Australian Government
Attorney-General's Department
Emergency Management Australia

HAZARDS, DISASTERS AND YOUR COMMUNITY

A BOOKLET FOR STUDENTS AND THE COMMUNITY

EMA
'safer sustainable communities'

HAZARDS, DISASTERS AND YOUR COMMUNITY

SEVENTH EDITION

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FOREWORD

Members of the public, particularly students and teachers, often seek information on a wide range of hazards and disasters, both in Australia and overseas. In these times of heightened interest in emergencies, incidents, disasters and related safety issues, Emergency Management Australia (EMA), along with emergency management and emergency services agencies and support organisations in the eight Australian States and Territories receive many requests for such information. This booklet will be of assistance in answering many of those questions, including vital ones about community safety through prevention, risk reduction and preparedness.

Enquiries are also received about Australia's national emergency/disaster management arrangements and the integral role of EMA with the various State and Territory emergency management authorities. A summary of this information is included in Chapter 13.

Information contained in this booklet was researched, written and prepared for publication by EMA's Community Awareness Program from our own and various other sources, including the authorities acknowledged, and has been incorporated into the publication in consultation with an education specialist.

Although secondary school students are the target audience of this booklet, it is also intended as a comprehensive reference for the whole community in the interests of public safety and awareness.

Further information on Australia's major natural hazards can be obtained from State and Territory Emergency Services organisations. Contact information for these organisations appears on page 71. Additional information on bushfires can be obtained through local rural fire services, and about more general hazards through local State and Territory Emergency Services.

Remember that triple zero (000) is for calling police and emergency services in life and property threatening situations; (for hearing impaired people – text or TTY 106). For non-life threatening situations call your local State or Territory Emergency Service (numbers are in all telephone directories).

For more information on hazard safety and related school resources visit the EMA web site: http://www.ema.gov.au.

David Templeman
Director General
Emergency Management Australia

CHAPTER 1

HOW DO WE COPE WITH HAZARDS AND DISASTERS?

WHAT ARE HAZARDS?

Hazards are dangerous conditions or events with potential for injury, loss of life, and/or damage to property, agriculture or environment. They can be categorised in various ways but, based simply on how they originate, hazards can be grouped in two broad, and six more-specific, categories (further described later):

1. Natural (hazards with meteorological, geological, biological or extraterrestrial (space) origins).
2. Unnatural (hazards with human-caused or technological origins).

WHAT ARE DISASTERS?

Almost every day, either in the newspaper or on TV, there are reports of disasters in Australia and other countries. So what are disasters? The loss of a sole income-earner in a car crash may be a disaster to a family, but only an accident to the community. What are the characteristics that make disasters different from accidents?

Variables

Disasters of all kinds and sizes happen when hazards seriously affect communities. They can occur anywhere and they are generally unpredictable. Disasters can vary in the following ways.

CAUSE: they can result from a natural or unnatural hazard (e.g. flood or transport accident).

FREQUENCY AND RISK: some occur more often and therefore present a greater risk than others (e.g. in Australia there is a much higher risk of damage from severe storms than landslides).

DURATION OF IMPACT: some are of limited duration, while others last for long periods (e.g. a tornado may last a few minutes, but a drought may go on for years).

SPEED OF ONSET: some happen suddenly, while others have a warning period of hours or days (e.g. there may be little warning of a flash flood, whereas the relatively slow onset of a cyclone allows a longer warning time).

SCOPE OF IMPACT: some disasters affect a relatively small area, and others affect whole countries (e.g. a volcanic eruption compared to widespread famine). Others, caused by a single hazard and initially affecting a small area, can cause a chain reaction involving several other hazards covering a much larger region (e.g. an earthquake which damages roads causing transport accidents, ruptures gas pipes causing fires, and fractures a dam causing flash flooding).

DESTRUCTIVE POTENTIAL: this can vary enormously with the type of hazard (e.g. a bridge collapse is a localised event causing damage over a much smaller area than a cyclone).

PREDICTABILITY: some hazards follow certain patterns, others don't (e.g. floods are usually confined to known floodplains, but toxic gas emissions have no boundaries).

CONTROL AND HUMAN VULNERABILITY: in some disasters we are totally helpless and must leave them to run their course. In others we can do something to lessen the impact, even if we cannot prevent them from occurring (e.g. unlike tornadoes, bushfires can often be prepared for and controlled; however, more Australians are vulnerable as bushfires happen more frequently and affect larger areas).

DEFINITION: In the Australian Emergency Management Glossary a disaster is defined as:

> *A serious disruption to community life which threatens or causes death or injury in that community and/or damage to property which is beyond the day-to-day capacity of the prescribed statutory authorities and which requires special mobilisation and organisation of resources other than those normally available to those authorities.*

NATURAL HAZARDS AND DISASTERS

Meteorological Origin

Parts of Australia suffer regularly from the effects or results of meteorological hazards in the form of tropical cyclones, droughts, bushfires, floods, heatwaves and severe storms. Rarer weather hazards, but among the most dangerous, are cyclonic storm surges (explained in Chapter 7) and tornadoes (see Chapter 5). Compared to some other countries, disasters caused by these hazards in Australia rarely take a large death toll, mainly because we are not densely populated and are quite well prepared. However, they regularly result in damage that can run into hundreds of millions of dollars.

Geological Origin

Unlike regional neighbours such as New Zealand, Papua New Guinea and Indonesia, the Australian continent is relatively geologically-stable. We are not affected by volcanoes at all, nor by intense earthquakes in populated areas, although several moderate ones have caused substantial building damage and the 1989 earthquake in Newcastle, New South Wales, caused heavy damage and loss of life (see Chapter 8). In 1996 and 1997 two landslide disasters claimed lives in Western Australia and New South Wales (see Chapter 10).

Biological Origins

Some biological hazards with potential for disaster in Australia include human disease epidemics (e.g. Ross River fever, hepatitis, AIDS, SARS), vermin and insect plagues (e.g. rabbits, mice, locusts), exotic animal diseases (e.g. foot-and-mouth disease, anthrax, avian influenza) and food-crop diseases.

Extraterrestrial Origin

Although presenting a very low risk, the impact on Earth by a comet or asteroid (large meteorite) could cause anything from a major regional disaster to a worldwide catastrophe.

NON-NATURAL HAZARDS AND DISASTERS

Human-Caused

Human error or deliberate acts include urban fires, terrorist bombings, riots, wars, crowd-crushes at mass gatherings, shooting massacres (e.g. Port Arthur) and sabotage of essential services (e.g. water or power supplies).

Technological Origin

As in most countries, development and population growth in Australia have contributed to an increase in technological hazards and accidents. These include major transport, mining and hazardous materials accidents (e.g. oil or chemical spills), industrial explosions, fire and bridge collapses. This category also includes dam failures, nuclear power accidents and re-entry of spacecraft to Earth (e.g. Skylab, WA 1979).

PERSONAL AND COMMUNITY AWARENESS AND SURVIVAL

As Australians we need to be aware of likely hazards and potential disasters; how, when and where they are likely to occur, and the main problems which may result. Most of all, we should be aware of how to cope with their effects. At the end of each chapter in this booklet, there is information on survival and property protection which details what we can do before, during and after the impact of a particular hazard to reduce the possibility of it becoming a disaster for us.

Self-Help and the Prepared Community

During disasters there will be a delay before outside help arrives. At first, self-help is essential and depends upon a prepared community—that is, a community which has:

- an alert, informed and actively-aware population;
- an active and involved local government; and
- agreed, coordinated arrangements for disaster prevention, preparedness, response and recovery.

CHAPTER 2

WILDFIRE HAZARDS AND DISASTERS

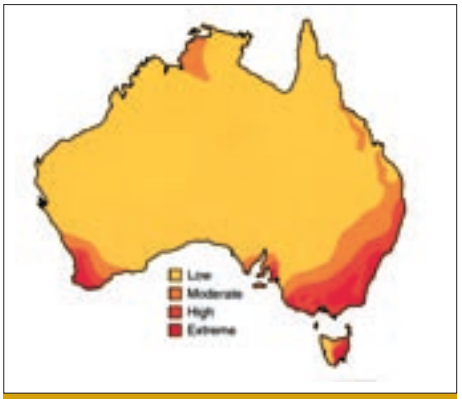
BUSHFIRE DISASTERS

Bushfire is one of the most destructive forces of nature. Firefighters, both professional and volunteer, risk their lives each year to control and extinguish them. Many of Australia's most devastating bushfires have raged through dense eucalyptus forests into the suburban fringes of major cities. Few bushfires earn the title of 'disaster', but repeated disastrous bushfires near each capital city in Tasmania, South Australia, Victoria and New South Wales have occurred, in which many people have lost their lives, or their homes and property. The worst were in Victoria, 1939 (Black Friday), 71 dead; southern Tasmania, 1967 (including Hobart), 62 dead; New South Wales, 1968 (Blue Mountains and coastal), 14 dead; southern Victoria, 1969, 23 dead; and South Australia and Victoria, 1983 (Ash Wednesday), 76 dead. Bushfires in Australia occur as either grass fires or forest fires.

GRASS FIRES. These occur mainly on grazing, farming or remote scrub country. Although they often destroy fences, livestock and some buildings, they rarely result in heavy loss of human life.

FOREST FIRES. Under adverse weather conditions, wildfires in eucalyptus forests cannot be stopped and often destroy homes and settlements. Huge amounts of flammable eucalyptus vapour, transpired from leaves, create fireballs which engulf the forest upper storey ahead of the main fire-front. Clouds of dense smoke can mask the fire-front from ground and aerial observation, making it even more difficult to attack the fire. During the Ash Wednesday fires, aircraft with infra-red heat-sensing equipment were needed to locate and plot obscured fire-fronts.

South-eastern Australia has the greatest wildfire hazard in the world. Bushfires are driven by strong, hot north-westerly winds. Long fire-flanks can suddenly become fire-fronts when south-westerly wind changes occur. Therefore, timely, accurate weather information is vital for firefighting teams. Really large bushfires, however, burn until stopped naturally by rain or lack of fuel, which may be weeks after ignition.



EACH RATING REFERS TO RELATIVE RISK TO PEOPLE FROM BUSHFIRES BASED ON AVERAGE INTENSITY FOR THAT ZONE.

Control Techniques

Bushfires are usually fought by numerous trained volunteers and a core of professional firefighters with vehicle-mounted equipment (in accessible terrain). Observation is often provided by light aircraft and helicopters. Water-bombing is also provided by helicopters with buckets which lift water from dams, lakes or swimming pools. They are effective in stopping spot fires ignited by windborne firebrands, sometimes kilometres ahead of the main fire-front. This greatly assists and contributes to the safety of firefighting crews. In large bushfires, bulldozers and graders are used to create emergency firebreaks ahead of fire-fronts. Back-burning from firebreaks is frequently effective in slowing or stopping the spread of fire.

Prevention and Reduction

Local government authorities have regulations controlling home-siting, design and building materials in bushfire-prone areas. Wide firebreaks along property boundaries must be maintained and fuel-reduction (controlled) burning is carried out during the cooler seasons.

The risk of bushfire can be reduced if people take care and use commonsense when dealing with fire or materials that can ignite easily. Carelessly thrown cigarette butts and campfires not properly extinguished are two common causes of fires. Local fire authorities can give you more detailed information about fire safety and prevention. Bushfire survival and property protection information appears at the end of this chapter.

Burning for Bio-diversity

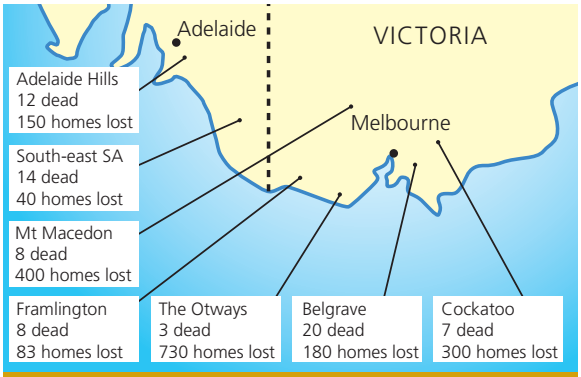
Wild fires and prescribed fires for management purposes periodically affect many of the vegetation communities found throughout South-eastern Australia. Some, like rainforest and stream-side vegetation, are severely damaged by fire. However, others like heathland, grassland, and the eucalypt dominated forests and woodlands, respond by rapid regeneration of species. In these communities it is the interaction of burning and species' regeneration strategies which maintains high species diversity.

MAJOR ACCESS ROUTE THROUGH THE ADELAIDE HILLS. IMAGE COURTESY OF TONY ZERNER

CASE STUDIES

AUSTRALIAN BUSHFIRES

1. SOUTH AUSTRALIA & VICTORIA, ASH WEDNESDAY, 1983



MAIN FIRE AREAS AND THEIR TOLL IN LIVES AND HOMES.

CONDITIONS FOR DISASTER. On 16 February 1983, Melbourne experienced a very hot, dry day. The temperature peaked at 43°C with relative humidity of only 6%. Drought conditions had persisted in south-eastern Australia for several years with the 1982–83 summer being extremely hot and dry. Fires burned over 100,000 hectares near the New South Wales/Victoria border on 1 February. On 6 February, 95 fires were reported. By 16 February, Ash Wednesday, South Australia and Victoria were tinder dry and fuel loads in forests were very high.

THE TOLL. In the 24 hours following that morning, a holocaust of bushfires erupted and in just a few days burned over 520,000 hectares across the two states (map shows worst-affected areas). More than 3700 buildings were destroyed. A total of over 2400 families or individuals lost their homes, while 75 people died. Many of the 1100 injured people required hospital treatment. Livestock losses were very high, with over 340,000 sheep and 18,000 cattle either dead or having to be destroyed. During that summer, at least a million hectares burned across South Australia and Victoria. Insurance losses exceeded $320 million and total estimated costs were $950 million in 1997 values.

2. NEW SOUTH WALES, EASTERN SEABOARD, 1994

CONDITIONS FOR DISASTER. In early January 1994, hot, dry, westerly winds began to blow from the inland, affecting most of the east coast of the state. Several large bushfires broke out in the north. These were soon followed by serious outbreaks along the coast, extending to the south of Batemans Bay (see satellite photo). Dangerous winds persisted for about three weeks, resulting in over 800 bushfires. The most serious fires were in the Hunter, Blue Mountains and Sydney regions. About 20,000 volunteer firefighters (including reinforcements from all states and territories) battled the flames and helped evacuate over 25,000 people from areas under serious threat.

THE TOLL. About 800,000 hectares were burned, including sections of Sydney suburbs and 40 national parks. Four deaths (including three firefighters) resulted, 120 people were injured and 800 people were left homeless after 205 homes and about 20 other buildings were destroyed. Insurance losses were $59 million, with total costs estimated at $165 million (1997 values).

SATELLITE PHOTO OF NSW BUSHFIRES, 1994.

