**1.1 Maps**

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

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

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

**MAP ESSENTIALS**

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

**TYPES OF MAPS**

There are many different types of maps. Each type is used to show or highlight a particular set of geographical features.

The most common types of maps are shown in Figures 1.1c–1.1g.

**Figure 1.1b** Map essentials.

**Figure 1.1a** Maps—you would be lost without them.

**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.)

**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.)

**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 6–9.)

**Legend**

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

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

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

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

FLOWLINE MAPS

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

MAP SYMBOLS

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

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

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

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. Using the legend for the topographic map in Unit 3.4 (page 48) to complete the following task. Draw the symbol used to show each of the following features:
   a. railway station
   b. embankment
   c. mine
   d. bridge
   e. cliff
   f. small dam
   g. exposed wreck
   h. swamp
   i. lighthouse.
11. Design your own symbol for each of the following features of the built environment:
   a. fast-food outlet
   b. shopping mall
   c. skateboarding 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.


**Linear scale.**

Figure 1.2b Linear scale.

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 1 cm:1 km or 1 cm = 1000 m.
3. As a linear scale. (See Figure 1.2b.)

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

The most common scales used for topographic maps are:

- **1:2500**, which is the same as 4 cm = 1 km, 1 cm = 0.25 km or 1 cm = 250 m
- **1:5000**, which is the same as 2 cm = 1 km, 1 cm = 0.5 km or 1 cm = 500 m
- **1:10000**, which is the same as 1 cm = 1 km or 1 cm = 1000 m
- **1:25000**, which is the same as 0.4 cm (4 mm) = 1 km, 1 cm = 2.5 km or 1 cm = 2500 m.

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

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

### Calculating Distances

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

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

#### Measuring a Straight-line Distance

To estimate a straight-line distance, place the edge of a sheet of paper between the two points and mark on the paper the distance between the points. Place the paper 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 1.2a, page 5.)

#### Measuring a Distance Along a Curved Line

To estimate a distance along a curved line, place a sheet of paper on the map and off the distance on the scale. (See Figure 1.2c, page 5.)

### Large-scale maps vs small-scale maps

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

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

To fit a map of the world onto an A4 sheet of paper (measuring 297 mm x 210 mm) you would need to use a scale of approximately 1:135,000,000 (a smaller scale). To fit a map of Australia onto an A4 sheet of paper you would need to use a scale of approximately 1:2,000,000. At a scale of 1:25,000 (a larger scale) it would take 50,000 A4 sheets map sheets to map Australia.

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**Figure 1.2a** ‘I’ve been scaled!’

**Figure 1.2b** Linear scale.

**Figure 1.2c** Different scales can show different levels of detail. The top map is drawn at a scale of 1:400,000 and the bottom map at 1:200,000.
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 (km²). (See Figure 1.2f.)

EXAMPLE

The area of the lake in Figure 1.2f is approximately 42 km².

CALCULATING DENSITY

The term ‘density’ refers to the number of people or objects per unit area, usually 1 km².

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

EXAMPLE

The density of buildings in AR 2736 is 7/km².

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.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Representative fraction or ratio</th>
<th>Linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>One cm represents 250 m</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>$\frac{1}{50,000}$ or 1:50,000</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Using the linear scale in Figure 1.2b (page 4) 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”?

Advanced skill: calculating time–distance relationships

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

EXAMPLE

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

1. Calculate how long it would take to travel 1 km at 80 km/h.
   Divide 60 (minutes) by 80 (speed in km/h).
   \[ = \frac{60}{80} \text{ of a minute} \text{ (that is, 45 seconds)} \]

2. Multiply the time taken to travel 1 km by the distance to be travelled.
   \[ = 0.75 \times 30 \text{ km} = 22.5 \text{ minutes} \]
### 1.3 Locating places

**LOCATION**

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

**ALPHA-NUMERIC GRIDS**

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

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

**GRID AND AREA REFERENCES**

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

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**Figure 1.3a** You are here.

**Figure 1.3c** Extract from a London street directory.

**Figure 1.3b** Grid lines.

**Figure 1.3d** Grid reference example.

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**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 219A.

**Example 4**

Find the area reference (AR) of the road bridge. The AR of the road bridge is 223B.
lines, which are a series of equally spaced, numbered vertical and horizontal lines. The horizontal lines are called northings and the vertical lines are called eastings. (See Figure 1.3b, page 6.) Northings are numbered from the south to north (from bottom to top). Eastings are numbered from west to east (from left to right).

