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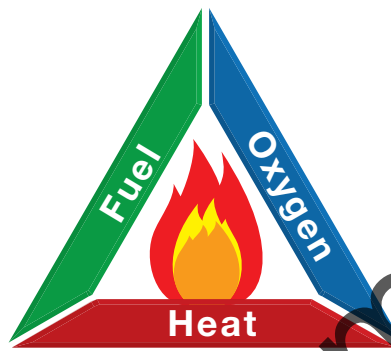
Bushfires in Australia

'Bushfire' is an Australian word that is used to refer to any fire burning out of control in bushland areas. In other countries, and increasingly in Australia, the term 'wildfire' is used to describe such events. Bushfires are common in Australia and are associated with the explosive burning of the 'bush', the eucalypt forests and woodlands. Grassfires are also common.

How bushfires start

A fire requires material that can burn (**fuel**), a source of ignition (heat) and a supply of oxygen. Fire is the **combustion** of fuel as it reacts with oxygen in the air. This process is known as the fire triangle. It is shown in Figure 6.1.

6.1 The fire triangle



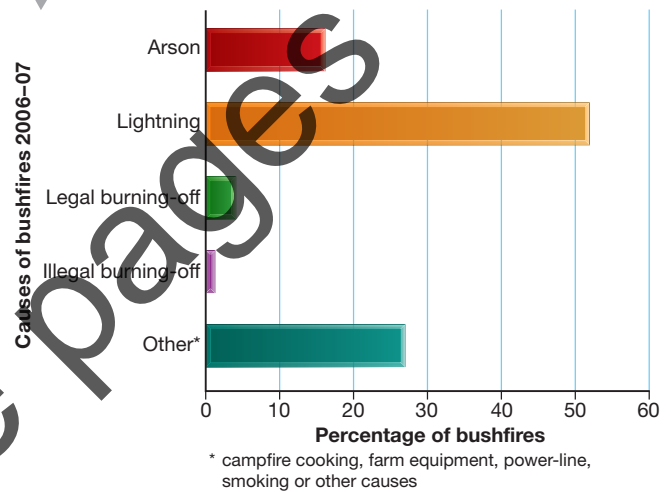
Fuel

The greater the **fuel load** (the amount of combustible material), the hotter and more intense a fire is. The main fuel for **bushfires** comes from trees, debris (fallen leaves and bark) and undergrowth. During **droughts** and in very hot, windy weather, the leaves and small branches of trees can become very dry and **flammable**. Dead or dried-out grass can also fuel grassfires, and some grasses can burn even when they are green.

Ignition

Bushfires have long occurred naturally in Australia, but they can also originate from human activity. Bushfire causes are shown in Figure 6.2. Lightning strikes account for over half of all bushfire **ignitions**. Sometimes controlled fires are initiated in an effort to reduce fuel loads. Occasionally, however, changes in the weather can cause these fuel-reduction fires to get out of control and become bushfires. Some very serious fires have been lit by arsonists (people who deliberately light fires).

6.2 Bushfire causes in Australia



Source: Emergency Management Australia

Fires can also be the result of accidents, such as when a mower blade hits a rock and produces sparks, or power lines are brought down during high winds.

Oxygen

Combustion requires oxygen, and once lit, a fire will only continue to burn if it has a supply of oxygen. Loose litter on the ground is vulnerable to fire in open spaces because there is plenty of oxygen available for it to burn.

How bushfires attack

Bushfires are a threat to life and property in various ways.

The fire front

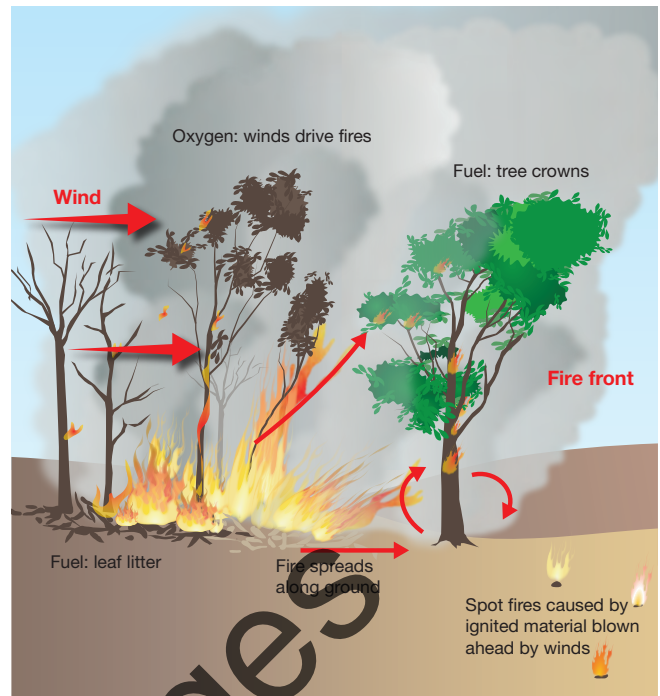
Flames at the **fire front** will ignite anything flammable with which they come into contact. The most dangerous of all fronts is that of a **running crown fire**. In eucalypt forests, bushfires can advance at alarming speeds through the upper layers of the forest, as outlined in Figure 6.4.