3. NEW SOUTH WALES, CHRISTMAS 2001

CONDITIONS FOR DISASTER. The longest official, continuous bushfire emergency in New South Wales occurred between 21 December 2001 and 13 January 2002 when widespread bushfires burned throughout much of the state and the Australian Capital Territory. Unusual fire behaviour was observed in many areas due to variable winds and extreme dryness of fuel. Up to 100 large and out of control bushfires burned simultaneously at the height of the crisis. It was the first time that large bushfires had travelled from the mountains to the coast (as they did in the Shoalhaven region). Over 650,000 hectares were burned. Fires in the Blue Mountains and outer western Sydney regions (including Hawkesbury and Warragamba) prompted a disaster declaration by the state government.

THE TOLL. A total of 121 homes were destroyed, 36 were seriously damaged and 304 sustained less serious damage (figures courtesy of NSW Department of Community Services). Fifteen businesses and 255 other structures were destroyed (including sheds, carports and urban fences).

Approximately 10,000 people were evacuated and 15,000 firefighters deployed from across Australia and New Zealand as hot, mainly north-westerly winds and very dry conditions persisted for over three weeks. Over 200 kilometres of fencing were destroyed, well over 5000 livestock died along with large numbers of native animals (many in national parks).

The insurance loss figure ($69 million) comprised mainly houses and commercial claims.

BUSHFIRES, CANBERRA ACT, IN JANUARY 2003.PHOTO COURTESY OF *THE CANBERRA TIMES*

4. AUSTRALIAN CAPITAL TERRITORY, 2003

CONDITIONS FOR DISASTER. 2002 was a year of severe drought for much of Australia, including the ACT. On Wednesday 8 January 2003 lightning strikes from thunderstorms started 80 fires in the ACT, the Kosciusko National Park in NSW, and the Victorian Alps. Three fires were ignited in the ACT in the Brindabella Ranges, 10 kilometres from the nearest grazing properties and 20 kilometres from the urban areas of Canberra. In addition, a fourth fire—the so-called McIntyre's Hut fire—was burning to the north west of the ACT in the Brindabella National Park in NSW.

THE TOLL. The fires of Saturday 18 January 2003 were an unprecedented disaster for the ACT resulting in the deaths of four people, the loss of almost 500 homes and 93 community, commercial and farm buildings, as well as damage to many other homes and buildings. There was also significant environmental damage to the Namadgi National Park and other areas of the ACT and New South Wales. During the emergency more than 5,000 people were evacuated to emergency centres, and 440 people treated for injuries and smoke inhalation. The fires burnt 157,000 hectares of land, and over 4000 livestock perished. The total estimated financial loss was $350 million.

5. SOUTH AUSTRALIA, 2005

CONDITIONS FOR DISASTER. The Eyre Peninsula fire began on Monday 10th January and was contained by fire authorities, but 70 km/h winds and temperatures above 40 degrees pushed the blaze over containment lines on the Tuesday morning. As the day progressed, more than 145,000 hectares were burnt. 48,000 hectares were burnt in and near the small townships of Wangary, Wanilla, North Shields, Poonindie, Louth Bay, Greenpatch, and Yallunda Flat. More than 300 Country Fire Service personnel, with assistance from landholders, combated the fire.

THE TOLL. Nine people died, including four children, and approximately 110 were reported injured. Property destroyed included 50 homes and dozens of cars and caravans. There was also extensive damage to rural infrastructure, including water mains, power lines and telephone infrastructure. There were approximately 47,000 livestock (primarily sheep) killed or subsequently destroyed by the fire. All fencing within about 890,000 hectares was destroyed, and of those hectares affected, 95% of pastures were also destroyed. The total insurance loss was estimated at $28 million.

Bushfire Survival and Property Protection

Many factors affect the risk to life and property. These include property location and access, the amount and type of nearby vegetation, building position and condition, availability of water and the physical capabilities of those involved. In bushfires, radiant heat, dehydration and asphyxiation (choking) are the major killers.

Preparation Before the Bushfire Season

- If possible, make a firebreak around your home (use mower, spade, rake). Trim branches well clear of the house. Clear roof gutters of leaves, twigs etc.
- Store wood, fuel, paints etc. well clear of the house.
- Remove rubbish, leaf litter and native shrubs close to the house. Keep grass short/green.
- Fit wire screens to doors, windows, vents. Enclose gaps at roof eaves and under house.
- Keep a ladder handy for roof access (inside and outside) and hoses to reach all parts of the house and garden. If water is not connected, obtain a high-pressure pump.
- Decide on a household plan to either leave early or stay to protect your properly-prepared home during a bushfire. Check you have bushfire insurance.

If a Bushfire Approaches

Make the decision to stay with or to leave your house well before a bushfire reaches your home. If you prepare your house well, and unless you decide to leave early or have been ordered by authorities to do so, stay in the house after taking extra precautions.

- Phone 000—do not assume emergency services know about the fire.
- Fill baths, sinks and buckets with reserve water and turn off gas and power.
- Remove curtains and move furniture away from windows.
- Wear long woollen or heavy cotton clothes and solid boots or shoes, a hat or woollen balaclava, and gloves.
- Plug downpipes with rags and fill all roof gutters with water. Hose down walls, garden, etc. on the sides of the house facing the fire-front and watch for spot fires.
- Inside, close all windows and doors, and block crevices and gaps. When the fire-front arrives, stay inside, away from windows, while it passes (usually five to 15 minutes).

- Quickly extinguish any fires which may have started in, on, or under the house. Check inside the roof cavity as well.
- If the house is alight and can't be extinguished, move away to safe burnt ground. Don't leave the area, wait for help. Listen to a battery-operated radio for official information.

If Caught in a Bushfire while Driving, Stay in the Vehicle

- Don't drive in or near bushfires. If caught in one, don't drive through flames or smoke.
- Stop at a clearing or by the roadside in a low vegetation area. Switch off ignition, and turn on hazard lights and headlights.
- Stay inside unless near safe shelter. Keep vents, windows and doors closed. Lie down below window-level, under a woollen blanket until the fire-front passes.

Research shows that in a bushfire, a car petrol tank is unlikely to explode in the period that a person needs to stay inside the car as protection against deadly radiant heat of the fire-front.

If Caught in a Bushfire on Foot

- Don't panic. Cover all exposed skin. Move across-slope, away from the fire-front, then down-slope towards the rear of the main fire. Find open or already-burnt ground.
- Do not try to out-run the fire or run uphill or go through even low flames unless you can clearly see a safe area close-by.
- If you can't avoid the fire, protect yourself from heat radiation by lying face-down under an embankment, rock, loose earth, or in a hollow, or if possible get into a pond, dam or stream—but not into a water tank.

STUDENTS: FIND FURTHER INFORMATION

As a project on bushfires, find out more about:

- causes of bushfires and how they spread, or bushfire prevention and control;
- Black Tuesday, Tasmania, 1967;
- Black Friday, Victoria, 1939; and
- the effects of radiant heat, dehydration and asphyxiation.

CHAPTER 3

FLOOD HAZARDS AND DISASTERS

WHAT ARE FLOODS?

Floods occur when water covers land that is normally dry. They may result from prolonged or very heavy rainfall, severe thunderstorms, monsoonal (wet season) rains in the tropics, or tropical cyclones. Other, less common causes include snow-melt, dam failure, or storm surge and tsunami which both involve rapid seawater flooding (see also Chapters 7 and 9).

People who live near rivers or in low-lying coastal areas live with the greatest threat of floods. Periods of heavy rain, not necessarily in their area, can lead to rises in the water level of the rivers to a point where they can no longer hold the volume of water. For some coastal dwellers, there is the threat from the sea from storm surge or tsunami.

COMMON TYPES OF FLOODING IN AUSTRALIA

SLOW-ONSET FLOODS. Flooding of rivers in the vast flat areas of central and western New South Wales and Queensland, as well as parts of Western Australia, may last for one or more weeks, or even months on some occasions. Floods in these areas can lead to major losses of livestock and damage to crops, as well as extensive damage to rural towns and road and rail links. This may result in the isolation of whole communities.

RAPID-ONSET FLOODS. Flooding can occur more quickly in the mountain headwater areas of large rivers, as well as in the rivers draining to the coast. In these areas, the rivers are steeper and flow more quickly, with flooding sometimes only lasting for one or two days. These floods can potentially pose a greater risk to loss of life and property. This is because there is generally much less time to take preventative action, and a faster, more dangerous flow of water. This type of flooding can affect most of our major towns and cities, especially along the East and South of Australian continent and Tasmania.

FLASH FLOODS. Flash flooding results from relatively short, intense bursts of rainfall, often from severe thunderstorms (see also Chapter 5). It can occur in almost all parts of Australia and poses the greatest threat of loss of life. People are often swept away after entering floodwaters on foot or in vehicles. These floods can also result in significant property damage and major social disruption. They are a serious problem in urban areas where drainage systems are often unable to cope.

FLOOD RISK MANAGEMENT

Townships living in threat of flooding have taken steps to mitigate the impact of the regular floods they endure by constructing levees, dams etc. These mitigation measures are often successful in giving protection against the smaller floods, but they are not designed to withstand every flood that may occur. Flood hazard is sometimes called a "silent killer" because it can build up quietly and people are often deceived as it does not appear dangerous. It is also one hazard against which we can prepare and respond properly. Flood warnings are issued by the authorities whenever there is a threat of flood, and except for flash floods, there is usually a reasonable warning period given to take protective action. It will be useful to understand some of the terminology used in this regard:

Flood Warnings Terminology

MINOR FLOODING: Causes inconvenience. Low-lying areas next to watercourses are inundated which may require the removal of stock and equipment. Minor roads may be closed and low-level bridges submerged.

MODERATE FLOODING: In addition to the above, the evacuation of some houses may be required. Main traffic routes may be covered. The area of inundation is substantial in rural areas requiring the removal of stock.

MAJOR FLOODING: In addition to the above, extensive rural areas and/or urban areas are inundated. Properties and towns are likely to be isolated and major traffic routes likely to be closed. Evacuation of people from flood affected areas may be required.

LOCAL FLOODING: Used where intense rainfall could be expected to cause high runoff in limited areas local to the rainfall, but not necessarily leading to significant rises in main streams.

FLASH FLOODING: Flooding occurring in less than 6 hours of rain, usually the result of intense local rain and characterised by rapid rises in water levels. They are difficult to predict accurately and give little time for effective preventive action.

FLASH FLOODS IN MELBOURNE DURING A SEVERE STORM, OCTOBER 1993.

CASE STUDIES

AUSTRALIAN FLOODS

1. 1990 GREAT FLOODS, QUEENSLAND, NEW SOUTH WALES, VICTORIA

THE APRIL/MAY 1990 FLOODS IN EASTERN AUSTRALIA COVERED MORE THAN ONE MILLION SQUARE KILOMETRES OF QUEENSLAND AND NEW SOUTH WALES AND A SMALLER AREA OF VICTORIA

The April/May 1990 floods in eastern Australia covered more than one million square kilometres of Queensland and New South Wales and a smaller area of Victoria (in a separate extreme flood).

CAUSES. In central-northern New South Wales and central-southern Queensland, continual heavy rains, partly caused by cyclones, drenched the inland plains. Further torrential rainfalls created almost instant floods. Many rivers which had already flooded once were in flood again at even higher levels.

EFFECTS. In both states, road and rail links were severed for long periods. Floodwaters inundated towns and many communities and properties were isolated. Entire grazing properties were submerged and livestock deaths of up to one million were estimated.

NYNGAN, NEW SOUTH WALES. The interaction of numerous flooded river systems in northern New South Wales and southern Queensland made flood-height prediction difficult. Residents of Nyngan, on the Bogan River, strengthened levee banks in expectation of a record flood height. The levee banks were exceeded and almost every building was flooded and 2500 people were evacuated, mainly by helicopters, under emergency conditions as all town services were lost. Residents could not return to their homes for three weeks; they were housed by the people of Dubbo, about 160 kilometres away.

NYNGAN FLOOD, 1990

TREACHEROUS FLASH FLOODS OFTEN CLAIM LIVES.

CHARLEVILLE, QUEENSLAND. Here, a similar situation occurred when over 80% of the town (of about 3000 people) was flooded, inundating all services. The hospital was evacuated by boat and a massive air evacuation (mainly by helicopters) saw over 2000 residents moved to the local airport, around which a huge tent city was established. This accommodated 2300 residents and up to 1000 emergency workers at the height of the disaster and was responsible for providing over 15,000 meals per day at the peak period.

DAMAGE. In Nyngan and Charleville alone, nearly 2000 homes were inundated and many were badly damaged. Commercial and public buildings were also badly affected and very heavy retail stock losses occurred. Similar damage occurred in smaller towns and properties in New South Wales and Queensland. At the same time, a series of brief, but violent floods wreaked havoc in the Gippsland region of Victoria, causing death and damage.

COST. Across the three affected states, the Great Floods of 1990 claimed seven lives, caused 60 injuries and left 5000 temporarily homeless. The total estimated cost of these floods was $415 million (1997 values), most of which was uninsured.

2. KATHERINE (AND DALY RIVER), NORTHERN TERRITORY, 1998

Three people drowned as record floodwaters from ex-tropical cyclone Les swamped Katherine and inundated 1000 square kilometres, causing Katherine's worst-ever flooding and triggering a state of emergency, which was also later invoked at Daly River, downstream from Katherine. Rainfall across the catchment was 448 millimetres (18 inches) in 48 hours.

The swiftness of the rising waters was the major problem. The river rose 18 metres above the dry season level and blocked roads within hours. The flood level, recorded at the town's bridge, reached a record peak of 20.3 metres. (The previous high mark of 19.3 metres was recorded in 1957.) At least 5000 people were evacuated.

Katherine's drainage system collapsed and sandbags proved useless. Half-metre waves washed through the central business district, destroying infrastructure and washing away belongings. About 500 businesses and an estimated 1200 of Katherine's 2054 apartments and houses were flooded (plus approximately 50 elsewhere). The town was blacked out as the local power grid failed, taking out radio station transmitters and interrupting telephone lines for several days.

Food shortages and an outbreak of gastroenteritis exacerbated the crisis. There were additional dangers of snakes and crocodiles in the town.

Pastoral and other properties near Katherine (a major part of the area's annual $60 million rural industry) suffered heavy losses. Much of the estimated $200 million damage was not covered by the $70 million insurance payout.

KATHERINE FLOOD, NORTHERN TERRITORY, 1998. IMAGE COURTESY OF "KATHERINE FLOODS '98 COLLECTION" – NORTHERN TERRITORY LIBRARY

FLOOD SURVIVAL AND PROPERTY PROTECTION

If your area is subject to flooding, the following advice could save your property or life.