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

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

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 ½°N), the Tropic of Capricorn (23 ½°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 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.

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.)

Activities

1. Explain the difference between relative location and absolute location.
2. State the name given to the grid typically used on maps in street directories.
3. Distinguish between northings and eastings on topographic maps.
4. Study Figure 1.3c: (page 6) and then complete the following tasks:
   a. Identify the features located at each of the following alpha-numeric grid references:
      i. G4
      ii. H1.
   b. State the alpha-numeric grid of each of the following features:
      i. Buckingham Palace
      ii. Admiralty Arch
      iii. Westminster Abbey
      iv. Houses of Parliament
      v. Westminster Cathedral.
5. Identify the circumstances in which area references are used instead of grid references.
6. Study Figure 1.3d: (page 6) and then complete the following tasks:
   a. State the grid reference of points C to F.
   b. State the grid reference of each of the following features:
      i. dam wall
      ii. road bridge
      iii. oval
      iv. shipwreck.

Table 1.3a

<table>
<thead>
<tr>
<th>Place/feature</th>
<th>Latitude and longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>17°58’S 25°45’E</td>
</tr>
<tr>
<td>b</td>
<td>Mt Kilimanjaro, Africa</td>
</tr>
<tr>
<td>c</td>
<td>Mt Everest, Asia</td>
</tr>
<tr>
<td>d</td>
<td>5°58’N 62°32’W</td>
</tr>
<tr>
<td>e</td>
<td>Grand Canyon, North America</td>
</tr>
<tr>
<td>f</td>
<td>Yosemite National Park, North America</td>
</tr>
<tr>
<td>g</td>
<td>13°08’S 72°30’W</td>
</tr>
<tr>
<td>h</td>
<td>Mount McKinley, North America</td>
</tr>
<tr>
<td>i</td>
<td>Niagara Falls, North America</td>
</tr>
<tr>
<td>j</td>
<td>79°04’S 86°21’W</td>
</tr>
</tbody>
</table>
**1.4 Direction, bearings and quadrants**

**DIRECTION**

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

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

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

**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 north. South is behind you, west is to your left and east is towards your right.

**ACTIVITIES**

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

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

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

**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˚.

**Quadrants**

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

**Activities**

6. State why geographers use bearings. Explain how bearings are calculated.
7. Explain what is meant by the term ‘quadrant’.
1.5 Relief

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.)

**CONTOUR LINES**

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

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

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

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

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

**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.

**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 1.5a Contoured!](image)

![Figure 1.5b Shading on Lake Coleridge topographic map extract.](image)

![Figure 1.5c Colour layering on Dungarvan topographic map extract.](image)

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

![Figure 1.5e Contour patterns and the shape of slopes.](image)

![Figure 1.5f Determining aspect.](image)
In the absence of a spot height, it is possible to estimate the height above sea level of a feature by studying the contour lines on a topographic map.

**EXAMPLE 1**

Estimate the height of the hill at point A in Figure 1.5h. Point A lies above 200 m but it is obviously less than 250 m. Your answer should be expressed as a statement; for example, ‘Point A is more than 200 m but less than 250 m.’

**EXAMPLE 2**

Estimate the height of point B in Figure 1.5i. 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’.

**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.

\[
\text{Local relief} = \text{Highest point} - \text{Lowest point} = 150 m - 50 m = 100 m
\]

**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**

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.
Advanced skill: calculating gradient

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

Calculating the gradient between two points involves the following steps.

STEP 1
Determine the two pieces of information required to complete the calculation.

• The first piece of information required is the difference in height between the two points. This is called the vertical interval, or rise. Find this by subtracting the lowest point from the highest point.

• The second piece of information required is the horizontal distance between the two points. This is sometimes referred to as the run. Find this by measuring the distance between the two points on the map and then using the scale to determine the actual distance.

STEP 2
To calculate the gradient of a slope use the following formula.

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

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

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

Gradient = \( \frac{7 \text{ m}}{450 \text{ m}} \) = 1 in 64 or 1:64

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

ACTIVITIES

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

Study Figure 1.5i and then complete the following tasks.

