4.1 A hazardous world?

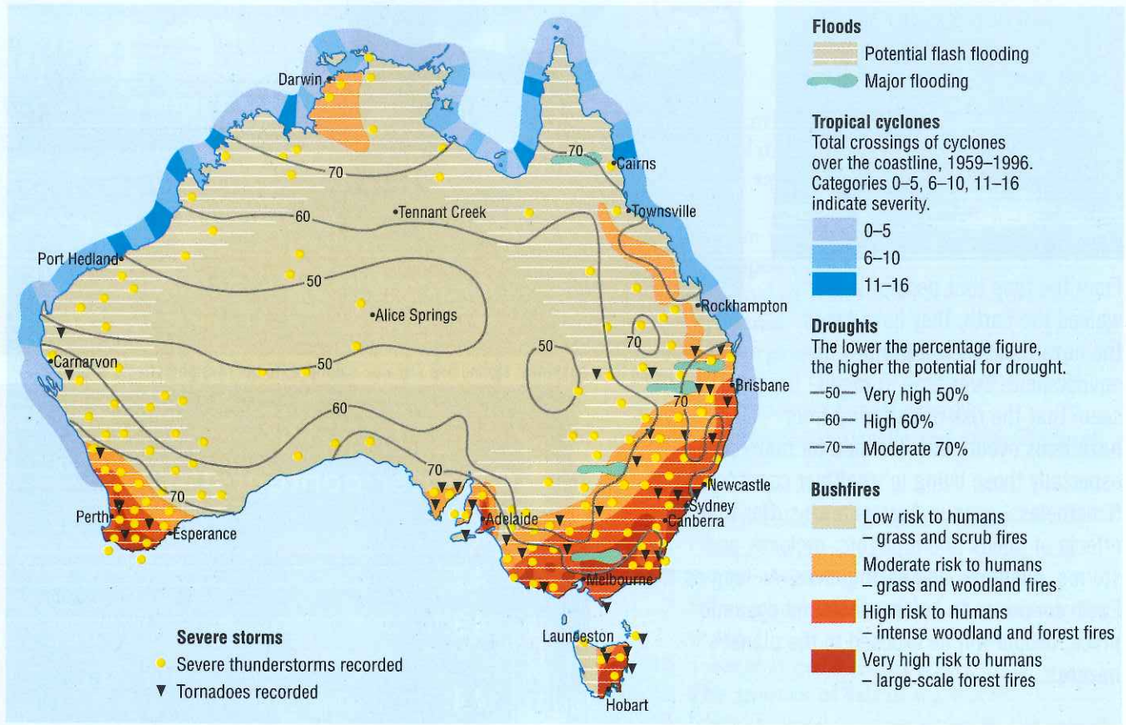
The Earth's surface is often a very dynamic place. Many areas, particularly those close to plate margins, frequently experience natural hazards such as earthquakes and volcanic eruptions. Because converging plate margins are areas of mountain building, they are also areas where landslides occur. In addition, mountainous areas often receive high rainfall and the foothills and valleys of such areas may experience severe flooding. Thus, young fold mountain regions, such as the Himalaya, Andes and Rocky Mountains, are particularly hazardous areas in which to live.

Australia's natural hazards

While Australia might not seem such a hazardous place, this is not entirely correct. It is just that the nature of Australia's hazards is different from those of areas near volcanoes or in high mountains. The most damaging of Australia's natural hazards are the tropical cyclones, which strike along the coasts of northern Australia each year. Other Australian hazards include floods and droughts, severe storms and bushfires. We also experience occasional earthquakes and landslides.

Thus, Australia is a naturally hazardous country. However, our relatively small population means that natural hazards are generally 'less disastrous' than in other more populated places in the world, where thousands of people may perish in cyclones, floods, volcanic eruptions and other natural disasters.

Figure 4.1
Where Australia's natural hazards occur.



Source: After *Australian Natural Hazards Education Map Kit*, produced by the Australian Surveying and Land Information Group and Australian Geological Survey Organisation for Emergency Management Australia.

Geobyte
A huge volcanic eruption of Mount Pelée on the island of Martinique in 1902 resulted in 29 000 deaths. In contrast, in one of Australia's most tragic natural disasters, the 1983 Ash Wednesday bushfires, 76 people were killed.

What makes natural events hazards?