Before a flood

- Identify local risks in your area. Your local council or State or Territory Emergency Service can inform you of local plans, warning systems and evacuation routes
- Prepare a home emergency plan, an evacuation strategy and prepare a checklist of important records
- Identify risks and fix faults around the home such as leaves which can block drains or damage roof tiles
- Store poisons and chemicals on high shelves to reduce contamination of flood water

Emergency Kit Check List (for use during and after a flood)

- A portable radio and torch with fresh batteries, candles and waterproof matches.
- Reasonable stocks of fresh water and tinned food, strong shoes, rubber gloves and a waterproof bag for clothing and values
- A first aid kit and good supplies of required medications
- A copy of your emergency plan, important papers and emergency contact numbers
- A waterproof bag for clothing and valuables and emergency contact numbers

When a flood warning is issued

- Be aware of any all hazards warning systems that may be in place for your area, what the warning levels mean and what actions you should take
- Listen to your local radio for information. Check that your neighbours know of the warning
- Protect valuables and goods by moving household items to a high place
- Secure dangerous or damageable items, and empty freezers and refrigerators, leaving doors open (to avoid damage or loss if they float about)
- Farmers should plan to move livestock and equipment to high ground
- Businesses should plan to relocate stock and equipment to high ground
- Check your car, fill the fuel tank, and check your emergency kit and supplies

If You Need to Evacuate

You may be asked to evacuate, but if you plan to leave of your own accord tell the police or State/Territory Emergency Service and neighbours. In either case, you should

- Listen/watch for flood reports and instructions and follow all instructions by emergency authorities
- Turn off electricity, water and gas and take your mobile phone and emergency kit
- Place a sandbag in the toilet bowl to prevent backflow of sewage
- Lock your home and take recommended evacuation routes for your area. Take pets with you
- Collect and secure your valuables, papers, photo albums and mementos

During and After the Flood

- Wait until authorities have declared the area safe before entering a flood zone
- Don't drink flood water or eat food that has been in flood waters
- Don't enter flood water until the depth and current strength has been assessed
- Don't exceed knee depth in flowing water and don't play in flood water
- Don't boat, drive or walk in flood waters unless absolutely necessary
- Before entering your house, wait until water has fallen below floor level and wear rubber boots (or at least rubber-soled shoes) and rubber gloves. Beware of snakes and spiders which may move to drier areas in your house

- If you are going into an isolated area notify the proper authorities
- Check with electricity, gas and water authorities to determine whether supplies to your area have been interrupted and are safe to be turned on by you. Don't use gas or electrical appliances until they have been checked for safety
- Beware of damaged power lines, bridges, buildings, trees, and don't enter floodwaters

STUDENTS: FIND FURTHER INFORMATION

As a project on floods, find out more about:

- effects on people of the Great Floods of 1990 and how they were helped;
- how levee banks are built and what makes them effective;
- other types of flood-control measures; and
- the beneficial effects of flooding (e.g. River Nile).

CHAPTER 4

HEATWAVE HAZARDS AND DISASTERS

DEFINING A HEATWAVE

A heatwave is a complex phenomenon resulting from a certain combination of temperature, humidity, air movement and duration. Simply stated, a heatwave is an extended period of very high summer temperatures with the potential to adversely affect communities.

HEATWAVE DANGERS AND EFFECTS

Heat Stress

HUMAN EFFECTS. Throughout the world, every summer tens of thousands of people suffer from heat stress when their bodies absorb more heat than they can dispel. Unless prompt treatment is received, they suffer the serious or even fatal consequences of heat stroke (hyperthermia). At most risk are very young children; the elderly; people with weight, chronic ailments or other health problems; and those on medications or with alcohol/drug dependencies, which have a drying effect or reduce perspiration (the body's cooling system).

AGRICULTURE. In the same way that heatwaves affect humans, animals suffer too, particularly when left without shade and adequate water. During heatwaves, especially in times of drought, stock losses can be very high. Plants, crops and vegetables are also subject to the effects of severe heat. For example, in January 1990 at Mildura in Victoria, grapevine damage alone cost $16 million (1997 values) on a day when the temperature reached 47°C.

Overheating and Excessive Consumption

INFRASTRUCTURE. During heatwaves railway lines can expand to the point where they buckle and cause derailments of trains. Road damage can also occur, with bitumen melting and concrete expanding and cracking. The old Gladesville Bridge over Sydney Harbour, on several occasions during the 1960s, expanded so much when it was opened for ships that it could not be closed again, causing traffic chaos.

UTILITIES AND SERVICES. Water and electricity consumption increases dramatically during heatwaves, often causing shortages. Increased use of fans and air-conditioners causes extra demands on electricity and appliances can overheat, fail or sometimes cause fires.

HEATWAVE PROTECTION AND SURVIVAL

Although the effects of heatwaves can be serious, they are one of the easier hazards to protect against if you are in good health. It is important to be aware of how to cope and survive:

- Wear lightweight, light-coloured, loose, porous clothes and a wide-brimmed hat
- Avoid direct sunlight if possible. Use strong sun screen, as sunburn limits the body's ability to cope with heat
- Do not leave children (or pets) in parked vehicles. Give animals access to shade and water
- If you have a baby or children under four years old, pay particular attention to the above advice and consult a doctor if they appear uncomfortable. If you are elderly or suffer from a chronic condition, illness, or just feel unwell, see a doctor immediately
- Avoid strenuous activities and drink two to three litres of water per day, even if you are not thirsty. Do not consume alcohol or carbonated drinks
- Avoid heavy protein foods (e.g. meat, dairy products) which raise body heat and increase fluid loss. Do not take salt tablets unless prescribed by a doctor
- Keep your home cool with curtains, shutters or awnings on the sunny sides and leave windows open at night
- If you don't have air-conditioning, use fans and damp towels to stay cool and have frequent cool showers. During the day spend as much time as possible in air-conditioned buildings (e.g. shopping centres, galleries, museums)
- Check on elderly neighbours and relatives to ensure they are comfortable and coping

STUDENTS: FIND FURTHER INFORMATION

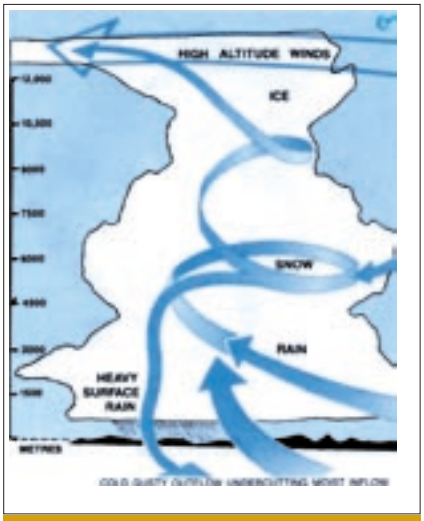
As a project on heatwave, find out more about heatwave in Australia:

- When was our most recent heatwave?
- Where did it occur?
- What where the minimum and maximum temperatures experienced?
- How long did the heatwave last?
- It is anticipated that the temperature in your town will be in the low 40's for the next three consecutive days, design a plan for your family that will minimise their risk of exposure to heat stress. Don't forget to include any pets you may have in your plan.

CHAPTER 5

SEVERE STORM HAZARDS AND DISASTERS

WHAT ARE SEVERE STORMS?



THE DIAGRAM ABOVE SHOWS A MATURE THUNDERSTORM WHICH IS PRODUCING HEAVY RAIN, LIGHTNING AND, POSSIBLY HAIL. THE TYPICAL ANVIL-SHAPED THUNDERCLOUD IS APPARENT AT THE TOP.

Severe storms are localised events, usually affecting smaller areas than tropical cyclones and floods, so their devastating impact is often under-estimated. These storms, which are more common than any other natural hazard, can occur anywhere in Australia.

Severe Thunderstorms

A severe thunderstorm is defined by the Bureau of Meteorology as one which produces;

- hail, diameter of 2 cm or more ($2 coin size); or
- wind gusts of 90 km/h or greater; or
- flash floods; or
- tornadoes (or any combination of the above).

Thunderstorms that do not produce any of these dangerous phenomena are not regarded as severe but may still cause death, injury or property damage due to lightning strikes.

WHAT CAUSES THEM? Thunderstorms develop when dense cold air overlies less dense, warm, moist air, resulting in strong upward currents and conversion of heat energy into wind and electrical activity. A severe thunderstorm develops when the atmosphere is especially unstable and wind flow provides the most efficient input of energy to the cloud, resulting in well organised, complementary up and down draughts capable of producing the following effects.

EXTREME WIND GUSTS CAN BE STRONG ENOUGH TO CAUSE SIGNIFICANT DAMAGE. AT THEIR MOST VIOLENT, THESE GUSTS ARE KNOWN AS MICRO-BURSTS AND DOWN-BURSTS, AND CAN SNAP LARGE TREES AND DEMOLISH BUILDINGS.

LIGHTNING AND THUNDER. Lightning is the discharge produced when voltage differences between ground and atmospheric electrical charge are large enough (several hundred million volts) to overcome the insulating effect of the air. Strikes can occur within the cloud, between clouds, or between clouds and the ground. Thunder is the sound produced by the explosive expansion of air heated by the lightning strike to temperatures as high as 30,000°C.

HAIL. Hailstones can form in a thunderstorm with a strong updraught when frozen raindrops, suspended in the updraught, grow rapidly by sweeping up small cloud droplets which freeze on contact. Hailstones larger than cricket balls have been recorded in Australia.

WIND GUSTS. In a mature thunderstorm, the falling rain and hail drag the surrounding air downwards. In addition, evaporation from the raindrops cools the nearby air, accelerating the downward rush. This strong downdraught spreads out upon reaching the ground, producing a cool, gusty wind that can cause damage.

FLASH FLOODS. The updraught of a mature thunderstorm produces raindrops by the condensation of moist air that cools as it rises. When the raindrops become too large to be supported they fall, but the intense updraught of a severe storm can suspend huge amounts of rain before releasing a deluge. Such rain can reach intensities of more than 200 mm/h, provided the environment is humid enough to feed the storm with enough moisture. Flash floods often result when the storm moves slowly, so that a small area receives most of the rain, but the drainage and run-off characteristics on the ground can also determine the area of greatest impact.

TORNADO, PORT HEADLAND, WA, 1970's.

TORNADOES. – These are the rarest but most violent of thunderstorm phenomena. A rapidly swirling mass of air (called the vortex) which can range in width from a few metres to hundreds of metres, descends in the well-known funnel shape from the base of a storm cloud. A tornado usually whirls clockwise (viewed from above) and contains very damaging winds that may reach more than 450 km/h. Many people believe that tornados do not occur in Australia; this is not true, they do and have caused numerous deaths. Most thunderstorms do not reach the level of intensity needed to produce these dangerous phenomena, but they all produce lightning which can cause death, injury and damage.

WHAT ARE LAND GALES?

Land gales are simply gale force (62 kph) or stronger winds which occur over the land. They usually last longer and affect much larger areas than thunderstorms. Gales blow when large differences in atmospheric pressure are concentrated over a small distance. This can happen between a "deep" low pressure system and a strong high, or near an intense cold front. In the southern half of Australia extreme winds generally occur in winter and spring and are usually due to land gales. In the tropical north the strongest winds usually hit in summer and autumn, and are often due to tropical cyclones.

WHERE AND WHEN DO SEVERE STORMS OCCUR?

Severe thunderstorms can occur at any time of the year, although they are very rare during the dry winter months in the north. Most strike between September and March when the supply of solar energy is greatest, but severe winter storms linked to cold fronts are common in the south-west of Western Australia and south-east South Australia.

The geographical spread of severe thunderstorms in Australia is difficult to determine because of our low population density and lack of observations over most of the continent. While records of storm impact show that the most damaging storms have occurred in the populous south-east quarter of the continent, analysis of wind, hail and tornado data suggests that severe thunderstorms are a significant threat throughout the country. The most damaging individual storms have hit south-eastern Queensland and the central NSW coast.

EFFECTS AND COST

Dangers to People

Unfortunately, storms can kill people: between 5 and 10 deaths are caused by lightning strikes each year. More deaths occur when strong winds cause tree limbs to fall, debris to become projectiles and small boats in open water to capsize. Although many people believe that tornadoes do not occur in Australia, they have caused at least 41 deaths here.

LIGHTNING DISPLAY NEAR ADELAIDE

Huge Damage Bills

Each year, on average, severe storms are responsible for more damage (as measured by insurance costs) than tropical cyclones, earthquakes, floods or bushfires. In 1996, for example, of 23 natural disasters each with total estimated costs of $5 million or more, 15 were severe storms, accounting for $772 million of the total of $1258 million (only droughts cost more). On average, about 35% of storm damage is insured.

REPAIRING SEVERE STORM DAMAGE, SYDNEY, APRIL 1999.

CASE STUDIES

AUSTRALIAN SEVERE STORMS

1. SYDNEY, 21 JANUARY 1991

Australia's second most-damaging severe thunderstorm with winds estimated at 230 kilometres per hour, large hail and torrential rain, tore through northern areas of Sydney, causing one death and injuring over 100 people. It damaged over 10,000 homes and businesses, and downed 140 kilometres of powerlines including three steel towers. The extreme winds, thought to have involved macro- and micro-bursts, felled or damaged at least 50,000 significant trees. Insurance losses of $226 million and total estimated costs of $670 million (1997 values) occurred.

2. WESTERN AUSTRALIA, MAY 1994

Perth, Mandurah and south-west Western Australia suffered violent winds up to 140 kilometres per hour during a storm which seriously damaged 600 houses, caused two deaths and 20 injuries, blacked-out 60,000 homes, and caused heavy losses to commerce and industry.

3. SOUTH-EAST AUSTRALIA, NOVEMBER 1994

The worst land gales for 10 years lashed Victoria, the Australian Capital Territory and New South Wales for several days with winds of up to 145 kilometres per hour. In the Melbourne region 500,000 homes were blacked-out and many were damaged. Huge duststorms spread for hundreds of kilometres in dry conditions and removed millions of tonnes of topsoil.

4. GEELONG, 27 JANUARY 1997

At Geelong, Victoria, during a thunderstorm, lightning struck a group of people sheltering under a park gazebo, killing two and injuring another four (one critically).

SYDNEY HAILSTORM DAMAGE, APRIL 1999.

5. SYDNEY, 14 APRIL 1999

Australia's costliest hailstorm pelted Sydney with giant hailstones, some reported as large as cricket balls, resulting in severe damage to homes, businesses, thousands of vehicles, boats, aircraft and powerlines. An insured loss of $1700 million and total estimated costs of $2300 million (1999 values) resulted.

6. SOUTH-EAST AUSTRALIA, 2 FEBRUARY 2005

A series of storms across the eastern states brought with them hail, strong winds and heavy rain, damaging homes, causing power outages and resulting in the one death. Storms across New South Wales dumped 40mm of rain in less than an hour, with 96,000 homes blacked out. Melbourne had winds of 100 kilometres per hour and 120mm of rain in 24 hours, with power cuts affecting over 120,000 households. In Tasmania, wind gusts of up to 130 kilometres per hour caused havoc, whilst hail also fell in Adelaide, the first seen in the city in February since 1977. Insurance losses as a result of the storms exceeded $216 million.