11 What is the contour interval on the Blue Lake topographic map?
12 Identify the feature of the physical environment located at:
   a GR 283681
   b GR 295635
   c GR 232698
   d GR 280670.
13 Identify the feature of the human or built environment located at:
   a GR 252679
   b GR 251668.
14 What is the physical landform feature located at AR 2363?
15 What is the land use found in AR 2970?
16 What is the vegetation type found in AR 2668?
17 What is the direction of Hope Island from the summit of Mt Smith?
18 What is the direction of Duck Island from the summit of Mt Brown?
19 In what direction is Duck Creek flowing in AR 2965?
20 What is the bearing of Mt Smith from Mt Brown?
21 What is the straight-line distance between the summits of Mt Brown and Mt Smith?
22 What is the difference in elevation between Mt Brown and Mt Smith?
23 What is the elevation of the following locations?
   a U (AR 2869)
   b V (AR 2469)
   c W (GR 270698)
   d X (GR 287689)
   e Y (GR 270640)
   f Z (GR 290650)
24 Calculate the local relief experienced on a traverse from Mt Brown to Mt Smith.
25 What is the aspect of the slope in each of the following locations?
   a AR 2670
   b AR 2766
26 Construct the cross-section between point A (AR 2968) and point B (AR 2963), using a vertical scale of 1:40 m.
27 Construct the cross-section between point C (GR 2569) and point D (GR 2763), using a vertical scale of 1:80 m.
28 Calculate the vertical exaggeration of the cross-section A–B.
29 Calculate the vertical exaggeration of the cross-section C–D.

Figure 1.5f Topographic map of Blue Lake. Scale 1 cm = 40 000 cm.
1.6 Landform features

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

COMMON LANDFORM FEATURES

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

- **Basin** – an area of relatively level ground surrounded by hills or an area drained by a river and its tributaries.
- **Crest** – the highest part of a hill or mountain range.
- **Escarpment** – the steep hillside formed by a sudden drop in elevation, usually from a plateau.
- **Gorge or canyon** – a deep ravine, usually with very steep sides.
- **Knoll** – a low, detached hill.
- **Plateau** – a large, elevated area of relatively flat land.
- **Ravine** – a long, deep valley carved out by a stream.

- **Re-entrant** – a valley or ravine, usually between two spurs, running inwards towards the hill or mountain top.
- **Ridge** – the line along a hill or range of hills or mountains from which the water flows in opposite directions; sometimes referred to as a ‘watershed’.
- **Saddle** – a depression between the tops of adjacent hills or mountains.
- **Spur** – a ridge running out from a hill or mountain.

ARID LANDFORM FEATURES

Running water is the most important agent of erosion in arid (desert) environments. Although it does not rain there often, when it does the rain is often very heavy and results in flash flooding. Because there is no vegetation, run-off is very rapid and can erode large amounts of weathered material. Surface run-off is channeled into dry riverbeds (wadis) that cut through plateaus, forming canyons or gorges. As plateaus are eroded, mesas (sometimes known as outliers) and buttes (see Figures 1.6c and 1.6d) are left isolated from the retreating escarpment. Mesas are wider than they are high, while buttes are higher than they are wide.

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

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

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

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

COASTAL LANDFORM FEATURES

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

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

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

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

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

1.6i show some of the distinctive landform features associated with glaciers. (See Figures 1.6i and 1.6j.) Figure 1.6i illustrates the landform features commonly found on the floodplain of a river.

Figure 1.6h Switzerland’s Aletsch Glacier.

Figure 1.6i Glacial landform features.

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

RIVERS: SHAPING THE LAND

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

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

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

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

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

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

Figure 1.6k A watershed divides one catchment from another.

Figure 1.6l Meander bends.

Figure 1.6m Formation of river meanders.

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

Figure 1.6o Scroll meanders.

Figure 1.6p The meandering river

Figure 1.6q The meandering river

Figure 1.6r The meandering river

Figure 1.6s The meandering river

Figure 1.6t The meandering river

Figure 1.6u The meandering river

Figure 1.6v The meandering river

Figure 1.6w The meandering river

Figure 1.6x The meandering river

Figure 1.6y The meandering river

Figure 1.6z The meandering river

Activities

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

**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.

**Transects**

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

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

**Drainage Patterns**

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

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

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

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

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

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

**ACTIVITIES**

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

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

GROUND-LEVEL PHOTOGRAPHS

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

AERIAL PHOTOGRAPHS

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

TYPES OF AERIAL PHOTOGRAPHS

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

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

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

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

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 represents.
in order to interpret the image. The images in Figure 1.8g are examples of false-coloured images. Other images look more like photographs because computer programs convert the data received from satellites into true-colour images. The false-colour images in Figure 1.8g, captured by Landsat satellites, show how the glacier and the surrounding landscape has changed since 1986.