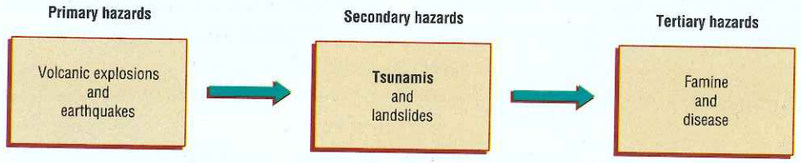
In order to be considered hazards, naturally occurring events have to threaten people and their property. Usually, hazards are extreme events, either in terms of their magnitude (their size) or frequency (how common they are). Thus, they are capable of causing significant material damage, loss of life or disease. When hazardous events actually cause human death and/or the destruction of property, they are called a natural disaster.

Although many places across the globe are at risk of hazards of various types, those that occur in poorer countries may be much more damaging. This is because poorer countries do not have the same level of emergency facilities to relieve the disaster (see Chapter 7), have poorer building standards and are usually more populated. Thus, people in poorer countries are much more vulnerable to hazards than those in wealthier countries. For example, cyclones and volcanoes occur in both poorer and wealthier countries, but the loss of life and material damage are usually far greater in poorer countries.

What causes hazards?

All natural hazards result from the operation of the Earth's natural systems. The Earth has four main systems (see Chapter 1), involving the lithosphere (crust), atmosphere (air), hydrosphere (water) and biosphere (living things). Each of these systems creates primary hazards for people (see Table 4.1), sometimes in isolation but often in combination. For example, cyclones have their origins in the atmosphere, but commonly create storm surges, which involve the hydrosphere. The hazards that result from other hazardous events are known as secondary hazards. It is also possible to have tertiary hazards, which are the longer term effects of primary and secondary hazards.

Figure 4.2
Primary, secondary and tertiary hazards.



Tsunami a large ocean wave caused by an earthquake on the ocean floor

Table 4.1 Earth systems with examples of hazards.

Lithosphere	Atmosphere	Hydrosphere	Biosphere
Earthquake	Tropical cyclone	Flood	Bushfire
Volcano	Thunderstorm	Storm surge	Locust plague
Landslide	Drought	Tsunami	Malaria

Figure 4.3

The Earth's hazards. (a) The floods, a primary hazard, in northern New South Wales in 2000–2001 caused billions of dollars of damage. (b) In July 1998 over 2000 people were killed or injured and the villages were destroyed by a 14-metre wave from a tsunami, a secondary hazard, that hit northern Papua New Guinea. (c) Droughts in Ethiopia have resulted in massive famines, a tertiary hazard.

activities

1 What is meant by a natural hazard?
2 Why are some parts of the world more hazardous than others?
3 Compare the types of hazards that occur in different parts of the world. For example, how are Australia's hazards different from those that occur in the Himalaya Mountains?

Refer to Figure 4.1.

4 Describe the location of areas in Australia most at risk of:
  a cyclones
  b disaster bushfires.
5 Describe the sorts of hazards your state is likely to experience.

Refer to Figure 4.2.

6 Explain what is meant by primary, secondary and tertiary hazards.
7 Suggest some of the possible primary, secondary and tertiary hazards associated with a tropical cyclone.

Refer to Figure 4.3.

8 With which of the Earth's natural systems is each hazard associated?
9 Explain why bushfires are classified as a hazard of the biosphere.
10 Compare the extent of the following effects of natural hazards in poorer countries with wealthier countries:
  a large numbers of people killed or displaced from their homes
  b thorough disaster planning and effective prevention methods
  c widespread damage to homes and other buildings
  d rapid response to the failure of power and water supplies
  e food shortages and outbreaks of disease.
11 What conclusions would you reach about the effects of hazards on the world's poorer and the world's wealthier countries?

4.2 Walls of flame: the hazard of bushfires

The danger of bushfires is worse in Australia than in any other part of the world. Australia's south-eastern corner faces the world's greatest risk, followed by California and the south of France. The severity of bushfires in Australia is a result of two main factors:

- hot, dry summer winds that blow from the desert regions in the centre of the continent towards the south-east
- the nature of the fuel provided by the forests typical of south-east Australia.

The threat of bushfire damage in Australia is always present in the outer suburbs of major cities as they grow and spread further into the surrounding bushland.

Causes of bushfires

Unlike most other natural hazards, bushfires can be caused by people. In fact, it is estimated that up to 90 per cent of Australia's bushfires are the result of human activity. The most common human cause of bushfires is burning off, either legal or illegal, while the most common natural cause is lightning. Other human causes include fallen power lines, sparks from machinery, and arson – the deliberate lighting of fires.