SEVERE STORM SURVIVAL AND PROPERTY PROTECTION

Most communities have damage prevention and reduction measures at local level. These may include enforcement of building standards, anchoring of light structures and caravans, clearing of tree limbs above roofs and powerlines, provision of timely weather reports and safety warnings, and the support of local state/territory Emergency Services to provide temporary repairs. You can minimise personal storm and lightning injury or property damage as follows.

Before the Storm Season

Trim tree branches well clear of your house. Check/clean roofs, guttering and downpipes

- Have a portable radio, torch, spare batteries and a first aid kit (and basic knowledge)
- Clear backyard of loose objects that could cause damage during high winds
- Purchase masking tape (for windows), plastic sheeting and large garbage bags (for emergency rain protection)
- List emergency contact numbers

As the Storm Approaches

- Listen to your portable radio and disconnect all electrical appliances
- Shelter and secure pets/animals. Shelter vehicles or cover with tarpaulin/blankets
- Tape (cross fashion 'x' plus strips) or cover large windows

When the Storm Strikes

- Stay inside in the strongest part of the house (bathroom, cellar). Don't use the telephone
- Keep clear of windows and glass doors, electrical items, pipes and metal fixtures
- If necessary, cover yourself with a mattress, doona, blankets, tarpaulin etc
- Listen to your portable radio for storm updates
- If outdoors find solid, enclosed shelter or a 'hard top' vehicle (not under a tree)
- If far from shelter, crouch (alone, feet together) preferably in a hollow. Don't lie down
- If driving, stop clear of trees, powerlines and streams. Stay in your car and keep clear of metal parts

After the Storm Passes

- Check your house for damage, listen to your radio and heed official warnings/advice
- If you need emergency assistance contact your State/Territory Emergency Service
- If unable to contact emergency services by telephone, form a self-help group with family and neighbours. Watch for emergency crews who will be checking your area
- If you don't need help, check neighbours. Don't go sightseeing: stay and help others
- Beware of damaged powerlines, buildings and trees and flooded streams

STUDENTS: FIND FURTHER INFORMATION

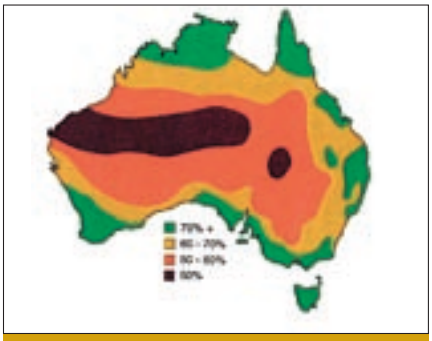
As a project on severe storms, find out more about:

- tornadoes—frequency, deaths and damage in Australia;
- common factors in the most-damaging severe storms; and
- micro-bursts and down-bursts during severe thunderstorms.

CHAPTER 6

DROUGHT HAZARDS AND DISASTERS

Although a few regions of Australia have a high annual rainfall, we live in the world's driest continent. On average, drought is Australia's most costly natural hazard in economic terms.



DROUGHT CONDITIONS ARE LIKELY WHEN THERE IS A REDUCTION IN NORMAL RAINFALL BY THE PERCENTAGE SHOWN FOR THAT ZONE (i.e. THE LOWER THE % FIGURE, THE-HIGHER THE POTENTIAL FOR DROUGHT).

WHAT IS DROUGHT?

The Bureau of Meteorology defines drought as a prolonged, abnormally dry period when there is not enough water for users' normal needs. However, low rainfall does not necessarily constitute a drought. If this was so, most of Australia's interior would suffer from permanent drought.

WHAT ARE THE CAUSES?

Natural Rainfall Variations

In Australia, even when not affected by global weather shifts, our rainfall pattern is among the most variable in the world. This is due to our size, location, geography and climatic range, this means many areas are subject to the regular threat of drought.

EL NIÑO/SOUTHERN OSCILLATION. The causes of drought originate with the fluctuations in global climate, which are a combination of the systems of atmosphere, oceans, ice masses and biosphere. The most widely known recurring climatic irregularity that develops every few years is the El Niño phenomenon (unusually warm ocean currents off the equatorial Pacific coast of South America). El Niño is actually an extreme swing in a recurring air pressure shift across the Pacific Ocean that is called the Southern Oscillation. Many droughts affecting eastern and northern Australia are a direct result of a strong swing in the Southern Oscillation, accompanied by cooler than normal ocean currents off northern Australia.

FEATURES OF AUSTRALIAN DROUGHT

Characteristics

FREQUENCY. In terms of rainfall, long-term averages indicate that for every 10 years we have about three good years, four average years, and three bad ones. Research also reveals that very severe drought affects some part of Australia approximately every 18 years.

INTENSITY AND DURATION. Drought intensity is a measure of rainfall deficiency over three months. For a particular region, between 5 and 10% above the lowest on record is rated as serious and less than 5% above lowest on record is rated as severe. Occasionally, droughts last for seven or eight years, but within that period the severity may fluctuate with spells of rainfall, although still well below average. Other droughts are shorter (one or two years) but more intense.

EXTENT AND PREDICTABILITY. Some droughts are localised, with relatively close areas receiving normal rainfall. Regional droughts often are not related to El Niño events, so they are more difficult to predict.

Effects

AGRICULTURE AND ENVIRONMENT. The effects of drought first impact on agriculture and cause reduction or loss of water supplies, crop failures and livestock losses. They can also lead to environmental damage through vegetation and wildlife loss, erosion, and toxic algal blooms in depleted dams, rivers and lakes.

COMMUNITIES. Country or city communities may face severe water restrictions and be affected by rising food prices and reduced supply. Other drought-related hazards in Australia are heatwaves, duststorms and bushfires.

EASTERN AUSTRALIA DROUGHT SCENE, 1983.

CASE STUDIES

AUSTRALIAN DROUGHTS

1. INTENSE DROUGHT, EARLY 1980S

The most intense period of drought since European settlement was in 1982–83, when very large areas of central and eastern (particularly south-eastern) Australia had record low rainfall. This was part of the 1979–83 drought and, the total impact on the economy was estimated at $7 billion (1997 values) in reduced productivity and insurance claims. This cost was due to an average drop of almost 40% in cereal grain, cotton and sugar production, and the loss of millions of livestock as well as tonnes of topsoil blown away in duststorms. By February 1985, major rivers such as the Murrumbidgee stopped flowing, reduced to a string of pools, and the Blowering, Burrinjuck, Hume, Wyangala and Keepit Reservoirs were all down to 6% of capacity.

2. NORTH-EASTERN AUSTRALIA, 1990S

A prolonged, severe drought gripped north-eastern New South Wales and most of Queensland from 1991 until late-1995 in most areas. Although less intense and widespread than the early 1980s drought, it lasted much longer, persisting in parts of central Queensland through 1996. Most areas between Cairns and Bundaberg, and inland roughly parallel with the coast, almost as far west as Longreach, suffered the lowest rainfall on record. Several major reservoirs in both states went dry and many others fell to dangerously low levels. Water had to be trucked to many towns for up to a year. Huge agricultural losses occurred in the eastern states as average rural production fell by over 10%. This largely contributed to the total estimated cost of the drought of $5 billion in 1997 values.

DROUGHT PROTECTION AND SURVIVAL

On the Land

We have to accept that droughts are a natural recurring hazard of the Australian environment. Farmers can prepare by developing plans which cover all aspects of managing a farm and take into account variable climatic conditions, especially drought. To further ensure an economically and environmentally sustainable agricultural business, advance strategies could include:

- appropriate additional fencing and pest/vermin control measures
- planting drought-resistant crops and pasture
- stabilising soil which is degraded or subject to erosion
- increasing water and stock-feed storage capacities and planting shelter-belts
- considering options for agistment and protecting plant and native species during drought

Plans need to be specific to each farm but consistent with regional catchment management plans.

In Towns and Cities

Water authorities plan for water shortages in towns and cities with reserve capacity in reservoirs. During prolonged drought, however, such stores may run low, requiring water restrictions. As an individual, the best place to prepare for droughts in urban centres is in the garden. Plan water-use wisely by reducing areas of grass, mulching garden beds and choosing dry-climate plants. In the home, always conserve water, especially during drought, by having shorter showers, turning off dripping taps, using water-efficient appliances, re-using water and collecting rain water in tanks.

STUDENTS: FIND FURTHER INFORMATION

As a project on drought, find out more about:

- The world's driest continent.
- List some of the impacts the drought has had on agriculture and the Australian environment. Research some of the impacts you identify.
- What is El Nino? Find out 5 facts about El Nino that you did not know before.
- Where is the closest reservoir to your community?
- What, if any, water restrictions are in place in your community?
- How can you conserve water around the home?

CHAPTER 7

CYCLONE HAZARDS AND DISASTERS

AUSTRALIAN TROPICAL CYCLONES

Tropical cyclones are low pressure systems in the tropics that, in the southern hemisphere, have well-defined clockwise wind circulations with a region surrounding the centre with gale force winds. The gale force winds can extend hundreds of kilometres from the cyclone centre. If the sustained winds around the centre reach 119 kilometres per hour, the system is called a severe tropical cyclone. These are referred to as hurricanes in North America and typhoons in Asia.

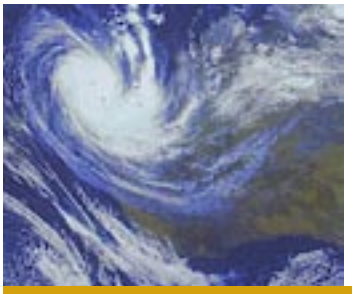
Cyclone Season and Effects

The tropical cyclone season in Australia extends from November to April. Cyclones generally affect coastal areas north of Perth along the Western Australia and Northern Territory coasts, most of the Queensland coast and occasionally the far northern New South Wales coast. The greatest threat lies north of the Tropic of Capricorn.

FREQUENCY. Cyclones occur frequently in the southern hemisphere, with an average of 10 per year being tracked by the Bureau of Meteorology in the Australian region. Cyclones in the Indian and Pacific Oceans are also closely monitored in case they threaten Australian islands or nearby countries.

SEVERITY CATEGORIES. The severity of tropical cyclones is described in terms of categories between 1 and 5 related to the zone of maximum winds. These range from Category 1 (strongest wind gusts less than 125 km/h), through Category 2 (125–169 km/h), Category 3 (170–224 km/h), Category 4 (225–279 km/h), to Category 5 for the most severe cyclones (wind gusts more than 280 km/h).

EFFECTS. Cyclones approach from the sea and bring torrential rains, extreme winds and sometimes storm surges. Damage varies widely depending on the path, but can include buildings, crops and boats at sea. Most deaths from cyclones occur as a result of drowning (both at sea and during floods), collapsed buildings, or debris which becomes lethal projectiles carried by the extreme winds.



SATELLITE PHOTO OF TC OLIVIA OVER WA, 1996.

STRUCTURE OF A CYCLONE (SCHEMATIC).
IMAGE COURTESY OF BUREAU OF-METEOROLOGY.

THE BIRTH AND ANATOMY OF A CYCLONE

Tropical cyclones derive their energy from warm tropical oceans and do not form unless the sea-surface temperature is above 26.5°C; once formed, they can persist over lower sea-surface temperatures. Tropical cyclones can persist for many days and may follow quite erratic paths. They usually dissipate over land or colder oceans.

If conditions are right, an ordinary tropical depression, or low, can develop into a tropical cyclone. In the southern hemisphere, in a low the winds spiral in a clockwise direction towards its centre, where they rise and spill over in an outward flow at high altitude. Summer heat on the warm ocean evaporates water, creating a deep layer of moist air. The uplift of this moist air in the centre of a low cools it, causing the intense rain characteristic of tropical cyclones. Higher in the upper levels the rising air spirals outward, removing air faster than it flows in, resulting in a fall in barometric pressure.

The Central 'Eye'

The circular eye or centre of a tropical cyclone is an area characterised by light winds and often by clear skies. Eye diameters are typically 40 kilometres, but can range from under 10 kilometres to over 100 kilometres. The eye is surrounded by a dense ring of cloud about 16 kilometres high known as the eye wall which marks the belt of strongest winds and heaviest rainfall.

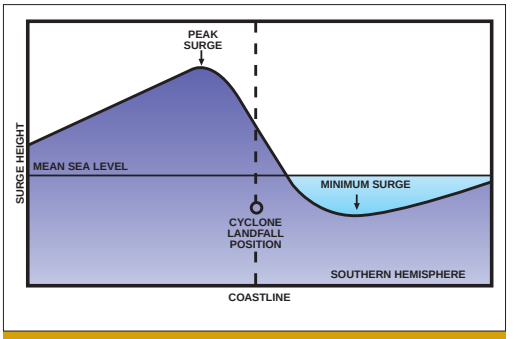
CYCLONE BEHAVIOUR AND WARNING TIME

Tropical cyclones in the Australian region have more erratic tracks than those in other parts of the world. Cyclones may exist for a few days, to over three weeks. They may move forward, double-back, stay motionless for periods or move in circles, and therefore need to be tracked carefully by weather observers. If they reach land, the friction of the earth and the loss of sustaining heat energy from the ocean cause cyclones to 'fill' and drop most of their rain. Cyclones move at 15–25 kilometres per hour, so there is usually sufficient warning time to prepare for their onset.

It is important for people in cyclone areas to remember that during the passage of the cyclone centre or eye there will be a temporary lull in the wind, but that this will soon be replaced by destructive winds from another direction.

STORM SURGE

Potentially the most destructive phenomenon associated with tropical cyclones that make landfall is the storm surge. A storm surge is a raised dome of water about 60 to 80 kilometres across and typically about 2 to 5 metres higher than the normal tide level. If the surge coincides with a high tide, massive flooding and additional destruction is likely to occur. People sheltering in low-lying coastal areas are potentially more at risk from a storm surge than from cyclonic winds, and should listen for storm surge warnings.



SEA-LEVEL CAN BE AFFECTED BY SURROUNDING WIND AND AIR PRESSURE AS THE CYCLONE'S CENTRE CROSSES THE COAST.

The diagram shows how sea-level can be affected by surrounding wind and air pressure as the cyclone's centre crosses the coast.

TC BENI, PORT VILA

1. TROPICAL CYCLONE TRACY, NORTHERN TERRITORY, DECEMBER 1974

Tracy claimed 49 lives in Darwin, while a further 16 were lost at sea on several small vessels which were in the path of this Category 4 cyclone. Approximately 650 people were treated for injuries on Christmas Day, while more than 35,000 people were evacuated in the days that followed. This was necessary as power, water, sanitation and communications were lost; over 80% of all buildings were destroyed; potential for disease was great; and only 400 of Darwin's 11,200 homes remained intact. Evacuation and relief efforts were coordinated by the Natural Disasters Organisation (now EMA). Insured losses were $837 million and total estimated costs were $4180 million (1997 values).