Ember attack

Spot fires can break out when hot embers (burning debris, such as twigs, bark and small branches) from the fire front are picked up by winds and deposited elsewhere. Embers can be carried as far as 30 kilometres downwind from the fire front.

Wind

Winds drive a fire by delivering a continuous supply of oxygen. They also blow the flames towards fresh fuel. Even a slight increase in wind speed results in a significant increase in the rate at which a fire can advance. Changes in wind direction also affect fire behaviour and can quickly cause the size of a fire front to increase and the direction in which it moves to change. Winds also enable fires to spread by causing spot fires, as they lift the burning embers into the sky and carry the embers ahead of the fire front.



6.4 How a bushfire attacks

SPOTLIGHT

Grassfires and bushfires

Grassfires move quickly, passing in 5 to 10 seconds, and smoulder for only minutes after the fire has passed. They are low to moderately intense fires, but can do a lot of damage to crops, livestock, fences and farm buildings (see Figure 6.3).

Bushfires usually move more slowly than grassfires, but are much hotter and more intense. They pass in 2 to 5 minutes, but logs and tree stumps can smoulder for days afterwards. Bushfires can incinerate vast tracts of country and destroy whole townships.



6.3 A grassfire

ACTIVITIES

Knowledge and understanding

- 1 Define the term 'bushfire'.
- 2 Identify the three things that must be present for a fire to occur.
- 3 Distinguish between a bushfire and a grassfire.
- 4 Explain the danger of ember attack.
- 5 Explain how winds influence bushfire behaviour.

Applying and analysing

- 6 Study Figure 6.2 and complete the following table.

Natural causes	Human causes

- a Write the fire ignition type in the correct column.
 - b Is the most common type of ignition due to humans or nature?
 - c Considering your answer to b, what measures would you suggest to reduce the incidence of bushfires?
- 7 Design an annotated visual display illustrating how bushfires start, progress and attack.

6.2

Severity of bushfire hazard

Bushfires have long been part of the Australian landscape and vegetation has evolved with them. Indigenous and European occupation of the continent have had a significant impact on the biophysical environment and the incidence and intensity of bushfires.

Drying Australian climate

When Australia was part of Gondwanaland, the climate was warm and wet. The separation of the Australian continent, and its northward drift, carried it into the latitudes characterised by dry air. The dominance of high-pressure systems over the continent produced fine, sunny conditions, resulting in low, unreliable rainfall and prolonged dry periods. The Australian continent today is generally hot, dry and has frequent droughts. Such conditions dry out the country and increase the bushfire threat.

Evolution of Australian flora

The drying of the climate resulted in vegetation that has adapted to the dry climate and poor soils. Plants such as the eucalypt (gum) trees developed characteristics that meant they require less water and fewer nutrients—small, thick, leathery leaves are tough and need to be replaced less often.

During times of drought, Australian eucalypts survive by reducing their water loss through shedding their leaves. The dead leaves build up on the forest floor with discarded bark, creating fuel. In dry conditions, the rate of decay slows significantly and so the fuel load builds up even further.

Eucalypt leaves also contain aromatic oils and waxes to discourage insects from eating them. The presence of these substances and the low water content in the leaves explains why they burn explosively. On hot days the oils in eucalypt leaves pass into the atmosphere as a vapour. This vapour is quite combustible given the right conditions, and when a fire passes through, tree crowns appear to explode when the oil-rich vapour given off by the leaves ignites in a fireball.

Evolution with fire

The Australian environment evolved in the presence of fire. Lightning strikes have ignited the country for millions of years. Many plant species developed a range of adaptations to survive bushfires and others even came to rely on regular burning to trigger the release or germination of seeds for the next generation of plants. Figure 6.5 shows regeneration after a bushfire.



