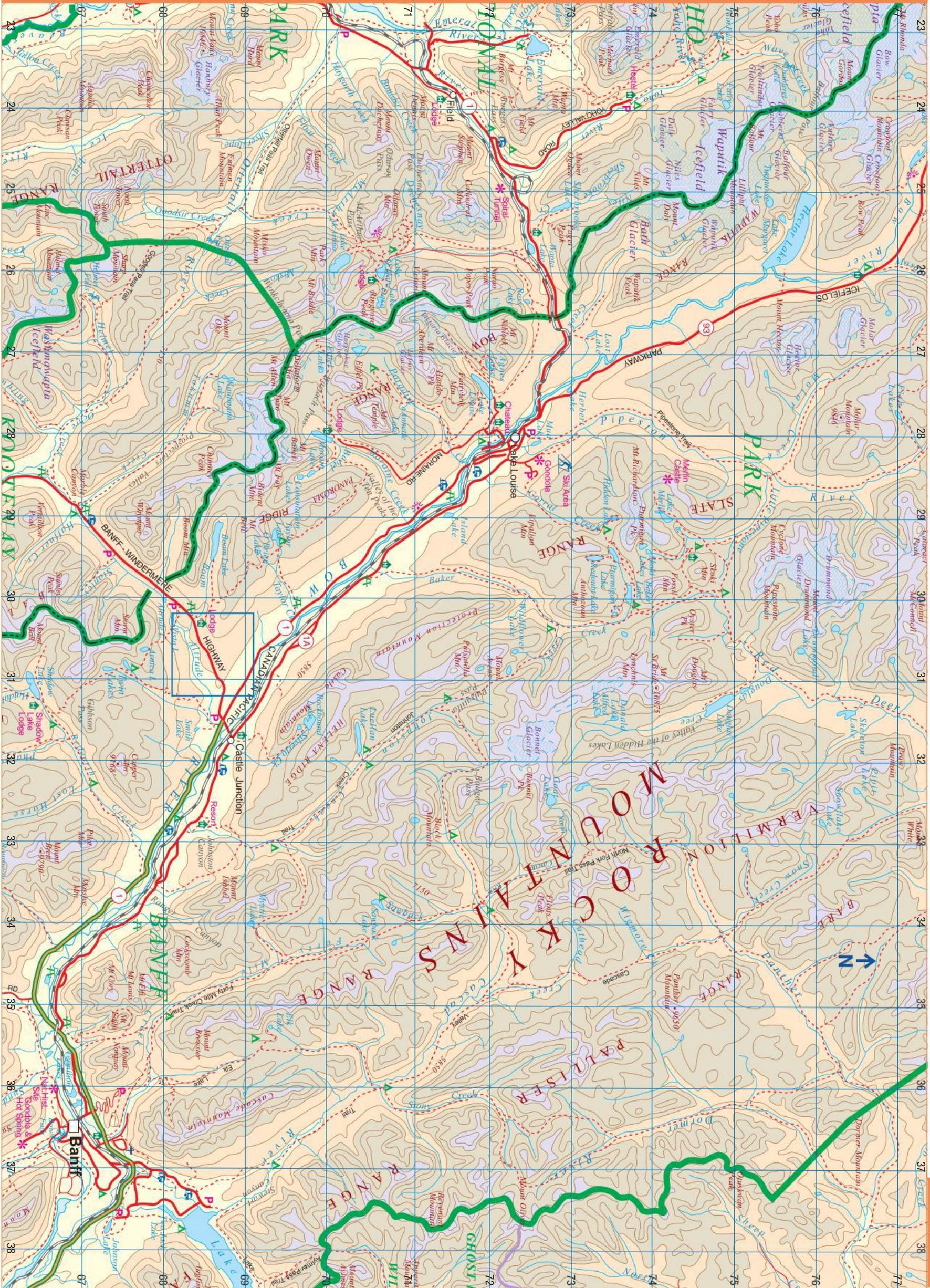




Figure 7.7a Oblique aerial photograph of Niagara Falls

Niagara Falls is the name for three waterfalls that straddle the border of Canada and the United States. From largest to smallest, the three waterfalls are the Horseshoe Falls, the American Falls and the Bridal Veil Falls.