2. TROPICAL CYCLONE OLIVIA, WESTERN AUSTRALIA, APRIL 1996

This Category 4 cyclone destroyed power installations and 55 houses (and damaged 27) at the mining town of Pannawonica. Several buildings and another 20 houses suffered roof damage at neighbouring Mt Tom Price. Ten minor injuries occurred.

3. TROPICAL CYCLONE JUSTIN, QUEENSLAND, MARCH 1997

Although only a Category 2 cyclone, Justin caused significant damage in the Cairns region which it approached on two occasions during its long (3.5 week) life. Houses were undermined by huge waves, a marina and boats were severely damaged, roads and bridges suffered from flood and landslide damage and huge losses were inflicted on sugar cane, fruit and vegetable crops. Seven people died in Queensland and 26 in Papua New Guinea which was also severely affected by this cyclone. Total estimated costs in Australia were $190 million (1997 values).

4. TROPICAL CYCLONE INGRID, QUEENSLAND, MARCH 2005

This Category 4 cyclone impacted on Queensland, Northern Territory, Western Australia, and the Timor Sea. Wind speeds reached 290 kilometres per hour. Croker Island, 200km northeast of Darwin was badly affected, with winds destroying the school, houses, the only store and power poles on the island, whilst 750 residents from the Tiwi Islands, 60 km north of Darwin were also forced to evacuate. Damages were estimated in excess of $5 million.

5. TROPICAL CYCLONE LARRY, QUEENSLAND, MARCH 2006

This Category 5 cyclone caused considerable damage to the northern Queensland region around Innisfail and the Atherton tablelands. Significant damage was sustained to buildings and the local agricultural industries of bananas, sugar cane and avocado farming, impacting on Australia's economy. Some injuries were received but fortunately no deaths resulted.

CYCLONE SURVIVAL AND PROPERTY PROTECTION

In cyclone-prone areas of Australia, strict building codes exist for all new constructions. In some areas public cyclone shelters are provided for people who live or work in sub-standard buildings. A cyclone warning system is provided by the Bureau of Meteorology, and State/ Territory Emergency Services run preparedness campaigns to support community emergency plans. If you live in a cyclone-prone area you should heed the following advice.

Before the Cyclone Season

- Know your community cyclone plan, and how the cyclone warning system works
- Have a portable radio and torch with spare batteries
- Check your house is in good condition, particularly the roof, and trim tree branches clear of your house. Clear property of loose items likely to cause damage in high winds
- In case of a storm surge warning, identify your nearest safe, high area in advance
- Create an emergency kit of tinned food, water containers, emergency lighting, first aid kit, medicines, tape and plastic bags

Upon a Cyclone Warning

- Listen to your local radio or TV for further warnings
- Board or tape windows, store loose articles inside
- Lock up pets, fill water containers, fuel car and place under cover
- Check your emergency kit and put spare clothing and shoes in plastic bags

On Warning of a Local Evacuation

- Switch off electricity, gas etc. and lock your house upon leaving
- Don't forget your emergency kit. Follow instructions from emergency personnel

When the Cyclone Strikes

- Stay inside and shelter in strongest part of the house (e.g. bathroom or cellar)
- Protect yourself with mattress, blankets etc. and anchor yourself to a strong fixture (such as water pipes) or get under a strong table
- Beware the calm 'eye'. Remain indoors until advised that the cyclone has passed

After the Cyclone

- Don't go outside until advised officially that the cyclone has passed
- Listen to your radio for further information and advice
- If you had to evacuate, don't go home until advised. Use recommended routes
- Beware of fallen powerlines, damaged buildings, trees and flooded watercourses

STUDENTS: FIND FURTHER INFORMATION

As a project on cyclones, find out more about:

- the Cyclone Warning System;
- Cyclone Orson, Western Australia and cyclone Aivu, Queensland; and
- cyclone-proof buildings, or the Coriolis Force (or Effect).

CHAPTER 8

EARTHQUAKE HAZARDS AND DISASTERS

WHAT ARE EARTHQUAKES?

Earthquakes are a shaking or trembling of the Earth's crust caused by the release of huge stresses due to underground volcanic forces, the breaking of rock beneath the surface, or by sudden movement along an existing fault line. The latter type results from constant gradual movement of the tectonic plates that make up Earth's crust, which causes stress to build up in rock layers. Small earthquakes sometimes result from human activity (e.g. filling of large reservoirs).

Characteristics and Measurement

VARIABILITY. Earthquakes are unpredictable and strike without warning. They range in strength from slight tremors to great shocks lasting from a few seconds to as long as five minutes. They can occur in a series over a period of several days.

MAGNITUDE. Energy released by (or magnitude of) an earthquake is recorded on a seismograph, using the Richter scale. This scale is open-ended, as there is no upper limit to the amount of energy an earthquake might release. The most severe earthquakes so far have not exceeded 9.5 on this scale. It is not a simple arithmetic scale; for instance, a magnitude 7.0 earthquake creates 10 times the ground motion of a magnitude 6.0 earthquake and the total energy release is about 30 times greater. This, in turn, is 30 times greater than a magnitude 5.0 earthquake and so on.

INTENSITY. Another scale used to describe earthquakes is the Modified Mercalli (MM). It rates the amount of shaking felt and damage caused (or intensity), and uses Roman numerals. On this scale, I is a barely detectable tremor, and XII is total damage.

CAUSES OF INJURY AND DAMAGE

Most earthquake casualties result from falling objects or debris when shocks damage or demolish buildings and other structures. Electricity and telephone lines, and gas, sewer and water mains can be damaged; landslides, ground displacement (faulting), subsidence and tsunamis (see Chapter 9) may result, leaving many people dead, injured or homeless.

Australian Earthquakes

GEOLOGY. Because of Australia's geological position, we are prone to what seismologists call intra-plate earthquakes. These are different and less well understood than the more familiar plate-margin type, common in the USA, Indonesia, Papua New Guinea and New Zealand.

HISTORY. In the last 80 years, 17 earthquakes in Australia have registered 6.0 or more on the Richter scale. This is about one every five years, compared to a world average of about 140 per year. Although the larger Australian earthquakes have caused significant damage, they are, on the whole, of much smaller strength than the world's most damaging shocks.

Until Newcastle's December 1989 event, the damage bill attributed to earthquakes in Australia had been comparatively low.

SEVERE DAMAGE TO THE KENT HOTEL, NEWCASTLE, 1989.

HAZARD ZONES.

The geographically oldest western and central parts of Australia are most seismically-active. Compared with many other countries in our region, earthquake activity in Australia is low. Our most severe earthquakes usually occur in unpopulated regions but several have caused damage in built-up areas, mainly in Western Australia, South Australia and New South Wales. All states and territories have experienced earthquakes.

CASE STUDIES

AUSTRALIAN EARTHQUAKES

1. ADELAIDE, SOUTH AUSTRALIA, 1 MARCH 1954

Adelaide was awakened by a loud rumbling sound. This was followed by shaking, severe enough to crack walls and loosen plaster and chimneys from many houses and other buildings. At magnitude 5.4, it was severe enough to cause damage estimated at $350 million (1997 values). Three serious injuries were reported.

2. MECKERING, WESTERN AUSTRALIA, OCTOBER 1968

One of the more serious Australian earthquakes in fairly recent years occurred at the small town of Meckering. Residents reported seeing ground waves as well as experiencing steering difficulties when driving as the magnitude 6.9 earthquake struck. Old buildings collapsed, railway lines were buckled and pipelines fractured, and a 37 kilometre-long fault scarp (up to 2.5 metres high) was caused. Although 16 injuries were reported, none were really serious. Total damage estimates reached $50 million.

3. NEWCASTLE, NEW SOUTH WALES, 28 DECEMBER 1989

At 10.27am, Newcastle was partially devastated by a moderate earthquake which measured 5.6 on the Richter scale. The devastation to buildings and other structures was extensive, which was unusual for a relatively small-magnitude earthquake. This was due mainly to an underlying, thin layer of alluvium which appeared to magnify ground motion (shaking). The epicentre was located 15 kilometres west-south-west of the city centre, near Boolaroo.

DEATHS, INJURIES AND DAMAGE. There were 13 deaths and 150 injuries in Newcastle, which was low considering 35,000 homes and 3000 other buildings had slight to serious damage in the Hunter region. Over 50,000 buildings in central-eastern New South Wales suffered some damage. Older buildings suffered the most. Outside the Kent Hotel in Beaumont

Street, Hamilton, three fatalities occurred under collapsed awnings loaded down by the failed outer brick wall. Nine people died in the Newcastle Workers Club when three floors of the western wing collapsed, trapping many people.

DAMAGE COST. Insured losses amounted to over $1 billion (1999 values). Total estimated loss, however, was over $4 billion (including uninsured losses, infrastructure damage and commercial and other disruption).

LESSONS. Newcastle revealed that a lethal earthquake can occur in a part of Australia traditionally considered of low seismic risk and that there is a strong correlation between foundation soil conditions and potential for damage. This has resulted in improved building codes and practices, and more intensive monitoring of seismic activity.

4. ELLALONG, NEW SOUTH WALES, AUGUST 1994

A damaging earthquake again affected the Hunter region, this time in the Ellalong–Cessnock area. Measuring 5.4 on the Richter scale, it was our third most-damaging earthquake. Several homes, hotels and other buildings suffered seriously and up to 1000 homes were damaged. Infrastructure, commercial and industrial losses also occurred. Insurance payouts were $38 million and total damage costs exceeded $150 million (1997 values).

EARTHQUAKE SURVIVAL AND DAMAGE REDUCTION

Know Your Local Earthquake Risk

Ask your state or territory Emergency Service, council and insurance company for the following information.

- Whether tremors or earthquakes have occurred in your area and what damage resulted
- Ask your local Emergency Service for a free pamphlet or poster showing Australia's earthquake hazard zones
- Ask your council how to make your house safer, even in a slight-risk zone
- Check that your insurance covers earthquake damage

Emergency Kit and Plan (for during and after an earthquake)

- Have candles, matches, a torch and a portable radio with fresh batteries
- Have containers of fresh water, a first aid kit and basic first aid knowledge
- Know safe areas to shelter, and danger areas to avoid (see below)
- Plan with family how and where to meet if separated. List emergency contact numbers

Watch for Possible Warning Signs

- Erratic animal behaviour—watch for frightened or confused pets running around, or a bird call not usually heard at night
- Ground-water levels—watch for sudden changes of water level in wells or artesian bores

During the Earthquake

- If indoors, stay there. There could be falling debris outside
- Take cover under an internal door frame, sturdy table, bench or bed
- Keep away from windows, mirrors, chimneys, overhead fittings and tall furniture
- In high-rise buildings, stay clear of windows and outer walls. Get under a desk near a pillar or internal wall. Do not use elevators
- In crowded areas, do not rush for doors. Stay clear of roof and wall fittings
- If outside, keep well clear of buildings, walls, powerlines, trees etc
- In a city street with tall buildings, shelter from falling debris under strong archways or doorways of buildings. Don't stand under awnings or parapets as they may collapse
- If in a vehicle, stop in the open until shaking stops. Beware of downed powerlines and damage to roads, overpasses or bridges. Listen to radio for warnings before moving

After the Earthquake

Tend injuries and watch for hazards as follows.

- Check for injuries. Apply first aid. Do not move the seriously injured unless in danger
- Do not use telephones (avoid congestion) unless there is a serious injury or fire
- Turn off electricity, gas and water. Check for gas/fuel leaks before lighting matches
- Check for water or sewerage leaks, broken electrical wiring etc
- Check for cracks and damage, including roofs, chimneys and foundations
- Be prepared for aftershocks. Evacuate if house is badly damaged
- Do not waste food and water, as supplies may be interrupted. Collect emergency water from heaters, ice cubes, toilet tanks and canned foods
- Listen to local radio and heed warnings and advice on damage and service disruptions
- Avoid driving unless necessary (keep streets clear for emergency vehicles)
- Do not go sightseeing or enter damaged buildings. Stay calm and help others if possible

SEVERE DAMAGE CAUSED BY THE TAIWAN EARTHQUAKE, SEPTEMBER 1999.

STUDENTS: FIND FURTHER INFORMATION

As a project on earthquakes, find out more about:

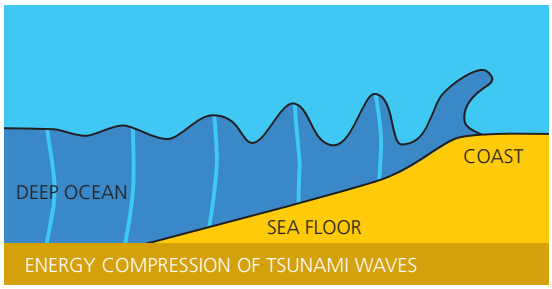
- earthquake waves, and seismographs;
- the San Andreas Fault, and the San Francisco earthquake, 1906;
- the earthquake in Armenia, 1988 or in Kobe, Japan, 1995; and
- compare the Newcastle earthquake, 1989 with major overseas ones.

Refer to a geological map to discover on what rock/soil type your house/school/workplace is built? How might this affect the building's chance of withstanding an earthquake?

CHAPTER 9

TSUNAMI HAZARDS AND DISASTERS

TSUNAMI EXPLAINED



ENERGY COMPRESSION OF TSUNAMI WAVES

Tsunamis are sometimes called 'tidal waves' but this is incorrect as they have nothing to do with tides. A tsunami is different from normal waves on the ocean. Normal ocean and wind swell waves may cause motion in the water to depths of 150 m. In contrast, the passage of a tsunami involves the movement of water all the way to the seafloor. Tsunami can be caused by under-sea events like earthquakes, landslides, volcanic eruptions or even ocean meteorite impacts. A tsunami is a series of sea waves, the first of which may or may not be the highest. The waves are of extremely long length and period. Tsunami waves move outwards, away from their source. As a tsunami crosses a deep ocean, the length from crest to crest may be as much as 150 km but the height may be less than a metre. Tsunami waves may therefore be unnoticed by ships or from the air, reaching speeds up to 1000 km/h. As a tsunami leaves the deep water of the open ocean and travels into the shallower water near the coast, the tsunami slows.

Effect on Coastal Regions

As tsunamis enter shallow water near coastlines, wave speeds drop and energy is rapidly compressed. Wave heights may increase dramatically (up to 40 metres), threatening life and property as they strike the shore with devastating force even though the tsunami may have been caused thousands of kilometres away.

Where Do They Occur?

AUSTRALIAN OCCURRENCES. The tsunami threat to Australia varies from relatively low for most of our coastline, to relatively high on the north-west coast of Western Australia. In May 1960, a great earthquake in Chile generated the largest recorded tsunami along the east coast of Australia from Hobart to Brisbane. In Sydney Harbour tsunami waves of about a metre (trough to crest) were recorded on the Fort Denison tide gauge.

PACIFIC REGION. Most tsunamis occur in the Pacific Ocean, although they have occurred in all oceans of the world. In our region, areas most at risk include many Pacific islands, New Zealand, and the heavily-populated coasts of Japan and Indonesia.