6.5 The bush regenerating after a bushfire

Australia's eucalypt forests and woodlands

Eucalypts dominate the less dry regions of the continent in the south-east and south-west. The forests occupy areas with relatively high rainfall nearest the coast, while the woodlands of smaller, more sparsely planted trees are further inland, where it is drier. These coastal and inland areas have the highest bushfire risk in Australia, as shown in Figure 6.6.

Human impact

While bushfires have always been part of Australia's natural environment, human attitudes and management of fire have had a significant impact on the severity of bushfires.

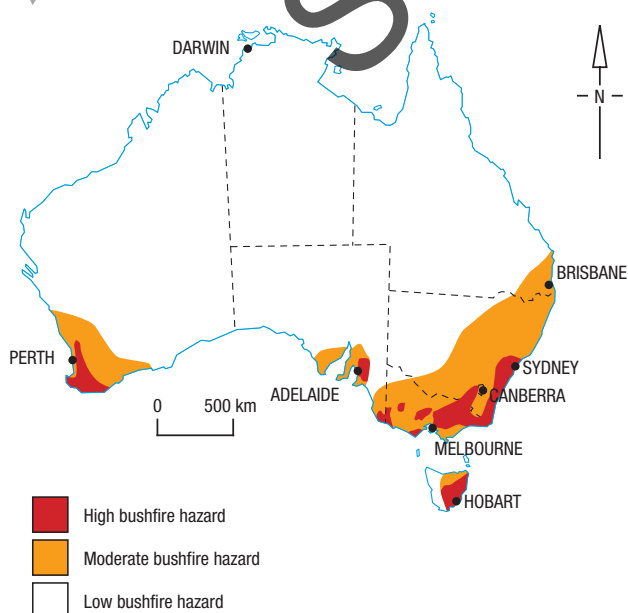
Aboriginal use of fire

When the first Aboriginal people arrived more than 60 000 years ago, they adapted their lifestyle to the conditions. They also learnt to manage the land in ways that met their needs. The main tool they used to do this was low-intensity fire, and their patterns of burning were quite sophisticated.

Aboriginal people made frequent and purposeful use of fire:

- to keep the country open and therefore easy to move through
- to promote the growth of fresh green grass and herbs that would attract the animals they hunted
- as a means of signalling and hunting
- for the purposes of warmth and cooking.

6.6 The east coast of Australia has the highest risk of bushfire.



European settlement

European settlers considered the Australian environment to be difficult and hostile, and they were especially fearful of bushfires. The explosive infernos in the Australian bush were unlike anything they had seen before. In Europe, fires had to be put out because they destroyed forests. There was no understanding that the vegetation in Australia actually benefited from burning. Bushfires were terrifying. They killed people and stock, and destroyed homes and properties. The response was to try to extinguish bushfires or to prevent them from occurring.

As the Europeans displaced the Aboriginal and Torres Strait Islander people, the regular burnings stopped and, as a result, there was a build-up of fuel loads in the bush. Fires, being part of the natural cycle in Australia, were inevitable, and with more fuel to burn they became more intense and destructive.

The pattern of European settlement also placed people in areas where the bushfire hazard was greatest. The majority of Australians live on or near the south-east coast of the continent, where the eucalypt forests are also located.

When the Europeans first arrived they settled on the flat land near the sea or along ridges where it was easier to build. They avoided the valleys, as these were too steep and, being moister, were covered by thick forest. This pattern of settlement can still be seen where the valley bush remains and homes are located on ridges. As fires race uphill, these properties are at severe risk of fire.

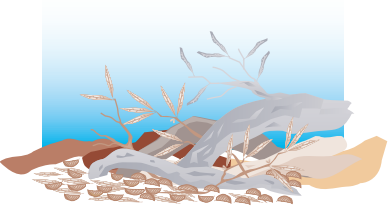
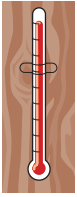

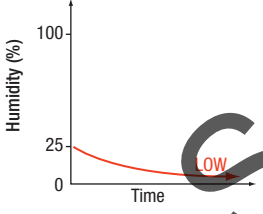

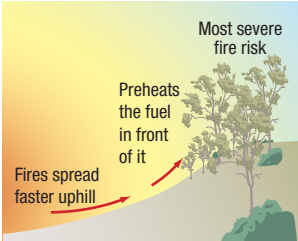
Factors affecting bushfires

The occurrence of bushfires and the rate at which bushfires spread are determined by a number of factors. These are shown and discussed in Table 6.7. A combination of these factors can result in 'blow-up' days when severe fires blaze out of control and spread rapidly.