Located on the Niagara River, which links Lake Erie to Lake Ontario, the falls collectively have the highest flow rate of any fall in the world. Horseshoe Falls is the most powerful waterfall in North America, as measured by vertical height and flow rate.

ACTIVITIES

- 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:
 - a GR 569762 b GR 571720
 - c GR 565714 d GR 574717.
- 4 Identify the feature of the constructed environment located at:
 - a GR 527698 b GR 585696
 - c GR 594785 d GR 555730.
- 5 State the productive activity located in the following locations:
 - a AR 5369 b AR 5482
 - c AR 5669 d AR 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.
- 20 Study Figure 7.7a. In what direction was the camera facing when the photograph was taken?

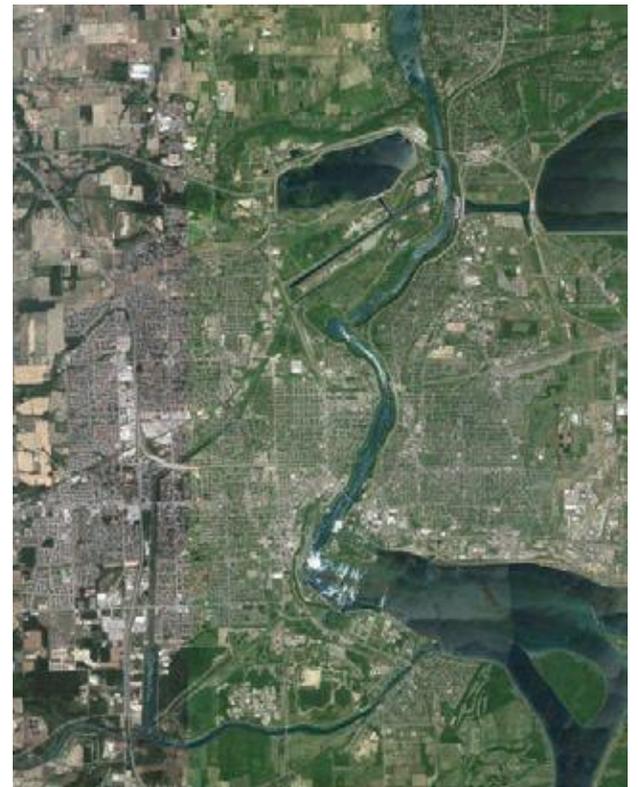
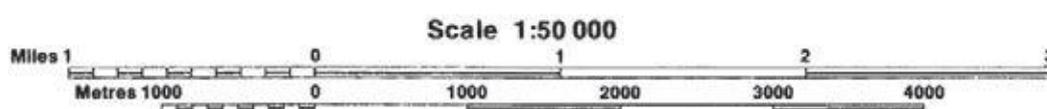
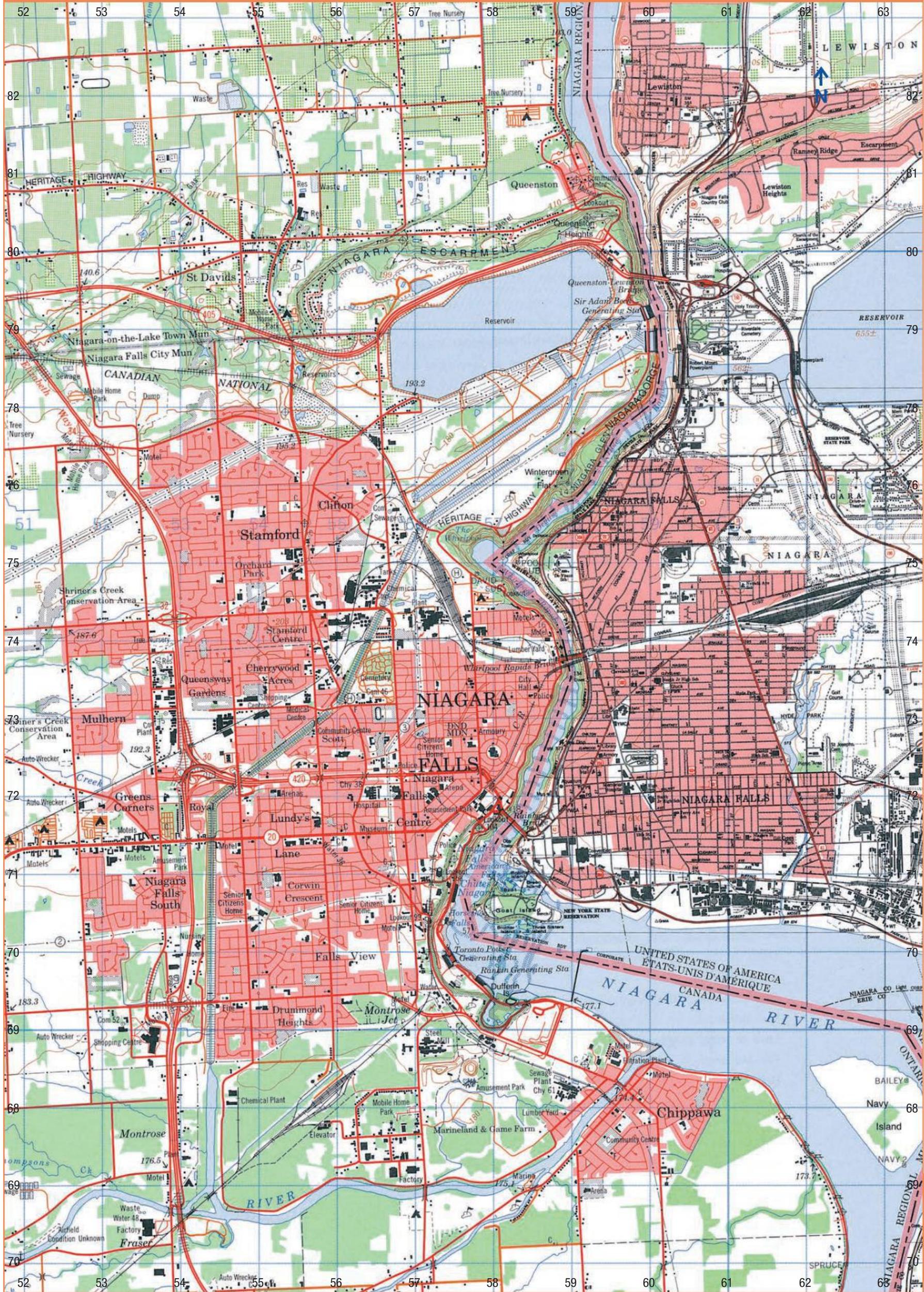