Fuelling the inferno

Eucalypt forest fires are particularly dangerous because of the nature and amount of fuel in such forests. The most flammable materials include grass, leaves, bark and twigs. In dry periods, a huge amount of such material, up to 40 tonnes per hectare, may accumulate as a thick layer of litter on the forest floor. The trees themselves often have loose bark and dead lower branches, which encourage fires to spread upwards to the tops of the trees. Eucalypt leaves also contain waxes and oils that are easily ignited and so add to the intensity of bushfires.

Figure 4.4

Australia's bushfire risk.

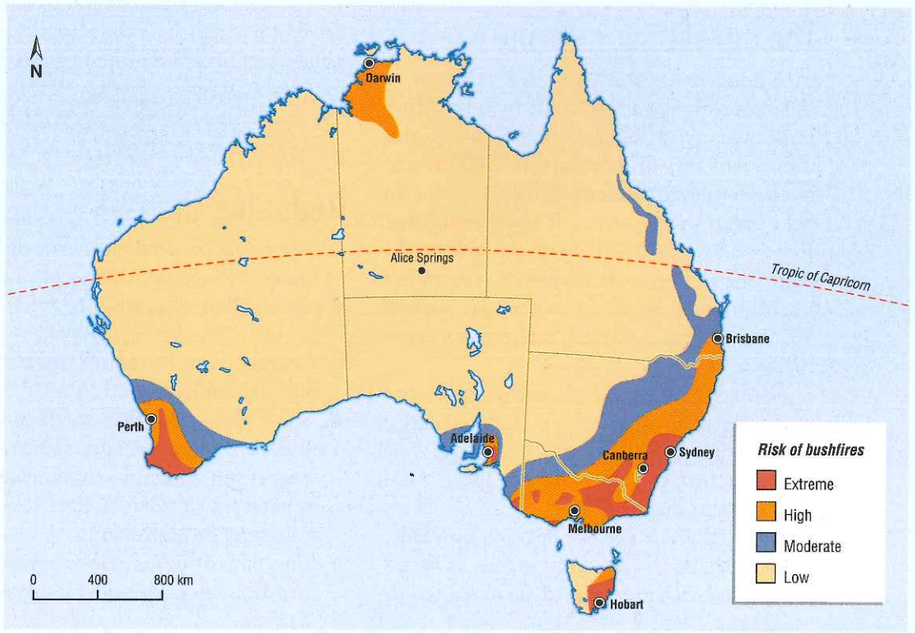


Figure 4.5
Australia faces the greatest risk of bushfires in the world. This bushfire is in Kakadu National Park.

Geobyte
Many of Australia's native plants have become adapted to fire; some even need fires to survive. Such plants are known as pyrophytes.

The spreading inferno

Fire intensity is the term that is given to the amount of heat given off by a bushfire. It is usually measured in kilowatts per metre (kW/m). A kilowatt, or 1000 watts, is about the equivalent of the amount of heat given out by a small radiator heater. Fires of up to 4000 kW/m are able to be controlled. The most severe of Australia's bushfires may reach intensities of around 100 000 kW/m – 100 000 heaters for every metre of the fire.

Wild forest fires go through several steps before they reach their greatest intensity.

- In the first stage, the surface litter begins to burn.
- Then, this surface fire spreads upwards, using bark and lower branches as fuel, and causes the crown of the trees to ignite.
- Once the crown is alight, the fire is then able to spread rapidly from one tree to the next in what is known as a running crown fire. This is the most dangerous of all bushfires, and the most difficult to control.

Because the bark of many eucalypts is easily torn off, it is able to be blown by winds accompanying the fire. Burning bark may then start spot fires well in advance of the main fire. In this way, wild fires often spread over wide areas.

Reducing the risk

It is possible to reduce the risk of bushfires in many ways. For example:

- Controlled or prescribed burning of forests occurs in many places. Such burning aims to reduce the amount of fuel available to wild fires.
- Some electricity authorities have placed their lines underground. Others have vegetation clearing programs and use separators to prevent electricity lines touching in high winds.
- Fire bans and increased surveillance by fire-fighters in periods of extreme fire danger.

Figure 4.6
In January 1997, bushfires in the Dandenong Ranges killed three people and destroyed 41 homes.