DID YOU KNOW?

The oil-rich vapour from eucalypt leaves gives the Australian bush its bluish appearance when it is viewed from a distance.

6.7 Factors that can affect the ignition and progress of a bushfire

Factor	Explanation
<p>Amount of fuel</p> 	<p>High fuel loads hold the potential for disastrous fires should they be ignited. Also of importance is the 'vertical structure' of the fuel. Dry shrubs and grasses, for example, enable fires to build in intensity and support the development of more advanced running crown fires.</p>
<p>High air temperatures</p> 	<p>The higher the temperature, the more oils are released from trees and so the more likely the fuel will catch alight because the air temperature is closer to its ignition point. Hot air can lower the moisture content of forests and grasslands to about 5 per cent and, in extreme cases, as low as 2 to 3 per cent. This greatly increases the speed at which a fire moves and the heat of the fire.</p>
<p>Prolonged drought</p> 	<p>Prolonged periods of below-average rainfall dry out the fuel load, creating what is commonly referred to as 'tinderbox' conditions.</p>
<p>Low humidity</p> 	<p>Hot, dry air with humidity below 25 per cent creates critically dangerous bushfire conditions, as it causes fuels to dry out and become more flammable. Dry air creates more intense fires.</p>
<p>Strong winds</p> 	<p>Air movement provides the oxygen to keep fires burning. Strong winds mean extra oxygen and more intense fires. They fan the fire and accelerate the speed at which the fire spreads. In fact, a doubling of the wind speed increases the rate of spread by a factor of four. An added danger of strong winds is that they can carry burning embers great distances ahead of the fire front. These ignite spot fires, thus enabling the fire to leap ahead of itself.</p>
<p>Terrain</p> 	<p>Fires tend to spread more quickly up hillsides and slopes because the fires preheat their fuel source. As hot air rises up hills, fires accelerate when travelling uphill. For every 10° of slope, a fire doubles its forward speed. (So for a 10° slope the fire is twice the speed it would be on level ground, for 20° it is four times the speed and for 30° it is eight times the speed.) This is reversed when the fire is travelling downhill. (On a 10° slope, for example, the speed of a downward fire is halved.)</p>

SPOTLIGHT

Eucalypts are messy trees

Every year, eucalypt trees grow another layer of bark. This increases the thickness of the trunk and branches. In some species the outermost layer of bark dies, cracks and falls off each year. Large strips and flakes hang from the tree until they fall to the ground to become part of the fuel load, as shown in Figure 6.8. When a bushfire occurs, the old bark burns like an oily rag, especially when there are strong winds to fan it.



- 6.8** Dead bark peeling off a eucalypt to reveal smooth, new bark underneath. The discarded bark is very dry and catches alight easily.

ACTIVITIES

Knowledge and understanding

- 1 Explain how the climate of Australia changed as the continent drifted northwards.
- 2 Describe the adaptations of eucalypts to the difficult Australian environment.
- 3 Explain why eucalypts are so fire-prone.
- 4 Compare the attitudes to fire of the Aboriginal and Torres Strait Islander people and the European settlers.

Applying and analysing

- 5 Discuss how the actions of Europeans have increased the severity of the bushfire hazard in Australia.

Geographical skills

- 6 Study Figure 6.6. List the states that have a high bushfire hazard.

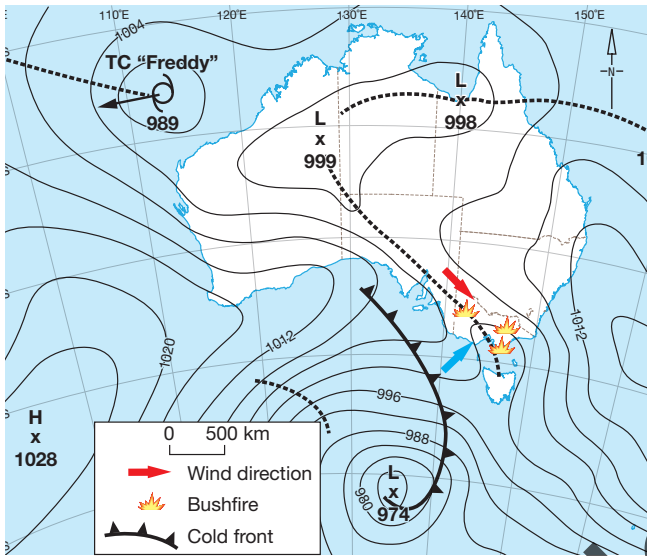
Investigating

- 7 Find a eucalypt tree and observe and photograph its features and surrounds.
 - a Collect a leaf and paste it in the middle of a page. Add annotations around the page to identify the adaptations of the eucalypt to a difficult environment. (Note features of the leaves and how they hang on the tree.)
 - b Using your photographs to support your findings, assess the potential of a eucalypt tree to burn easily. (Check for debris from the tree that would increase the fuel load on the ground.)