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

### Table 1.8a Colour guide for false-coloured images

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

### Table 1.8b Colour guide for true-coloured images

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

### Interpreting aerial photographs

Interpreting aerial photographs involves the following steps:
1. Determine whether the photograph is a vertical aerial photograph or an oblique aerial photograph.
2. Look for evidence of location and time. Often the caption provides some relevant information about the photograph, especially about the location.
3. Look for a familiar feature of the built environment that will give you some indication of scale.
4. Identify the main features of the photograph. You may find it useful to group them under the following headings:
   - Features of the physical environment: landforms; for example, relief and drainage features
   - Features of the built environment: transport networks, settlements—rural and urban.
5. Ask yourself the following questions:
   - Is the area predominantly characteristic of the physical and built environments?
   - What is the physical nature of the environment: fluvial, coastal, arid, glacial, mountainous and so on?
   - To what extent has the area been modified by human activity?

### Using photographs to record information

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

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

### Activities

1. Outline how satellite images differ from photographs.
2. Study Figure 1.8b, page 17. Based on your knowledge of the types of photographic images, complete the following tasks:
   a. Identify the type(s) of images that result in no distortion of the scale of the objects on the ground.
   b. Identify the type of image that is likely to give the greatest distortion of the features in the foreground.
   c. Identify the type of image that might block out views of distant features.
   d. Identify the type of image that is likely to cover the largest area of the Earth’s surface.
3. Use the Internet to locate examples of ground-level, oblique and vertical aerial photographs.
4. Use Google Earth to explore some of the landscapes featured in the topographic maps in Sections 3 and 5–9 of this text.
5. Study Figure 1.8g. Trace the retreat of the Columbia Glacier.
6. Use NASA’s Earth Observatory website (www.cambridge.edu.au/skillsgeo1 weblinks) to locate examples of satellite images that you find interesting. Mount a wall display that shows the diversity of the images available at the site.
1.9 Field sketches, line drawings and sketch maps

FIELD SKETCHES AND LINE DRAWINGS

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

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

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

Once completed, field sketches and line drawings can be used to classify and explain spatial patterns and relationships. You could, for example, identify the features of the physical and built environments; note the relationship between landforms, settlement patterns and transport networks; and identify the main physical processes shaping the landscape.

Constructing 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.

Constructing line drawings from photographs

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

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

Figure 1.9a Hold that look!

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

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

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

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

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

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

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

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

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

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].

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

Figure 1.9h(i) Matterhorn, Switzerland.

Figure 1.9h Mono Lake, United States.
### CLIMATE GRAPHS

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

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

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

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

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

#### Constructing a climate graph

To construct a climate graph, follow the steps below:

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

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

**Whistler:**

- **Latitude:** 50º07’N
- **Longitude:** 123º25’W

**Cairo:**

- **Latitude:** 30ºN
- **Longitude:** 31ºE

**Durban:**

- **Latitude:** 29ºS
- **Longitude:** 31ºE
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 1.10d 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.**

**HOW WARM WILL IT BE?**

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

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

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

**WILL IT RAIN?**

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

**WILL IT BE WINDY?**

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

**ACTIVITIES**

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

LINE GRAPHS

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

Constructing line graphs

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

BAR AND COLUMN GRAPHS

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

Constructing bar and column graphs

To construct a simple bar or column graph, follow the steps below:
1. Select the set of information to be represented on the horizontal axis; for example, the year, country or age group in the case of column graphs, or the quantifiable variable in the case of bar graphs. (See Figures 1.11c and 1.11d.)
2. Select the variable to be plotted on the vertical axis. For column graphs this is usually the data that have a quantitative value and tend to rise and fall. For bar graphs 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, ensuring they are 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, page 24.) A complete pie graph (360°) represents 100 per cent. Therefore, each percentage point equals 3.6°. Knowing this statistic will help you to construct and interpret pie graphs.