AUSTRALIAN TSUNAMI ALERT SERVICE

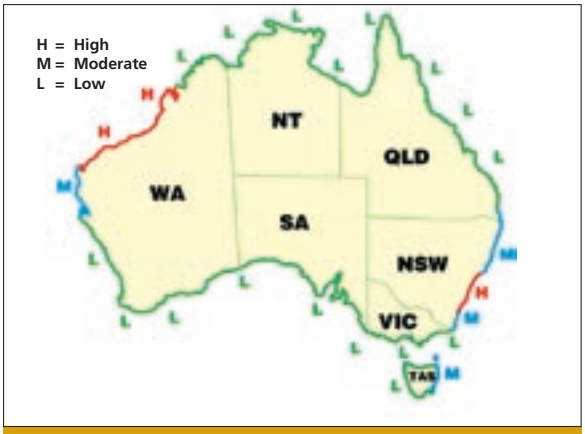
To ensure Australian citizens are alerted of impending tsunamis, an Australian Tsunami Alert Service (ATAS) is run in partnership between Geoscience Australia, the Bureau of Meteorology, EMA and the National Tidal Facility with the following roles.

GEOSCIENCE AUSTRALIA: continuous monitoring and interpretation of earthquakes in Australia's region.

BUREAU OF METEOROLOGY: re-transmission of alerts and warnings provided by the Pacific Tsunami Warning Center in Hawaii and the transmission of advice provided by Geoscience Australia on potentially tsunamigenic earthquakes.

EMA: transmission of advice from Geoscience Australia to state and territory emergency management organisations.

NATIONAL TIDAL FACILITY: provision of expert advice on sea monitoring and behaviour including modelling.



TSUNAMI HAZARD MAP

CASE STUDIES

TSUNAMIS

1. JAVA, INDONESIA AND NORTH-WESTERN AUSTRALIA, 1994

On 3 June 1994, a tsunami took more than 200 lives along the Indian Ocean coastline of Java and impacted on the northern Western Australian coast three to four hours later. A small tsunami was recorded at Broome, King Bay, Onslow and Carnarvon. Water carried hundreds of fish, crayfish, rocks and coral inland for up to 300 metres. An eyewitness at Onslow said that from a calm sea she saw two large waves appear, the second of which was estimated to be two to three metres high.

2. NORTH-WEST PAPUA NEW GUINEA, 1998

On the evening of 17 July 1998, a powerful earthquake (Richter scale magnitude 7.0) occurred beneath the seabed about 30 kilometres off the coast of West Sepik province and generated shock waves in the form of three rapidly-moving tsunami waves. Within minutes the tsunami reached the shallow waters near the coast, causing the waves to grow dramatically to a height of 7 to 10 metres before crashing ashore, engulfing and almost obliterating whole villages along approximately 30 kilometres of coastline, felling trees, scouring the ground, crushing and scattering buildings, and washing away heavy bridges. In the aftermath, reports described the scene 'as though some giant toothcomb had been dragged across the landscape'. The final human toll was approximately 2000 dead, 100 serious injuries and 10,000 homeless.

3. INDIAN OCEAN, 26 DECEMBER 2004

A magnitude 9.3 earthquake occurred off the west coast of Sumatra where the Indo–Australian plate is sliding under the Eurasian Plate. The 'Indian Ocean Tsunami' ruptured the entire 1200 km length of the Andaman Thrust. The width of the fault was 100–150 km, and had an average slip of 5–10 m. The displacement of the ocean floor generated a tsunami which spread from its epicentre across the Indian Ocean, devastating communities in Indonesia, Sri Lanka and Thailand and affecting many other countries along the Indian Ocean rim. Close to 300

thousand people lost their lives. For Australia, the impact of the 26 December 2004 Sumatra earthquake was relatively minor. A half metre wave passed Cocos Island while abnormal sea-level variations were recorded on the west coast of Australia.

TSUNAMI SURVIVAL

If you hear that a strong earthquake has occurred, stand by for a possible tsunami emergency and be prepared to move from low-lying coastal or lakeside areas to high ground at short notice. All tsunamis are potentially dangerous and destructive.

- When an official warning is issued, it means a tsunami actually exists. Some tsunami victims have dismissed such warnings as false alarms and died as a result.
- Approaching tsunamis are sometimes preceded by a rapid rise or fall in sea-level. This is nature's warning and should be heeded. Vessels should head for deep water immediately.
- A small tsunami at one point on the shore can be extremely large a few kilometres away, so don't let the modest size of one make you lose respect for all.
- A tsunami is not a single wave, so stay out of danger areas until an official all-clear.
- Never go to the shore to watch a tsunami. If you can see it, you are too close to escape.
- Cooperate with your local emergency authorities if asked to evacuate.

INDIAN OCEAN TSUNAMI 26 DECEMBER 2004

STUDENTS: FIND FURTHER INFORMATION

As a project on tsunamis, find out more about:

- the tsunami warning system in the Pacific Ocean;
- tsunami disasters of the 20th century; and
- countries that are likely to be affected by a tsunami hazard.

CHAPTER 10

LANDSLIDE HAZARDS AND DISASTERS

THE NATURE OF LANDSLIDES

What Causes Landslides?

A landslide is the movement of a mass of rock, debris or earth down a slope. All landslides have two things in common—they are the result of failure of the soil and rock materials that make up the hill slope and they are driven by gravity. They can vary in size from a single boulder in a rock fall to tens of millions of cubic metres of material in a debris avalanche. Landslides can be triggered by natural causes or by human activity.

NATURAL CAUSES: these include saturation of slope material from rainfall or seepage, vibrations caused by earthquakes or volcanic eruptions and undercutting of cliffs and banks by waves or rivers.

HUMAN ACTIVITY: this may include the removal of vegetation; interference with or changes to natural drainage; leaking pipes (water, sewer); the modification of slopes by the construction of roads, railways or buildings; mining activities; vibrations from heavy traffic or blasting; or the displacement of rocks.

Indicators of Potential Landslide Activity

- Saturated ground or seeps in areas that are not typically wet
- New cracks and scarps or unusual bulges in the ground, roads or pavements
- Movement of ancillary structures such as decks and patios in relation to the house
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or displaced road surfaces
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)

How Do Landslides Affect Us?

Australia's most devastating landslides occurred in the New South Wales alps at Thredbo in 1997 when 18 people were killed (see Case Study 3); in Gracetown, Western Australia, when a cliff collapsed killing nine people (see Case Study 2); and at Riverstone, Queensland, in 1900 when five men were killed in a tramway cutting cave-in. Almost half the landslides causing injury or death in Australia were the result of human activity. Every year in Australia, landslides damage many houses and cause millions of dollars damage to buildings, roads, railways, pipelines, agricultural land and crops.

Areas Generally Prone to Landslide Hazards

- On existing or old landslides
- On or at the base of slopes
- In or at the base of minor drainage hollows
- At the base or top of a fill slope
- At the base or top of a cut slope
- Any sloping ground in an area known to have a landslide problem

Landslide Types

Once a landslide is triggered along a plane of weakness, material is transported by various mechanisms including sliding, flowing or falling.

Rate of landslide movement varies from extremely slow in landslides moving at only millimetres or centimetres per year to a sudden rapid (metres per second) avalanche of large volumes of debris. Sudden events are the most dangerous because of the lack of warning, the speed at which they can travel down the slope and their size.

Distance travelled by landslide material varies greatly, from a few centimetres to many kilometres when large volumes of debris, mud and water flow down river valleys.

Australian Landslides

Compared to other countries, Australia is subject to minimal landslide activity. However, isolated areas affected by landslides commonly have cliffs or steep colluvial deposits and receive intense rainfall events. Areas include coastal cliffs, the Great Dividing Range, the Strzelecki and Otway Ranges of Victoria, the Mt Lofty Ranges near Adelaide, and the Tamar Valley and north-west coast of Tasmania. More localised areas also include the Illawarra Escarpment near Wollongong, the northern beaches area of Sydney, the Lake Macquarie and Newcastle suburbs in New South Wales, and the Townsville, Cairns and Mt Tambourine areas in Queensland.

DAMAGE AND COSTS. Between 1842 and 1997 more than 150 landslides have caused well over $200 million damage to buildings, roads, railways, pipelines and crops. A total of over 200 buildings are known to have sustained damage due to landslides. In the worst recorded case, at Lawrence Vale, Launceston, Tasmania, 35 houses were destroyed in two adjacent landslides in the 1960s.

CASE STUDIES

AUSTRALIAN REGION

1. COLEDALE, NEW SOUTH WALES, 1988

On 30 April 1988 in a small coal mining town near Wollongong, a landslide which resulted from a combination of human interference and two weeks of heavy rainfall had fatal consequences. A 20-metre high railway embankment collapsed after blocked drains caused earth and rock ballast in an old mine dam to become saturated and suffer severe undermining. A sudden rush of mud and rock collided with a house below, turning it through a 60° angle before completely demolishing it and killing a woman and her infant son inside.

2. GRACETOWN, WESTERN AUSTRALIA, 1996

On 27 September 1996, a 20-metre high limestone sea-cliff collapsed on spectators at a school surf carnival at Cowaramup Bay near Gracetown (Margaret River). They had been sheltering from rain under the overhang when about 30 tonnes of rock and sand fell, killing nine people (four adults and five children) and injuring three others. One survivor, a 10-year old girl, was dug from beneath the rubble by emergency workers after being trapped for 90 minutes.

3. THREDBO, NEW SOUTH WALES, 1997

At about 11.30 pm on 30 July 1997 Australia's worst landslide occurred when a large section of steep mountainside below the Alpine Way road collapsed immediately above part of Thredbo Ski Village. About 1000 tonnes of earth, rock and trees slid down the steep slope, shearing the Carinya Lodge off its foundations and causing it to collide with the Bimbadeen Lodge at high speed. Both multi-level buildings were completely crushed, and debris and parked cars were scattered over and under the lower 250 metres of the 400-metre landslide. Rescue efforts were hampered by several further minor slides and the very unstable mass of earth, rock, shattered lodges and trees and vehicles.

AUSTRALIA'S WORST LANDSLIDE OCCURRED ON 30-JULY-1997 AT THREDBO IN NEW SOUTH WALES.

After 55 hours, rescuers located a survivor buried in a void below three huge concrete slabs, 2.5 metres below the rubble. Ten hours later, the slightly injured man was successfully rescued after surviving the complete demolition of his lodge. Eighteen people died. The disaster also caused many millions of dollars damage.

LANDSLIDE SURVIVAL AND PROPERTY PROTECTION

Some local governments and land managers have learned from past events and now impose stringent planning and design requirements in landslide-prone and unstable areas. These include:

- implementation of regional hazard and risk assessments in land-planning policies. This ensures appropriate processes are in place so that development applications are assessed with respect to slope instability issues and zoning for future development is directed toward areas with low or very low risk
- engineering and geotechnical investigations that further define landslide threat at site specific levels of investigation
- mapping of landslide vulnerability to help with the development of emergency response scenarios

Further, you should:

- request information and assistance from your local government authority prior to land purchase or construction. This information could include, amongst other things, past landslide activity and any known landslide risk assessments
- consult a geotechnical engineer or engineering geologist for advice concerning development and slope instability
- ensure you do not undercut steep banks, develop near the top or base of steep slopes, or place fill on steep slopes
- make sure you do not stand on, or seek cover below or near, coastal cliffs or overhangs and be aware of the potential dangers they represent. Take notice of signs warning of loose rocks and debris
- learn more about the geological hazards in your area and become familiar with tell-tale signs of ground movement

STUDENTS: FIND FURTHER INFORMATION

As a project on landslide, find out more about:

- On a map, locate regions across Australia that are prone to landslide. List the causes of landslides.
- Choose one of the listed case studies and research it in greater detail.
- What caused the landslide to occur? What was the cost involved? Were people injured in the landslide? What emergency plans have the local council/government put in place since the landslide, if any?

CHAPTER 11

VOLCANO HAZARDS AND DISASTERS

THE FIERY PACIFIC REGION

The Earth, in geological terms, is relatively young and still changing. There are over 1500 potentially-active volcanoes worldwide and eight to ten erupting at any time. There are at least as many more under the oceans. Pacific region countries contain about 80% of these volcanoes, which encircle the Pacific Ocean in a belt known as the Ring of Fire. Although there are no active volcanoes in Australia, vulcanologists believe that at least minor future activity is still possible from dormant volcanoes in eastern South Australia and western Victoria. There are also two active volcanoes in the Australian Antarctic Territories of Heard and McDonald Islands, the larger of which is named Big Ben (2750 metres).

Range of Destruction

Volcanoes form when a break in the Earth's crust allows magma (molten rock) and hot gas to reach the surface under pressure, resulting in dangerous eruptions.

In the immediate area, the main threats are high-speed, super-heated toxic gases and debris (pyroclastic flows); blast effects; lava flows; volcanic earthquakes; landslides; collapses; and lahars (mudflows). Ash clouds or deposits and tsunamis can be hazards much further away.

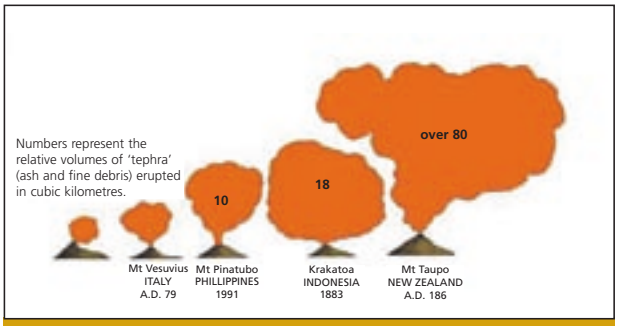
Over 100,000 deaths have been caused by volcanoes worldwide. Volcanoes can cause immense destruction to whole towns, crops, forests and roads, creating many evacuees who must be sheltered, fed and resettled. Lava flows may also block streams, causing floods, mud flows and landslides.

THE AUSTRALASIAN REGION

INDONESIA AND PHILIPPINES. Eruptions of the Galunggung volcano in West Java, one of many in Indonesia, caught our attention in 1982 when volcanic ash temporarily stopped engines of passenger planes en route to Australia. (It also destroyed many hundreds of homes and crops.) Australian scientists have since developed the Airborne Volcanic Ash Detection System (AVADS) which enables pilots to detect ash clouds due to heat radiation produced.

PAPUA NEW GUINEA AND NEW ZEALAND. In September 1994, two volcanoes, Vulcan and Tavurvur, erupted and buried the town of Rabaul, Papua New Guinea, under millions of tonnes of ash and made 80,000 people homeless. In late 1995 and June 1996 Mt Ruapehu in New Zealand erupted, closing ski fields, causing floods from its crater lake, and interrupting air traffic in the North Island. Mt Pago, on the island of West New Britain, Papua New Guinea, erupted in August 2002, discharging volcanic ash and lava. Local villages were inundated by ash which destroyed their subsistence crops and posed a significant health problem, approximately 12,000 people were evacuated. The volcano continues to show signs of further eruptions.