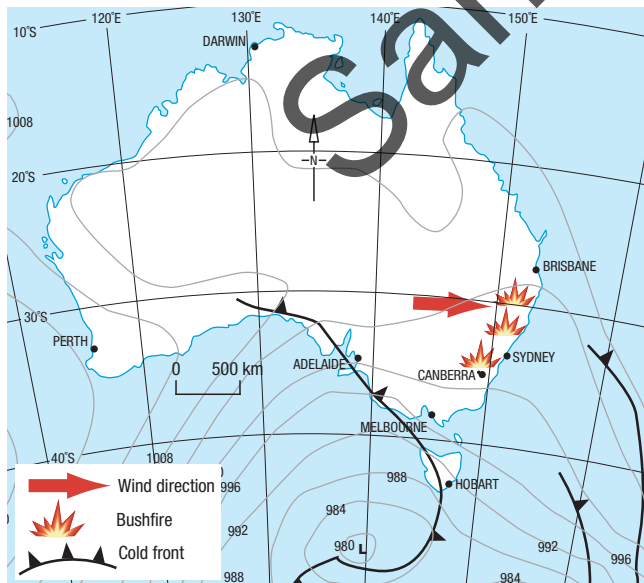
High-risk weather patterns South-east Australia

By mid-summer, the grasslands, woodlands and forests of south-east Australia have usually dried out. The most dangerous fire conditions occur when a strong cold front approaches a slow-moving high in the Tasman Sea. The weather conditions associated with the Black Saturday fires of 2009 are shown in Figure 6.11.



Source: Australian Bureau of Meteorology

6.11 Weather conditions on 7 February 2009 in south-eastern Australia



Source: Australian Bureau of Meteorology

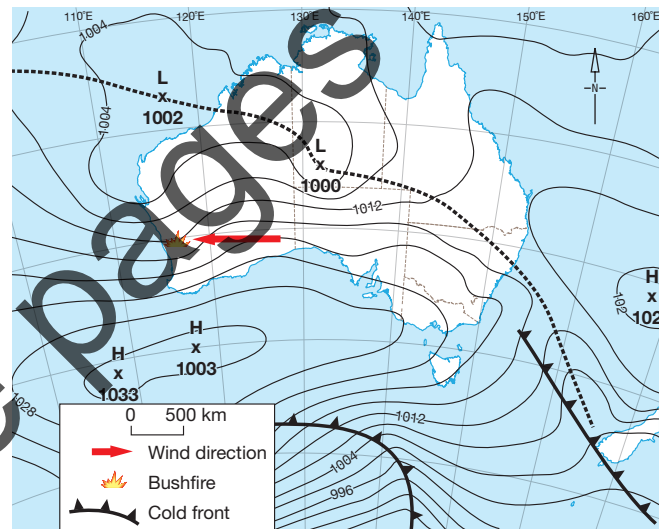
6.12 Weather conditions on 7 January 1994 on the east coast of Australia

New South Wales and southern Queensland

The worst conditions occur when deep low-pressure systems near Tasmania bring strong, dry, westerly winds to the coast. This can be seen observed in Figure 6.12, which shows the weather pattern when disastrous fires struck New South Wales in January 1994.

Southern Western Australia

The hot dry winds from the interior are easterly winds in this part of the continent. The fires in the Perth Hills in February 2011 were brought on by such winds (see Figure 6.13).



Source: Australian Bureau of Meteorology

6.13 Weather conditions on 6 February 2011 in the Perth Hills

ACTIVITIES

Knowledge and understanding

- 1 Identify the main conditions that lead to extreme fire danger days.
- 2 Describe the temperatures experienced in Australia.
- 3 Explain how winds from the interior of the continent influence weather.

Geographical skills

- 4 Study Figures 6.9 and 6.10. Write two paragraphs explaining how the passage of a cold front affects bushfire behaviour.
- 5 Study Figures 6.11, 6.12 and 6.13. Assess the role of wind direction in creating extreme fire danger on each of the days shown.