Figure 4.7
People living in areas susceptible to bushfires can reduce the danger of bushfires.

activities

1 Why is Australia the world's most dangerous place for bushfires?

Refer to Figure 4.4.

2 Describe the location of the parts of Australia that face the most extreme risk of bushfires.

3 In what locations in Australia is the risk of bushfire low?

4 Suggest some reasons for the distribution of bushfire risk areas in Australia.

5 The text lists some ways in which people are responsible for the outbreak of bushfires. Suggest some other ways in which people's activities might lead to bushfires.

6 Why are fires in Australia's eucalypt forests particularly dangerous?

7 Briefly explain what is meant by the following types of fires:
- **a** surface fires
- **b** crown fires
- **c** running crown fires
- **d** spot fires.

8 Which of these types of fires is the most dangerous and why?

Refer to Figure 4.5.

9 What type of fire is illustrated by this photograph?

Refer to Figure 4.7.

10 If you lived in this house, list some of the ways in which you could reduce the danger of bushfires.

Refer to Figure 4.6.

11 Suggest some reasons why the Dandenong Ranges are particularly prone to the hazard of bushfires.

12 Suggest some ways in which people living in the Dandenong Ranges might reduce the risk of bushfires. Use the table below as a guide. Include at least two points for each aim.

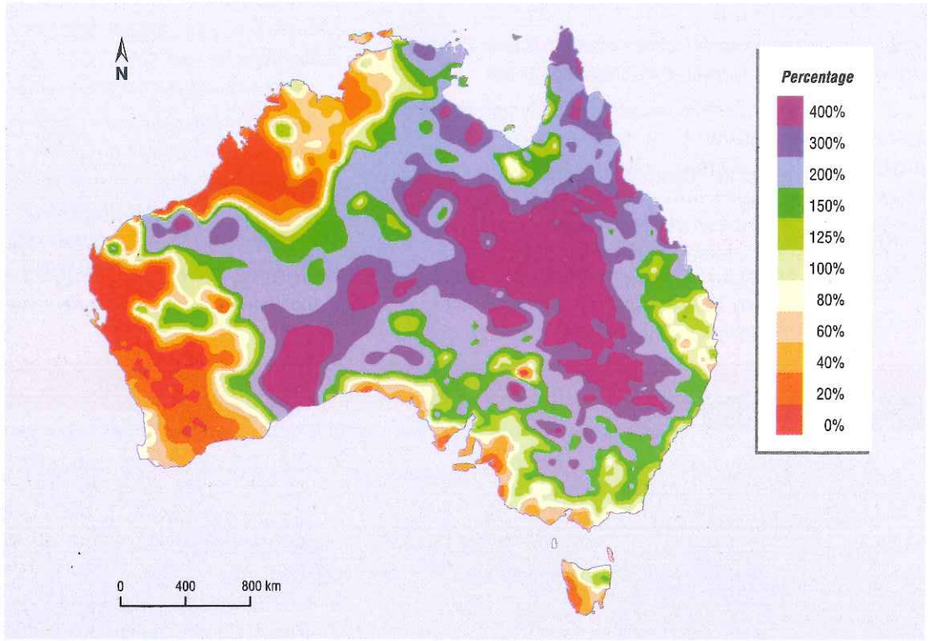
Aim	Bushfire risk could be reduced by:
Better protected homes	
Less intense bushfires	
Good fire control methods	
Good bushfire education	

4.5 Australia: a land of drought and floods

The year 2000 was Australia's second wettest on record. As a result, devastating floods were experienced in much of New South Wales and southern Queensland. However, at the same time, some places remained extremely dry. For example, Brisbane only received 578 millimetres of rain in 2000, its second lowest total, and only 2 millimetres higher than its record low.

Geobyte
Mount Bellenden Ker in far north Queensland is Australia's wettest spot. In 2000, it received nearly 12.5 metres of rain, its highest ever total.

Figure 4.14
Australian rainfall percentages in November 2000 based on the monthly mean.



Source: Bureau of Meteorology

The Spanish connection: La Niña and El Niño

Normally, warm water is pushed across the Pacific Ocean from South America towards Australia by south-easterly trade winds. When this happens, rising warm, moist air in the north of Australia brings heavy rain and often cyclones. Sometimes, very strong trade winds may develop. This causes a build-up of warm water near Australia and a La Niña event. Australia's very high rainfall in 2000 was a result of a La Niña.

During an El Niño, the south-easterly trade winds weaken in the western Pacific and the warm water flows away from Australia towards South America. This results in descending dry air and drought conditions in Australia.

