HAZARDS, DISASTERS AND YOUR COMMUNITY

SIXTH EDITION

A BOOKLET FOR STUDENTS AND THE COMMUNITY

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FOREWORD

Emergency Management Australia (EMA) and related organisations in the eight Australian states and territories receive many requests from the public, particularly students and teachers, seeking information on a wide range of hazards and disasters, both in Australia and overseas. 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 emergency/disaster management arrangements and the integral role of EMA and 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 was 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. Postal addresses for these organisations appear on page 71. Additional bushfire information can be obtained through local rural fire services.

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

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Safer Sustainable Communities

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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), vermin and insect plagues (e.g. rabbits, mice, locusts), exotic animal diseases (e.g. foot-and-mouth disease, anthrax) 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

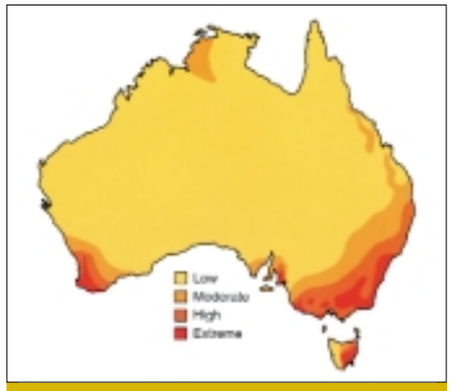
Bushfire Disasters

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. Most 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

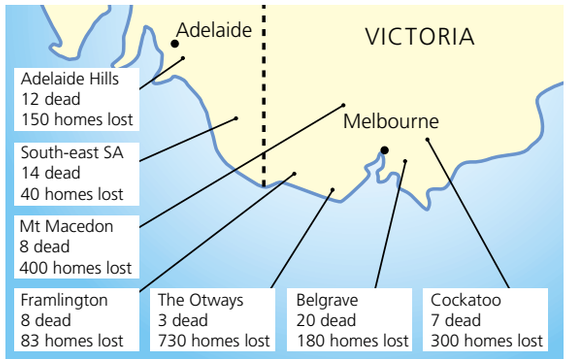
Local government authorities have regulations controlling home-siting, design and building materials in bushfire-prone areas. Wide firebreaks along property boundaries must be maintained and fuel-reduction (controlled) burning is carried out during the cooler seasons.

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.

HOME DESTROYED IN DANDENONG BUSHFIRES, VIC. 1997.

CASE STUDIES

AUSTRALIAN BUSHFIRES



MAIN FIRE AREAS AND THEIR TOLL IN LIVES AND HOMES.

1. SOUTH AUSTRALIA & VICTORIA, ASH WEDNESDAY, 1983

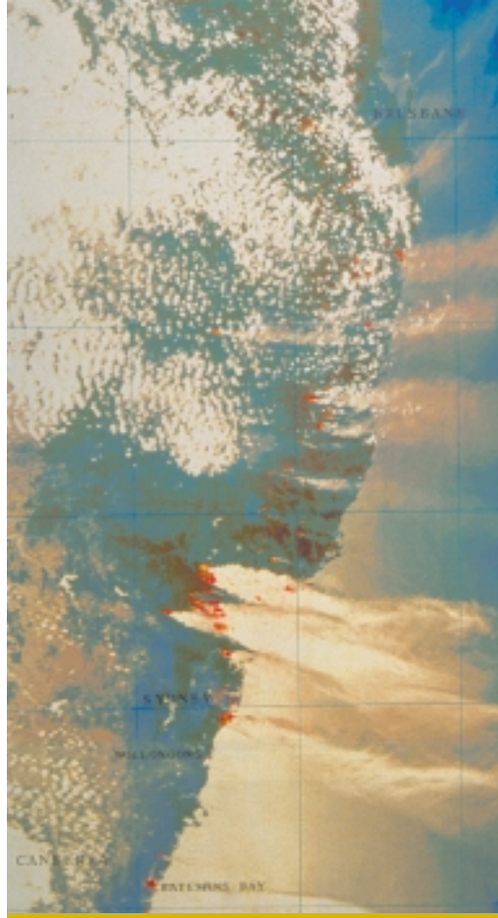
CONDITIONS FOR DISASTER. On 16 February 1983, Melbourne experienced a very hot, dry day. The temperature peaked at 43°C with relative humidity of only 6%. Drought conditions had persisted in south-eastern Australia for several years with the 1982–83 summer being extremely hot and dry. Many small to moderate bushfires occurred in South Australia and Victoria over this period. 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 $56 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, while well over 5000 livestock died along with large numbers of native animals (many in national parks).