USA. Hawaii's Kilauea Volcano is the world's most active volcano. It erupted many times during 1982–85 (48 times in 1983 alone) and again in 1990. There was no loss of life, but huge lava flows destroyed a building, several main roads and vehicles, and threatened homes and properties in the area.



A COMPARISON OF SELECTED RECENT AND HISTORIC VOLCANIC-ERUPTIONS.

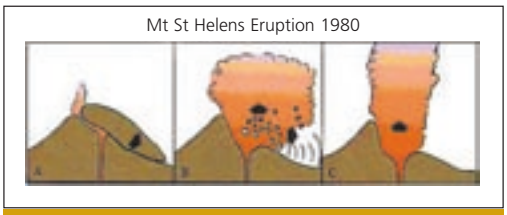
SPECTACULAR LAVA FLOW, KILAUEA VOLCANO, HAWAII, 1980'S.

CASE STUDIES

VOLCANIC ERUPTION

1. MT ST HELENS, WASHINGTON, USA, 1980

BUILD-UP. During 1980 scientists warned that a large bulge which was developing on the snow-covered, upper-northern slopes of Mt St Helens might trigger a great avalanche or eruption. They were correct. The disaster began early on 18 May with an earthquake (magnitude 5.0) which loosened the whole northern slope of the mountain. A gigantic avalanche followed (A).



MT ST HELENS ERUPTION 1980.

ERUPTION. In an enormous blast, hot gases, earth and rocks rocketed out of the volcano's side, flattening forests over 25 kilometres away (B). At the same time, furious blasts sent lava, steam, ash and rock skyward (C). The initial blasts ejected about 400 million tonnes of debris.

DEATH TOLL AND DAMAGE. Sixty-two people died in thick ash and choking smoke and many more were injured. Damage caused by the eruption and subsequent ash-fall has never been fully calculated. Rivers were flooded and silted for up to 24 kilometres, 400 square kilometres of forests were flattened and disappeared, and roads and bridges were demolished. Total economic losses were estimated at US$1.2 billion (in 1980 values).

2. MT PINATUBO, PHILIPPINES, 1991

THE RE-AWAKENING. On 9 July 1991, the 1463 metre dormant volcano near Subic Bay came back to life after six centuries. It began a series of eruptions which lasted for months.

MASSIVE ERUPTIONS. By mid-July the eruptions reached an initial, mighty climax and belched billions of cubic metres of red-hot magma, gases and ash (tephra) from a three kilometre-long fissure (crater) near the mountain's summit. Such was the explosive force of the main eruption, that it ejected enormous clouds of ash and gas vertically to an altitude of about 40 kilometres.

MT. PINATUBO ERUPTION, PHILIPPINES, 1991.

PHYSICAL EFFECTS. Ash fallout from the volcano settled deep on the ground over huge areas, up to hundreds of kilometres away. By mid-afternoon on 17 July, the sky was as black as night as far south as Manila (85 kilometres away). A relentless 'rain' of golfball-size pumice pebbles and ash poured down, while thunder and lightning from a tropical storm alternated with brilliant orange flashes from the volcano. There were also numerous earthquakes, all resulting from Pinatubo's continual violent eruptions. Fortunately, because the bulk of its eruptive energy was directed upwards (unlike Mt St Helens), it did not produce large pyroclastic and molten lava flows that could have devastated towns on the mountain's flanks.

SECONDARY EFFECTS. A week later, heavy rains from typhoon Brenden sent thousands of tonnes of ash, silt and volcanic debris surging down the mountain. Enormous mud flows and slides (taller than houses) wrecked many foothill villages, killed many people and forced thousands to flee from their homes.

DEATH TOLL AND DAMAGE. The secondary events caused the greatest loss of life and human suffering. Over the period of eruptions, about 700 died. One million others were forced from their homes (42,000 were destroyed) and 40,000 hectares of cropland were buried under ash.

ATMOSPHERIC EFFECTS. Mt Pinatubo's massive eruption was the largest on record in the Philippines, producing the largest cloud of climate-modifying gases since Krakatoa erupted in Indonesia in 1883. Scientists estimated that Pinatubo's eruption added more aerosols (light gases and particles) than all human-caused greenhouse gases since the industrial revolution. A reduction of up to 1°C in the Earth's average temperature was recorded by satellites within a year of the main eruption. This cooling effect persisted for about two years, temporarily more than offsetting any global-warming effect.

STUDENTS: FIND FURTHER INFORMATION

As a project on volcanoes, find out more about:

- the difference between active, dormant and extinct volcanoes;
- extinct and dormant volcanoes in Australia and active ones in New Zealand;
- the eruption of Mt Vesuvius, Italy, 79 AD, or Krakatoa, Indonesia, 1883; and
- the possible effect of volcanic gases etc. on global warming.

CHAPTER 12

OTHER TYPES OF HAZARDS AND DISASTERS

OTHER NATURAL HAZARDS AND DISASTERS

Biological Origin

HUMAN EPIDEMICS AND PANDEMICS. Human populations have been devastated in the past by disease in disastrous epidemics and pandemics (geographically unconfined epidemics). During a worldwide influenza pandemic of 1918–19 over 21.5 million people died, including 10,000 in Australia (January–December 1919). Mosquito-borne diseases such as malaria and, in Australia, Ross River fever and encephalitis, periodically approach epidemic proportions, particularly following monsoon seasons or widespread floods.

EXOTIC ANIMAL DISEASES. Due to Australia's geographic isolation and careful management, the threat from exotic animal diseases has been quite low. Should an epidemic occur (e.g. foot-and-mouth disease), the situation could be disastrous, threatening our entire local and export livestock industry, and seriously affecting public health. In early 1997, a small outbreak of anthrax, which affected hundreds of dairy cattle in Victoria, was a timely reminder of the constant need for vigilance. More recently, Avian flu has presented itself as a real threat to the agricultural industry of many nations.

INSECT AND VERMIN PLAGUES. In ideal conditions locusts, mice and rabbits multiply prolifically, creating plagues which decimate food crops on a large scale. Such events in Australia regularly cause heavy rural export losses, but in poorer countries can cause famine. Biological control is proving to be safer and more effective than chemical sprays and poisons.

Extreme Cold (Meteorological)

In Australia severe cold snaps sometimes occur during winter in higher areas of New South Wales, the Australian Capital Territory, Victoria and Tasmania. These coldest regions are sparsely populated, so deaths rarely occur, but roads are often cut by snow and occasionally small

settlements have been isolated without power for extended periods. Some residents of the Monaro region of New South Wales were cut off without heating in July 1987 when deep snow broke power and phone lines and blocked roads for up to a week.

EFFECTS OF SEVERE FROSTS. A more frequent and widespread hazard for agriculture in many parts of south-east Australia is severe, late-spring frost. This can cause very heavy fruit, vegetable and crop losses.

ASTEROIDS AND COMETS (EXTRATERRESTRIAL). About every 700 years on average, a 100-metre diameter asteroid (or larger) strikes the Earth at up to a quarter of a million kilometres per hour. They destroy everything in the vicinity and throw up millions of tonnes of dust into the atmosphere from the large crater they create. In Australia alone, 22 impact craters have been found, the best-known large one being at Wolf Creek in Western Australia.

HUMAN-CAUSED HAZARDS AND DISASTERS

Urban Structure Fires

Perhaps the most common human-caused hazard is fire in large, occupied buildings. Causes can be accidental or deliberate, but unless structures have been built to safe fire standards, and sound emergency procedures are used, heavy loss of life can result. Notable overseas cases include a high-rise building fire in Sao Paulo, Brazil; the Kings Cross Station inferno in London and Bradford Soccer Stadium, both in England.

Terrorist Bombings and Shooting Massacres

Perhaps the most upsetting disasters are those which involve deliberate brutal acts of mass-murder against people. Examples include the Oklahoma City bombing, USA, which killed 168 people; the 1996 Dunblane massacre of 16 school children and their teacher in Scotland; and the Port Arthur massacre of 35 people in Tasmania in April 1996. Terrorist attacks on the World Trade Centre in New York and the Pentagon in Washington on 11 September 2001 killed thousands of people. More recently, the bombings in Bali in which 92 Australians (88 in the Oct 2003 attack and 4 in the October 2005 attack) were killed. This brought terrorism closer to our shore.

TECHNOLOGICAL HAZARDS AND DISASTERS

Transport Accidents

The worst railway disaster in Australia was the January 1977 accident in Granville, Sydney. A full, peak-hour electric train derailed and collided with a concrete bridge support, bringing it down on carriages, killing 83 people and injuring 213. From October 1989 to October 1994, eight major passenger bus accidents caused a total of 95 deaths and 272 injuries. The worst was the December 1989 Kempsey two-bus collision which left 35 dead and 41 injured.

Australia has suffered two major bridge collapses. In 1970, Melbourne's Westgate Bridge collapsed during construction (35 dead) and in Hobart, 1975, a huge pylon of the Tasman Bridge was smashed by a ship which then sank when a massive concrete bridge-span collapsed. Cars plunged into the river, killing 12, and Hobart's vital road link over the Derwent River was severed for many months.

Nuclear Power Accidents

CHERNOBYL. The only nuclear power disaster was in 1986 at Chernobyl, near Kiev, Ukraine, (then part of the Soviet Union). Officials admitted to only 31 deaths and 400 casualties initially, as a result of the explosion, but as years pass there is evidence that the health, and ultimately the lives, of thousands of people are being adversely affected by radiation produced in the accident.

Hazardous Materials

BLEVE. In 1979 in Mississauga, Ontario, Canada 250,000 people had to be evacuated following a train accident which triggered a series of Boiling Liquid Expanding Vapour Explosions (bleves). Liquefied gas Bleves occurred in Cairns in 1987 (one dead, 24 injured) and in Sydney (no casualties).

TOXIC EMISSION. In 1984 cyanide gas escaped from a fertiliser factory in Bhopal, India. The resulting deadly cloud caused the deaths of approximately 2000 people. In Australia in August 1991, the Coode Island fire burnt 8.6 million litres of chemicals in the heart of Melbourne and loomed as a potential disaster, but winds dispersed toxic fumes away from residential areas. Over 250 workers were evacuated from nearby ships and factories. Two fire-fighters were injured.

TOXIC EMISSION SURVIVAL STEPS

If you hear a warning signal or announcement of dangerous fumes etc:

- Remain in, or immediately enter, a house or building. Do not attempt to evacuate.
- Close external doors and windows. Draw curtains and seal (tape) ventilators.
- Turn off air-conditioners, extinguish naked flames (e.g. pilot-lights).
- Move to a room furthest away from the hazard area.
- Listen to radio/television for official emergency information.
- Stay indoors until the official all-clear, then open doors and windows to restore ventilation.
- Avoid telephone use until the all-clear and cooperate with official instructions.

STUDENTS: FIND FURTHER INFORMATION

Research an unusual event from Annex A. Also, find out more about:

- AIDS and hepatitis, or typhoid and cholera; and
- exotic animal diseases or the long-term effects of the Chernobyl disaster.

CHAPTER 13

AUSTRALIAN EMERGENCY AND DISASTER MANAGEMENT ARRANGEMENTS

RESPONSIBILITIES

Prime responsibility for the protection of life, property and the environment rests with the States and Territories. The Australian Government is committed to supporting States and Territories in developing their capacity for dealing with emergencies and disasters, and provides physical assistance to requesting States or Territories when they cannot reasonably cope during an emergency. Under the Constitution, the Australian Government is allocated responsibility for external affairs matters including the provision of humanitarian assistance for emergency and refugee relief overseas.

The Australian Government, through Emergency Management Australia (EMA), supports a comprehensive approach to emergency management. EMA fosters active partnerships with a network of international, Australian and State/Territory agencies, local government, volunteers, non-government and community organisations, businesses, professional bodies and individuals. In doing so, EMA seeks to encourage an "all agencies", "all hazards" approach to the prevention or mitigation of disasters, preparedness for their impact, response to that impact and recovery from the consequences.

Participating Organisations

In Australia many people are involved in helping when disaster strikes. In addition to police, fire and ambulance services, there are professional and volunteer emergency organisations, such as the State and Territory Emergency Services, with personnel trained to help communities in trouble. The Red Cross, St John Ambulance, Salvation Army and many other volunteer groups also act when disasters strike. Emergency response volunteer groups have over 500,000 trained members throughout Australia.

EMA

History

EMA's predecessor, the Natural Disasters Organisation (NDO), was established in mid-1974 within the Department of Defence. The NDO brought together all elements of Commonwealth civil defence capability (brought about by the Cold War), but with an expanded scope that included combating natural disasters. In December 1974, the NDO's capabilities were tested by the devastating impact of Cyclone Tracy on Darwin. This event resulted in an increased focus on natural disasters and the provision of resources to support disaster response.

With the emergence over the next two decades of the broader concepts of emergency management embracing prevention, preparedness, response and recovery, the NDO's role was further broadened. In 1993, the NDO was renamed Emergency Management Australia (EMA) to better reflect this wider perspective. In November 2001, EMA was moved from Defence to the Attorney-General's Department to reflect its changing responsibilities and the greater emphasis on consequence management in respect of national security arrangements.

Mission and Role

EMA's mission is to provide national leadership in the development of measures to reduce risk to communities and to manage the consequences of disasters.

EMA responds to the challenges presented by the continually changing emergency management environment and seeks to achieve its mission by working in four key areas of activity and by delivering a range of services and products. These areas are: strategic partnerships; developing community capacity and resilience, developing emergency management capability; and strategic leadership.

Plans for emergency and disaster response

The ability to effectively respond to emergencies requires careful planning. Contingency plans are in place to meet State and Territory requests for Australian Government assistance arising from any type of disaster. These plans include the *Commonwealth Government Disaster Response Plan* (COMDISPLAN), which details procedures for provision of Australian Government assistance through EMA in the event of a disaster in Australia. Requests for disaster assistance from overseas countries are managed through a separate plan on behalf of the Australian Agency for International Development (AusAID).

EMA also maintains a number of hazard-specific contingency plans including: plans for coordinating actions related to the re-entry of radioactive space debris; managing the reception of persons evacuated into Australia due to disasters or civil unrest in neighbouring countries; responding to accidents involving ships carrying nuclear waste material past Australia; and repatriating and providing care for Australians injured or killed in mass casualty events overseas.

Consequence management

Consequence management is a developing concept involving protecting public health and safety, restoring essential government services and providing emergency relief to businesses and individuals affected by the consequences of natural, technological and human-caused disasters. EMA is the lead Australian Government agency involved in consequence management and works closely with State and Territory organisations such as police, fire agencies, ambulance services, State and Territory Emergency Services and public health authorities to ensure appropriate consequence management arrangements are established

TRAINING COURSE – EMA MOUNT MACEDON

Response Coordination

EMA is responsible to the Attorney-General for the coordination of physical disaster assistance provided by the Australian Government. Such assistance results from a formal request from a State or Territory if government and commercial resources are unable to cope with an emergency. The Director General of EMA, after obtaining approval from the Attorney-General, can call on the resources of any other Australian Government Department or Agency, and can request assistance from other States or Territories. This is coordinated through the National Emergency Management Coordination Centre (NEMCC) which is located at EMA Canberra.