Constructing pie graphs

To construct a pie graph, follow the steps below:
1. Draw a circle and then extend a line from its centre to the 12 o’clock position.
2. Convert the percentage value of each value or variable to degrees by multiplying it by 3.6. For example, if the percentage was 20%, this would represent 72° on the pie graph; that is, $20 \times 3.6 = 72°$.
3. List your converted values from the largest to the smallest. Place categories such as ‘others’ at the end of your list.
4. Starting at 12 o’clock, mark in each segment using a protractor. Work in a clockwise direction, starting with the largest segment.
5. Shade in and label each segment. It may be useful to provide a legend. If a legend is included it is not necessary to label the segments.
6. Add an appropriate title.
**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 smallest. For example:
   - the area of Asia: 44 614 000 km²
   - the area of Africa: 30 319 000 km²
   - the area of North and Central America: 24 247 000 km².

2. Calculate the square root of each value. For example:
   - Asia: the square root of 44 614 000 = 6679
   - Africa: the square root of 30 319 000 = 5506
   - North and Central America: the square root of 24 247 000 = 4924.

3. Determine a scale that allows the circles to be a suitable size. In this example 1 mm = 100 units.

4. Use the scale to determine the radius of each circle. For example:
   - Asia: 6679/100 = 66.8 mm
   - Africa: 5506/100 = 55.1 mm
   - North and Central America: 4924/100 = 49.2 mm.

5. Draw three circles that have a radius of 66.8 mm, 55.1 mm and 49.2 mm.

6. You can, of course, scale down your graph. For example, by dividing each value in step 5 by two you significantly reduce the space occupied by the graph.

7. Label each circle and record the actual area of each continent in brackets next to each name.

8. Give your graph an appropriate title.

**PICTURE GRAPHS**

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

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

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

**POPULATION PYRAMIDS**

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

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

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

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

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

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

**INTERPRETING STATISTICAL DATA: PERCENTAGE**

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

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

**EXAMPLE**

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

\[
\text{Difference} = 7.08 \text{ billion} – 2.55 \text{ billion} = 4.53 \text{ billion}
\]

\[
\text{Percentage change} = \frac{4.53}{2.55} \times 100 = 178\%
\]
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.

**ACTIVITIES**

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

---

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800</td>
<td>1.00</td>
</tr>
<tr>
<td>1850</td>
<td>2.55</td>
</tr>
<tr>
<td>1900</td>
<td>1.60</td>
</tr>
<tr>
<td>1950</td>
<td>2.55</td>
</tr>
<tr>
<td>2000</td>
<td>6.00</td>
</tr>
<tr>
<td>2050</td>
<td>9.20</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Country</th>
<th>Population (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>1628</td>
</tr>
<tr>
<td>China</td>
<td>1437</td>
</tr>
<tr>
<td>United States</td>
<td>420</td>
</tr>
<tr>
<td>Nigeria</td>
<td>299</td>
</tr>
<tr>
<td>Pakistan</td>
<td>295</td>
</tr>
</tbody>
</table>

---

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

<table>
<thead>
<tr>
<th>Country</th>
<th>Rate of natural increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.7</td>
</tr>
<tr>
<td>Germany</td>
<td>−0.2</td>
</tr>
<tr>
<td>India</td>
<td>1.5</td>
</tr>
<tr>
<td>Mali</td>
<td>3.2</td>
</tr>
<tr>
<td>Russia</td>
<td>−0.1</td>
</tr>
<tr>
<td>World</td>
<td>1.2</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Region</th>
<th>Population (Billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>More developed</td>
<td>1243</td>
</tr>
<tr>
<td>Less developed</td>
<td>5814</td>
</tr>
<tr>
<td>Least developed</td>
<td>876</td>
</tr>
<tr>
<td>Total</td>
<td>7058</td>
</tr>
</tbody>
</table>

---

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

**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.
1.12 Specialist maps

CHOROPLETH MAPS

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

When drawing choropleth maps, each area that falls within a particular range is allocated the appropriate colour or shade until the overall pattern is revealed. Shadings should be graded from the deepest colour for the highest value down to the lightest colour for the lowest value. Usually, shades of one colour are used; for example, dark red down to light red.

DOT MAPS

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

FLOWLINE MAPS

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

CARTOGRAMS

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

ACTIVITY

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