Meteorologists use a measure known as the Southern Oscillation Index (SOI) to predict El Niño and La Niña events. This index compares atmospheric pressure over Darwin with that over Tahiti in the middle of the South Pacific Ocean. An SOI above +10 indicates a La Niña. El Niño and drought conditions in Australia have an SOI below –10.

Disaster and renewal: the hazard of floods

Floods can destroy crops and buildings and devastate people's lives. They can also bring life-renewing water and silt, as the ancient Egyptians living along the Nile knew well. Floods occur when water levels rise above their natural or artificial confines and cover surrounding areas of land. They are most common along coastlines and river courses, especially the flood plains of rivers.

Floods are usually the result of large amounts of rainfall. The rainfall might come from a cyclone or thunderstorm or there might just be long periods of heavy rainfall over an area. Floods can also result from earthquakes and landslides, which might cause natural or artificial dams to fail.

People can also influence floods. Flooding in towns and cities often occurs because stream courses have been altered or covered over. Buildings and roads stop water from soaking into the ground and increase the surface flow of water.

Figure 4.15
(a) The normal weather pattern in Australia.
(b) The weather pattern during an El Niño.

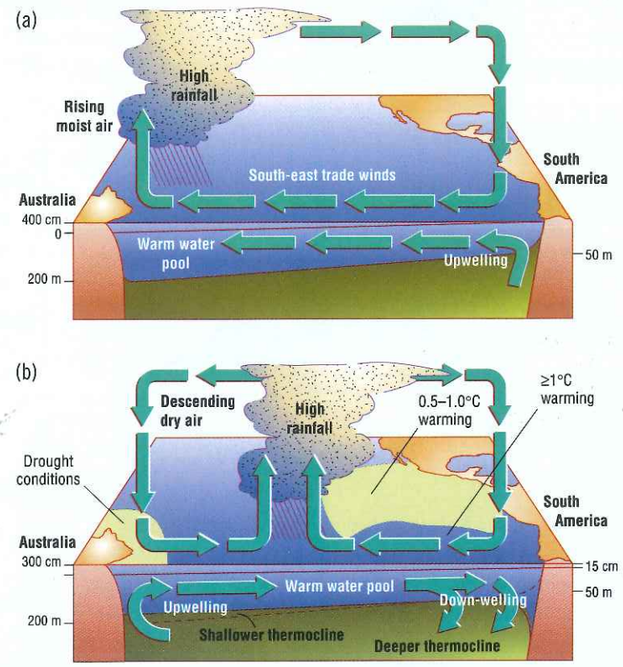
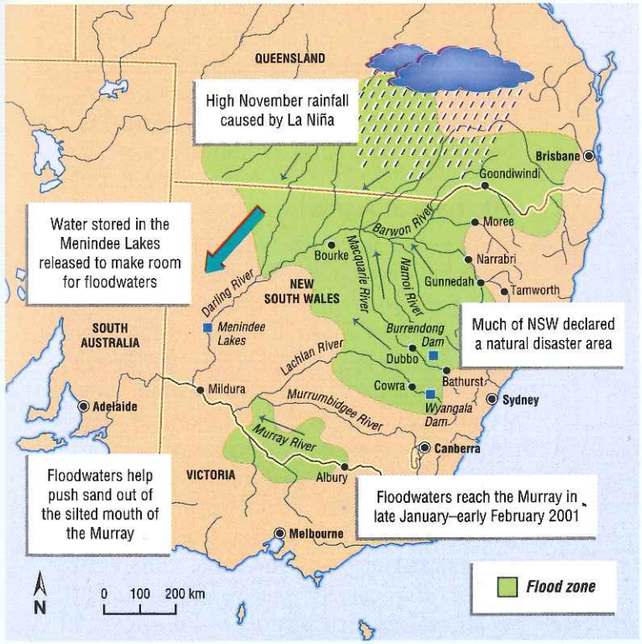


Figure 4.16
Extent of floodwaters in south-eastern Australia in 2000.



Clearing of trees from the catchments of rivers also increases the amount of water that flows into rivers, increasing the risk of flooding.

Australia's year 2000 floods

In November and December 2000, floods ravaged much of New South Wales and parts of southern Queensland. Most of northern and central New South Wales was declared a natural disaster area by the NSW government. The cost of crop loss alone was estimated to be $600 million.

Thermocline the boundary between warm surface water and underlying cooler water