Education and Training

EMA's Education and Training activities are managed from Mount Macedon in Victoria. This includes the identification and development of best practice in emergency management, and development and delivery of accredited education and training programs, many of which are derived from the National Emergency Management Competency Standards.

EMA's programs address key aspects of prevention, preparedness, response and recovery in such topics as emergency planning in evacuation, business continuity management, establishing an Emergency Coordination Centre, and managing recovery. In addition, EMA conducts two nationally recognised higher education programs, the *Graduate Certificate in Emergency Management* and the *Advanced Diploma of Public Safety (Emergency Management)*.

Training, education and professional development programs are delivered at Mount Macedon, and extension courses are provided throughout Australia and overseas.

ANNEX A

SELECTED DISASTERS IN AUSTRALIA 1945 TO FEB 2005

Disasters which caused at least 12 deaths or 50 injuries or $200 million total estimated costs (1997 values). For more information about Australian disasters, please visit the EMA Disasters Database at www.ema.gov.au.

DATE	DISASTER CATEGORY	LOCATION	DEAD	INJURED	EST. COST
1945	Drought (1939–1945)	Australia-wide	0	0	2,500
Mar 1946	Aviation	Tas – near Hobart	25	–	–
May 1947	Land Transport – Train	Qld – near Brisbane	16	–	–
Jun 1950	Aviation	WA – near Perth	29	–	–
1954	Cyclone	Southern Qld & Northern NSW	26	–	–
Mar 1954	Earthquake	SA – Adelaide	0	–	350
1955	Flood	NSW – Singleton/Maitland	24	–	–
Feb 1955	Flood	Eastern NSW	50	300	500
Apr 1958	Bushfire	SA – Wandillo	8	50	–
1959	Heatwave	Southern Australia	105	3,000	25
Jan 1960	Heatwave	Southern Australia	98	1,000	15
Jun 1960	Aviation	Qld – Mackay	29	–	–
1962	Bushfire	Vic – Lara	14	200	92
Feb 1964	Maritime – HMAS Melbourne/ HMAS Voyager collision	ACT (NSW) – Jervis Bay	82	–	
Jan 1965	Bushfire	Vic	10	50	–
Aug 1966	Structure Fire – convalescent home	Vic – Melbourne	30	–	
Sep 1966	Aviation	Qld – Mt Isa	24	–	–
Feb 1967	Bushfire – 'Black Tuesday'	Tas – Hobart & region	62	900	300
Sep 1968	Drought – (1958–1968)	Most States	0	0	4,200
Nov 1968	Bushfire	NSW – Blue Mtns & Sth Coast	14	70	106
Dec 1968	Aviation	WA – Port Hedland	26	–	–
Jan 1969	Bushfire	Vic – Southern regions	23	100	210
Jan 1970	Cyclone – 'Ada'	Qld – Whitsunday Islands	14	100	390
Apr 1970	Land Transport – Train/bus collision	SA – near Gawler	17	45	–
Aug 1970	Flood	Tas – Deloraine and Latrobe	1	5	240
Oct 1970	Structural Collapse – Westgate Bridge collapse	Vic – Lower Yarra River, Melbourne	35	18	–
Dec 1971	Cyclone – 'Althea' (incl. storm surge)	Qld – Townsville	3	25	730

DATE	DISASTER CATEGORY	LOCATION	DEAD	INJURED	EST. COST
Jul 1972	Mining	Qld – Ipswich	17	–	–
Jan 1973	Heatwave	Southern Australia	26	750	24
Mar 1973	Cyclone 'Madge'	(Nth Qld, NT & WA)	0	10	750
Sep 1973	Land Transport – Bus	NSW – Snowy Mountains	18	21	–
Feb 1974	Flood (Cyclone 'Wanda' – rainfall)	Qld – Brisbane	16	300	980
Feb 1974	Flood (Cyclone 'Wanda' – rainfall)z	Southern Qld & Northern NSW	–	–	1,220
April 1974	Flood	NSW – Sydney	0	12	415
Dec 1974	Cyclone – 'Tracy' (incl. storm surge)	NT – Darwin	65	650	4,180
1975	Mining	Qld – central – Kianga near Moura	13	–	–
Jan 1975	Structural Collapse – Tasman Bridge	Tas – Hobart	13	–	120
Mar 1975	Flood	NSW – Sydney	0	7	295
Dec 1975	Cyclone – 'Joan'	WA – Nthn (Port & South Hedland)	0	5	300
Dec 1975	Structure Fire – Savoy Hotel, Kings Cross	NSW – Sydney	15	–	
Nov 1976	Severe Storm	NSW	0	10	220
Dec 1976	Cyclone – 'Ted'	Qld	0	2	220
Jan 1977	Land Transport – Train crash/bridge collapse	NSW – Granville	83	213	–
Feb 1977	Bushfire	Vic – Western Districts	8	60	
Mar 1977	Flood	NSW	0	5	220
Mar 1978	Flood	NSW – Sydney and Penrith	5	50	132
Mar 1979	Cyclone – 'Hazel'	WA (at sea)	15	5	150
Jul 1979	Mining	NSW – Appin	14	25	–
Feb 1980	Cyclone – 'Dean'	WA – Pilbara region	0	7	220
Feb 1981	Heatwave	South-eastern Australia	15	220	10
Apr 1981	Structure Fire – Nursing home	NSW – Sydney – Sylvania	16	–	–
Aug 1981	Structure Fire – Rembrandt Hotel	NSW – Sydney – Kings Cross	19	–	–
Feb 1983	Bushfire – 'Ash Wednesday'	Vic & SA	76	1,100	960
Apr 1983	Drought – (1979–83)	Australia-wide except WA	0	0	7,000
May 1983	Flood	SE Qld & NE NSW	1	10	610
Nov 1984	Flood	NSW – including Sydney	0	20	550
Jan 1985	Severe Storm (incl. tornado)	Qld – Brisbane	0	20	390
Jan 1986	Cyclone – 'Winifred'	Qld – North (Cairns to Ingham)	3	12	325
Aug 1986	Flood	NSW – Sydney & Hawkesbury Valley	6	30	265
Oct 1986	Severe Storm	NSW – Sydney & Western Suburbs	0	10	253
Apr 1988	Flood	NSW – Sydney	0	5	220
Apr 1989	Cyclone – 'Aivu' (including storm surge)	Qld – Ayr, Home Hill, Wunjunga	2	13	200
Aug 1989	Aviation – Hot-air balloon collision/crash	NT – near Alice Springs	13	0	–
Oct 1989	Land Transport – Bus/truck collision	NSW – near Grafton	21	22	–
Dec 1989	Earthquake	NSW – Newcastle	13	150	4,480
Dec 1989	Land Transport – Two-bus collision	NSW – Cowper, near Kempsey	35	41	–
Jan 1990	Heatwave	SA – Southern/ Vic – Northern	5+	100	22

DATE	DISASTER CATEGORY	LOCATION	DEAD	INJURED	EST. COST
Feb 1990	Flood (Cyclone) – 'Nancy'	Qld – Southern/NSW – Northern	6	25	240
Mar 1990	Severe Storm	NSW – Auburn (southwest Sydney)	0	25	550
Apr 1990	Flood – 'Great Floods'	Qld/NSW/Vic	7	60	415
May 1990	Land Transport – Two-train collision	NSW – Brooklyn	6	99	–
Dec 1990	Heatwave	Vic – Melbourne	4+	60	–
Jan 1991	Severe Storm (incl. tornado)	NSW – northern Sydney	1	100	670
Jan 1991	Flood (Cyclone 'Joy')	Qld – Central Coast	6	35	385
Apr 1991	Cyclone – 'Fifi'	WA (27 died as ore ship sank)	29	10	38
Dec 1992	Flood	SA – Adelaide	1	4	275
Feb 1992	Severe Storm	NSW – Sydney	0	10	335
Oct 1993	Flood	Vic – Northeast	1	30	440
Feb 1993	Heatwave	South-eastern Australia	17+	500+	10
Jan 1994	Bushfire	NSW – Eastern seaboard	4	120	165
Jan 1994	Heatwave	Qld – Northern incl Townsville	5	150	8
Oct 1994	Land Transport – Bus	Qld – Brisbane	12	39	–
Nov 1994	Severe Storm	Vic – Melbourne/ Geelong region	1	54	88
Oct 1995	Drought (1991–1995)	Eastern Australia	0	0	5,000
Nov 1995	Heatwave	NSW – Western Sydney and region	1	100+	–
Feb 1996	Land Transport – Bus	Vic – Murray Valley Highway	0	57	–
Feb 1996	HAZMAT – Chemical truck fire	NSW – Sydney (Epping)	0	60	–
Apr 1996	Shooting Massacre	Tas – Port Arthur	35	22	30
May 1996	Flood	Qld – Southern and NSW – Northern	4	20	220+
Jun 1996	Aviation – 2 Army Blackhawk helicopters collided	Qld – near Townsville	18	10	–
Sep 1996	Severe Storm (including 3 tornadoes)	NSW – Armidale	0	10	340
Feb 1997	Heatwave	Vic/SA/NSW	10+	220+	8+
Mar 1997	Cyclone 'Justin'	Qld, Cairns-Innisfail region	7	50	190
July 1997	Landslide	NSW – Thredbo	18	1	40
Jan 1998	Flash floods	Qld – Townsville-Cairns region	2	40	210
Jan 1998	Flood	NT – Katherine-Daly River	3	30	200
July 1998	Flood	NSW – Central/ Northern region	2	5	265
Sept 1998	Gas explosion	Vic – Longford	2	8	1300
April 1999	Severe storm	NSW – Sydney	1	50	2300
Jan 2000	Heatwave	Qld – South eastern region	22	350	2
June 2000	Structure fire	Qld – Childers 'Palace' hostel fire	15	5	0.5
Nov 2000	Flood	NSW – Northern region	0	0	825
Mar 2001	Flood	NSW – Grafton & Kempsey	1	10	300
Nov 2001	Severe storm	NSW – Sydney & Central West	3	50	120
Dec 2000	Bushfire	NSW – most regions	0	50	210
Jan 2001	Severe Storm	NSW – Sydney	1	50	12mil
Nov 2001	Severe Storm	NSW – Hunter	3	50	29.356 mil
Jan 2003	Bushfire	ACT – Canberra	4	260	342.4 mil
Jan 2003	Bushfire	VIC – widespread	–	400	12 mil
Jan 2005	Bushfire	SA – Eyre Peninsula	9	110	27.7 mil
Feb 2005	Severe Storms	East coast of Aus	3	12	216.7 mil

ANNEX B

SUGGESTED ACTIVITIES FOR STUDENTS

1A. What is the difference between a hazard and a disaster?

1B. Give two examples of hazards with the following origins:

- Geological, meteorological, biological, extra-terrestrial

1C. Give three examples of hazards with the following origins:

- Human-caused
- Technological

2. On a map of the world identify any disasters which occur during the time you are studying this topic. Make sure you include the dates, scale of the disaster – for example, the area covered, number of people killed and injured, rendered homeless, etc. You may prefer to graph this information or write a short paragraph about each disaster. What responses were made within the countries concerned? Did the rest of the world send aid? If so, in what form?

3. On a map of Australia identify any forms of hazard impacts or disasters which occur during the time you are studying this topic. Answer the same questions above but relate answers to the local community, the state counter-disaster or emergency management organisations and if, and when Emergency Management Australia became involved.

4. Choose one Australian natural disaster from this book or media reports:

- Identify what it was, where and when it occurred
- What effects did this disaster have on transport, communications, housing and essential services?
- What sort of problems did householders have to cope with during and immediately after the disaster?
- Did people themselves contribute in any way to this disaster?
- Can anything be done to guard against this kind of disaster occurring again?

5. Collect information about any type of disasters as they occur, from newspapers, magazines or TV reports. Produce your own news report to present to the class orally

but using your clippings to illustrate your talk in some way, eg as a visual chart or collage or as an illustrated booklet.

6. Using information you have gained from your studies, design a poster advising people of the precautions they should take in the event of a particular natural disaster occurring in their area, for example an earthquake, cyclone, flood, bushfire, severe storm, etc.

7. Look at your own city, town, suburb or general region. Does it have a history of emergencies or disasters? Does it have hazards which create the probability/possibility of disasters occurring? Identify them. What can be done in the event of a major hazard threatening you and your family? Who can you contact for help? What can you do to help yourselves?

8. Imagine a natural disaster affects your family. Write a story describing what happens from the time the disaster strikes until everything is resolved. Make your story as exciting as possible but make sure it reflects accurate information you have learned during your studies. You may base your story on a disaster you have learned about.

9. Research famous disasters of the past, eg Pompeii, the sinking of the Titanic, Bangladesh, Cyclones, San Francisco Earthquakes, Victoria's 1939 'Black Friday' Bushfires, Bhopal (India) gas tragedy, the Great Fire of London. Write a brief account of one.

10. The United Nations Disaster Relief Organisation (UNDRO) declared the period from 1990 to 2000 as the International Decade for Natural Disaster Reduction (IDNDR). Find out what Australia did at home and overseas to contribute.

Further activities and resources for students can be obtained from the EMA Schools website: http://www.ema.gov.au/schools

FURTHER INFORMATION

Further information on Australia's major natural hazards can be obtained from the following State and Territory Emergency Services. These organisations have copies of the EMA poster map Australia's Natural Hazard Zones and pamphlets and booklets relating to natural hazards. Class sets and education resource kits for schools are also available.

EMA publishes and distributes a 120-page book, Hazard-Wise. It is specifically designed as a geography/science teachers' resource for lesson preparation and use within the classroom. It complements this booklet. Please direct inquiries regarding Hazard-Wise to ema@ema.gov.au.

Australian Capital Territory

ACT Emergency Services Authority

http://www.esa.act.gov.au

New South Wales

New South Wales State Emergency Service

http://www.ses.nsw.gov.au

Northern Territory

Northern Territory Emergency Service

http://www.nt.gov.au/pfes/es

Queensland

Department of Emergency Services

Counter Disaster and Rescue Services

http://www.emergency.qld.gov.au/cdrs

South Australia

South Australia State Emergency Service

http://www.ses.sa.gov.au

Tasmania

Tasmania State Emergency Service

http://www.ses.tas.gov.au

Victoria

Victoria State Emergency Service

http://www.ses.vic.gov.au

Western Australia

Fire & Emergency Service Authority of WA

http://www.fesa.wa.gov.au

Further information relating to natural hazards can be obtained from the following:

Geoscience Australia

http://www.ga.gov.au

For information about earthquakes, tsunamis and volcanoes.

Bureau of Meteorology

http://www.bom.gov.au

For information about cyclones, severe storms and floods.

www.ema.gov.au

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