Figure 7.7b Satellite photograph of Niagara Falls, Google Earth, © 2016 Google, Images © 2016 DigitalGlobe



CONTOUR INTERVAL 10 METRES IN CANADA
Elevation in metres above mean sea level
CONTOUR INTERVAL 25 FEET IN USA



Yosemite Valley, located in California's Sierra Nevada Mountains, 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 (flowing water) and glacial processes. Yosemite National Park was established in 1890.

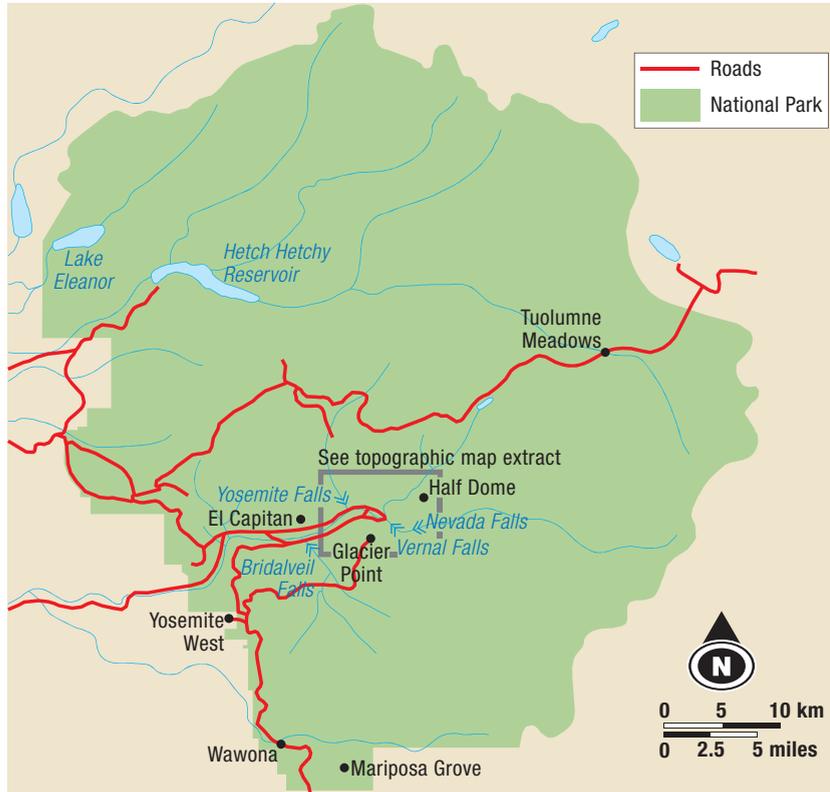


Figure 7.8a Location of key features in Yosemite National Park



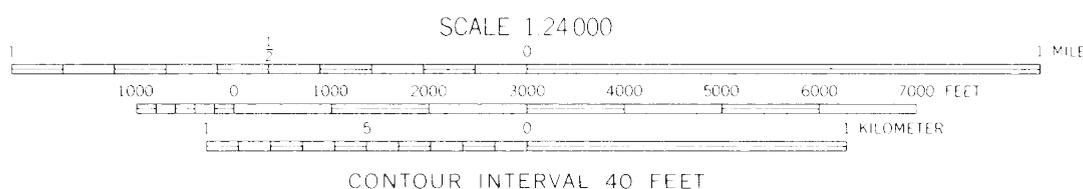
Figure 7.8b Oblique aerial image of Yosemite National Park