The provisional insurance loss figure ($80 million) comprised mainly houses and commercial claims.

DAMAGED HOUSE. ASH WEDNESDAY BUSHFIRES, 1983.

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

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.

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

- Phone the bushfire brigade—do not assume they 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 Chapters 7 and 9 respectively).

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 streams and rivers to a point where channels can no longer hold the volume of water. Alternatively, for some coastal dwellers, there is the threat from the sea.

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.

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 be potentially much more damaging and can 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. Such flooding had a very severe effect on the north-eastern Victorian towns of Benalla, Shepparton, Wangaratta and Euroa in October 1993 when 12 rivers suddenly flooded simultaneously. A total of 5500 people were evacuated as floodwaters swirled into more than 4000 homes, shops, farms and orchards. Thousands of livestock and fruit and vegetable crops

were lost, and dairy production was affected. These losses and massive damage to roads and bridges contributed to total estimated costs of $440 million in 1997 values.

FLASH FLOODS. Flash flooding results from relatively short, intense bursts of rainfall, often from thunderstorms. 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. Two frightening examples occurred in 1971. In Elizabeth Street, Melbourne, metre-deep floodwaters washed cars away and in Canberra, seven motorists died after their cars were swept off a road into a flooded creek during intense rain.

Severe storms and cyclones, especially in northern Australia, can cause vast areas to be affected by flash floods. Damage may be limited to property and stock losses, but in more severe cases, human lives are lost or fatal injuries sustained by people caught in flash floods, such as those which have occurred in the normally-dry Todd River at Alice Springs, Northern Territory.

Flood Warnings

Except for flash floods, there is usually a reasonable warning period. Common terms are used in warnings issued by the Bureau of Meteorology.

MINOR FLOODING: causes inconvenience, closing minor roads and low-level bridges.

MODERATE FLOODING: low-lying areas inundated, requiring removal of stock, equipment and evacuation of isolated homes. Main roads and rail bridges may be covered.

MAJOR FLOODING: higher areas inundated, towns/properties isolated, extensive damage.

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

LOCAL FLOODING: intense rainfall, some high run-off but usually no flooding in main streams.

SIGNIFICANT RIVER RISES: this warning is issued if it is not certain that the initial flood levels will be exceeded in the main streams. It lets people know that appreciable rises are expected.

CASE STUDIES

AUSTRALIAN FLOODS

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

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 (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 had already flooded once and 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

INUNDATED CBD, BRISBANE RIVER FLOOD, 1974.

TREACHEROUS FLASH FLOODS OFTEN CLAIM LIVES.

services were lost. Residents could not return to their homes for three weeks; they were billeted by the people of Dubbo, about 160 kilometres away.

CHARLEVILLE, QUEENSLAND. Here, a similar situation occurred several days earlier 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 in many cases were badly damaged. Most commercial and public buildings were also badly affected and very heavy retail stock losses occurred. The story was repeated many times over 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.

BULK MILK DELIVERY INTERRUPTED, SHEPPARTON VIC. FLOODS, 1993.

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.

FLOOD SURVIVAL AND PROPERTY PROTECTION

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

Know Your Local Flood History

Ask your local council or state/territory Emergency Service about the following:

- What the terms major, moderate and minor flooding mean to your area and at what official river height your home becomes isolated or inundated.
- Local flood plans: whether you may need to evacuate and how to find the nearest safe location.