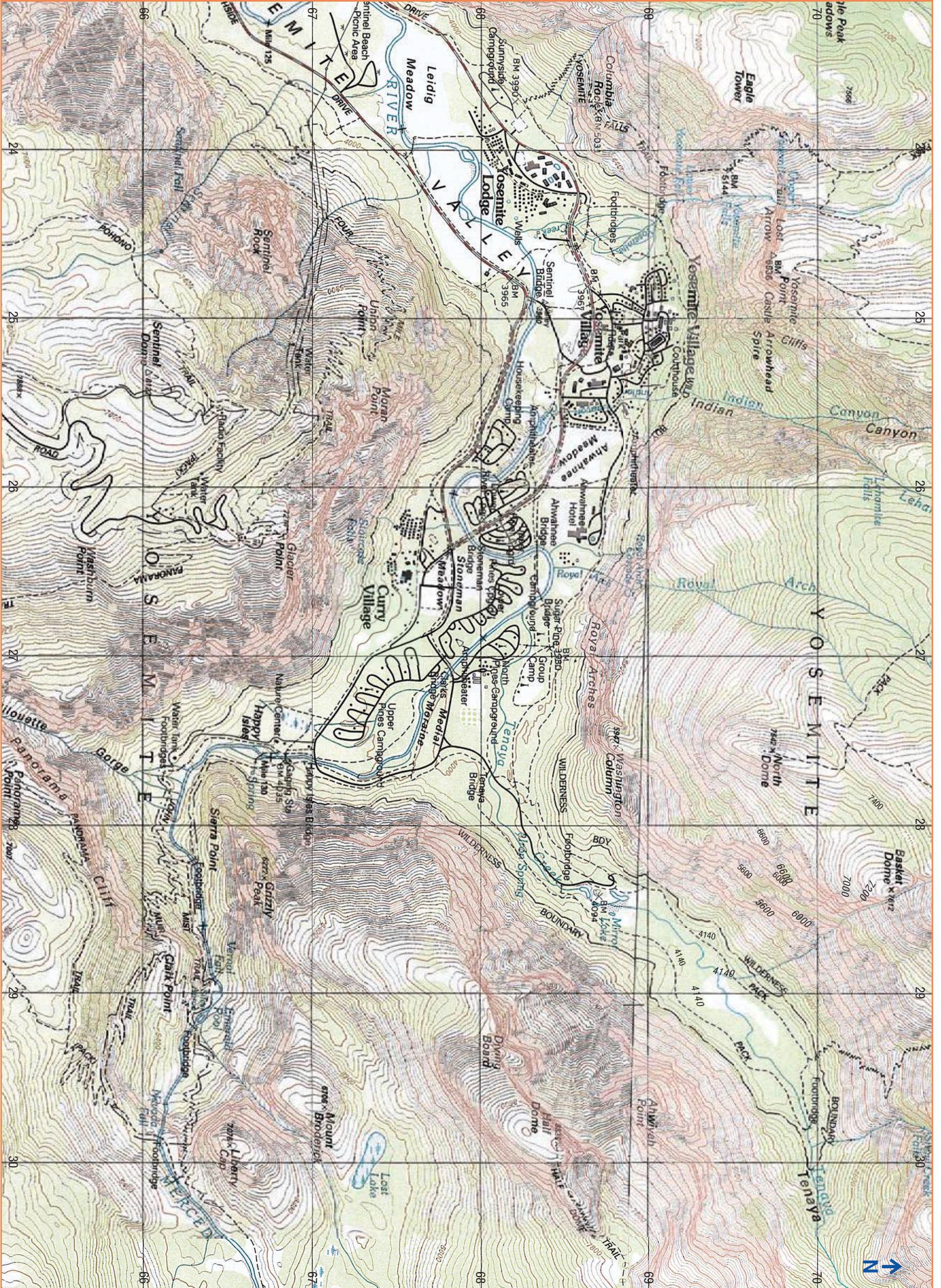


Figure 7.8c Yosemite National Park

ACTIVITIES

- What is the scale of the map extract?
- What is the contour interval used on the map extract?
- Identify the features of the biophysical environment located at:
 - GR 276688
 - GR 285688
 - GR 243694
 - GR 253660
 - GR 298662
 - GR 272687
 - GR 264668
 - GR 247698.
- Identify the features of the constructed environment located at:
 - GR 263686
 - GR 269679
 - GR 255665
 - GR 282663.
- What is the area reference of the Yosemite Lodge?
- What is the land use in AR 2367?
- On what creek is the Royal Arch Cascade (AR 2668) located?
- What creek flows into the Merced River at GR 245682?
- Name the tributary that joins the Merced River at GR 267683.
- In what direction is Sentinel Creek flowing in AR 2466?
- What is the direction of:
 - Glacier Point (AR 2666) from Yosemite Point (AR 2469)
 - North Dome (AR 2769) from Half Dome (AR 2968)?
- What is the bearing of:
 - Glacier Point (AR 2666) from Yosemite Point (AR 2469)
 - Grizzly Peak (AR 2866) from the summit of Mount Broderick (AR 2967)?
- Estimate the straight-line distance, in miles, between:
 - the summits of Half Dome (GR 298683) and North Dome (GR 275697)
 - Yosemite Point and Glacier Point.
- What is the elevation of:
 - Lost Lake
 - Half Dome (AR 2968)?
- What is the difference in elevation between Mount Broderick (AR 2967) and Liberty Cap (AR 2966)?
- What is the local relief experienced on a traverse from Grizzly Peak (AR 2866) to North Dome (AR 2769) via Iron Spring?
- Complete the cross-section from the summit of North Dome to Mirror Lake using a vertical scale of 1 cm = 1000 ft.
- Study Figure 7.8b, 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.
- Name the features labelled 1–6 on Figure 7.8b. Locate these features on the map extract and describe their location using area references.
- Construct a photo sketch of Figure 7.8c. Label any landform features you can identify.
- Undertake research to investigate the geographical processes responsible for the landform features you drew in Activity 20.
- View additional photographs of Yosemite National Park at the following websites:
 - TravelYosemite.com
 - Terragalleria.com.
- Use Google Earth to explore Yosemite National Park.





Use the following map legend for Units 7.2, 7.3, 7.4 and 7.7.

	Road: hard surface, more than 2 lanes; toll gate; service centre Route : revêtement dur, plus de 2 voies; poste de péage; centre de service
	Road: hard surface, 2 lanes; less than 2 lanes; snowshed Route : revêtement dur, 2 voies, moins de 2 voies; paravalanche
	Road: hard surface, street; conduit bridge; loose or stabilised surface, street Route : revêtement dur, rue; pont de canalisation; de gravier, aggloméré, rue
	Road: loose or stabilised surface, all season, 2 lanes or more; less than 2 lanes Route : de gravier, aggloméré, toute saison, 2 voies ou plus; moins de 2 voies
	Road: loose surface, dry weather; vehicle track or winter road; trail; portage Route : de gravier, temps sec; chemin de terre ou d'hiver; sentier; portage
	Highway interchange: highway route number; built-up area Échangeur; numéro de route; agglomération
	Railway, single track; railway station; bridge; turntable; multiple tracks Chemin de fer, voie unique; gare; pont; plaque tournante; voies multiples
	Railway, abandoned; railway yard Chemin de fer, abandonné; gare de triage
	Rapid transit: rail, road; footbridge Transport rapide : voie ferrée, route; passerelle
	Causeway; covered bridge; tunnel; bridge; moveable bridge Chaussée; pont couvert; tunnel; pont; pont mobile
	Boundary: International; boundary monument Limite : Internationale; repère d'arpentage
	Boundary: Provincial and Territorial Limite : Provinciale et territoriale
	Boundary: unsurveyed provincial or territorial; area outline Limite : Provinciale ou territoriale non arpentée; surface délimitée
	Boundary: administrative; recreational Limite : administrative; récréative
	Boundary: geographic; unsurveyed geographic; small Indian reserve Limite : géographique; géographique non arpentée; petite réserve indienne
	Waterbody/shoreline; watercourse; disappearing stream Plan d'eau/littoral; cours d'eau ou rive; cours d'eau disparaissant
	Navigation light; ferry; crib or abandoned bridge pier Feu de navigation; traversier; caisson ou pilier de pont abandonné
	Coast guard station; seaplane base: active, condition unknown; marina Station de la garde-côte; hydrobase : actif, condition inconnue; marina
	Fish ladder; dam: small, large, carrying road Échelle à poissons; barrage : petit, grand, portant une route
	Dyke/seawall: boat ramp; wharf; pier or dock; ford; breakwater Digue/mur de protection; rampe de chargement; quai; jetée; gué; brise-lames
	Slip; drydock; ford; small islands; navigational beacon Cale; cale sèche; gué; îlots; balise de navigation
	Navigable canal; lock; ditch, conduit, irrigation canal; spring Canal navigable; écluse; fossé, canalisation, canal d'irrigation; source
	Reservoir; underground reservoir; fish pound Réservoir; réservoir souterrain; viviers dans l'eau
	Alluvium: dry river bed, sand in water, foreshore flats Alluvion : lit de rivière à sec, sable dans l'eau, estrans
	Rapids; falls (height) Rapides; chutes (hauteur)
	Rocky ledge; reef; rocks in water; exposed shipwreck Barre rocheuse; récif; rochers dans l'eau; épave émergée
	Moraine, glacial debris; permanent snow and ice Moraine, débris glaciaires; neige et glace permanentes
	Marsh, swamp, marsh in water; string bog Marais, marécage, marais dans l'eau; tourbière réticulée
	Tundra ponds; tundra polygons; palsa bog Étangs de toundra; polygones de toundra; tourbière à palse
	Sand; esker; pingo; wooded area Sable; esker; pingo; région boisée
	Contours: index; intermediate; approximate Courbes de niveau : maîtresses; intermédiaire; approximative
	Depression contour; spot elevation; cave Courbes de cuvette; point coté; caverne

	Wall; fence Mur; clôture
	Power transmission line; multiple lines; submarine cable Ligne de transport d'énergie; lignes multiples; câble sous-marin
	Pipeline: oil, natural gas; control valve; multi-use; underground Pipeline : pétrole, gaz naturel; valve de contrôle; multi-utilisateur; souterrain
	Mine: pit; sand, gravel, clay; quarry Mine; banc : sable, gravier, argile; carrière
	Airport/airfield: active, condition unknown; heliport Aéroport/terrain d'aviation : actif, condition inconnue; hélicoptère
	Industrial building; chimney; industrial, flare stack, burner; lumberyard Industrielle bâtiment; cheminée; industrielle, torche, brûleur; parc à bois débité
	Oil tank; water tank Réservoir de pétrole; réservoir d'eau
	Silo; grain elevator; clearance tower; satellite tracking station Silo; élévateur à grains; tour de dégagement; station de poursuite de satellite
	Electric facility; oil or natural gas facility; wind-operated device Installation électrique; installation pétrolière ou gazière; éolienne
	Tower: communication, radar antenna; radio telescope; fire; control Tour : communication, antenne radar; radiotélescope; feu; contrôle
	Domestic waste; liquid waste; industrial solid depot Déchet domestique; déchet liquide; dépôt de solide industriel
	Sportsplex; arena; community centre Centre sportif; aréna; centre communautaire
	Lookout; historic site; zoo Belvédère; lieu historique; zoo
	Golf course; campground; ruins Terrain de golf; terrain de camping; ruines
	Ski lift; sports track Remonte-pente; piste de course
	Building(s); building(s), religious; educational; cabin Bâtiment(s) : bâtiment(s); religieux; d'enseignement; cabine
	Hospital; medical centre; senior citizens home; lodging Hôpital; centre médical; résidence pour personnes âgées; gîte
	City hall; Parliament Building; municipal hall Hôtel de ville; édifice du Parlement; salle municipale
	Customs post; ranger /warden station; cemetery Poste de douane; poste de garde forestier /poste de garde de parc; cimetière
	Court house; penal institution Palais de justice; établissement pénitentiaire
	Fire station; police station; armoury Casernes de pompiers; poste de police; manège militaire

Use the following map legend for Unit 7.5.

	Railway w/ Station
	Paved Major Highway
	Main Road (hard surface)
	Dirt Road (logging road)
	Dirt Track (not reliable) & Hiking
	Paved Bike trail / Mountain Bike Trail
	Town Area WHISTLER
	Area Names ALTA LAKE
	Rivers / Lakes / Waterfalls
	Hydro Corridor
	Helipad / Scenic View
	Campsite / Campground (RV)
	Parking Lot
	Point of Interest
	Hotel / Condo Accomodation
	Mountain Peak w/ Elevation
	Gondola
	High-Speed Quad Chairlift
	Triple Chairlift
	Double Chairlift
	T-Bar Lift
	Lift's Name & Elevation Gain
	Ski Run
	Glacier (permanent ice)
	Provincial Park BC PARKS
	Golf Course
	Whistler Municipality Border
	Downhill / Cross-Country Skiing
	Hiking / Climbing Areas
	Wildlife / Picnic Areas
	Fishing
	Intercity Bus Stop Greyhound

1829 m +	6000 feet +
1524 m	5000 feet
1220 m	4000 feet
915 m	3000 feet
610 m	2000 feet
0 m	0 feet