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 and rubber gloves.
- A first aid kit and basic first aid knowledge and good supplies of essential medication.
- A waterproof bag for clothing and valuables and emergency contact numbers.

Act on Flood Warnings

- Listen to your local radio for information. Check that your neighbours know of the warning.
- Stack furniture and possessions above the likely flood level (on beds, in the roof etc.), with electrical equipment at the top. Secure heavy objects that could float and cause damage.

- Move garbage, chemicals, poisons, fuel etc. to a high, secure place.
- Protect/relocate stock and equipment in commercial/industrial premises.
- Move livestock to high ground.
- Check your car, fill the fuel tank, and check your emergency kit and fresh water stocks.

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:

- If possible, empty freezers and refrigerators and leave the doors open.
- Collect and secure your valuables, papers, photo albums and mementos.
- Place a sandbag in the toilet bowl to prevent backflow of sewage.
- Turn off electricity, gas and water. Don't forget your emergency kit.

During and After the Flood

If you remain in your home or when you return:

- Keep your emergency kit safe and dry. Do not eat food which has been in contact with floodwater and boil all water until supplies have been declared safe.
- Don't use gas or electrical appliances which have been flood-affected until safety-checked.
- Beware of snakes and spiders which may move to drier areas in your house.
- Avoid wading, even in shallow water, as it may be contaminated. If you must enter shallow floodwater, wear solid shoes. Check with police for safe routes before driving anywhere and don't enter water without checking depth and current.
- Listen to your local radio or television station and heed all warnings and advice.

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. In many parts of 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. If global warming increases, heatwaves will become hotter, longer and even more frequent, so 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.

CHAPTER 5

SEVERE STORM HAZARDS AND DISASTERS

SEVERE STORM CATEGORIES

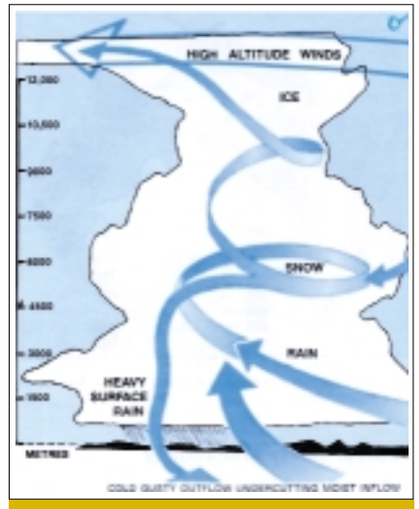
Severe storms can be divided into two types: severe thunderstorms and land gales.

Severe Thunderstorms

By definition, these produce:

- flash flooding; or
- damaging hailstones (2 centimetre diameter+); or
- destructive wind gusts (90 kilometres per hour+); or
- tornadoes (or a combination of any 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.



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.

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 windflow 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.

HEAVY RAIN. Intense up-draughts produce raindrops through condensation of moist air. As raindrops become too large to be supported, they fall, producing heavy rain which can exceed 200 millimetres per hour and cause flash floods.

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.

HAIL. Hailstones form when raindrops freeze at high levels and are recycled through up- and down-draughts, growing all the time. Hailstones larger than cricket balls have been observed in Australia. Such large, usually jagged, ice hazards can cause serious damage or fatal injury.

LIGHTNING AND THUNDER. Lightning is the discharge produced when differences in ground and atmospheric electrical charges are large enough (several hundred million volts) to overcome the insulating effect of air. An average thunderstorm can release several hundred megawatts of electrical power. Lightning can occur within the cloud, between clouds, or between the cloud and ground. Thunder is the sound produced by the explosive expansion of air heated by the lightning stroke to temperatures as high as 20,000°C.

TORNADOES. Tornadoes (or twisters) are rapidly-rotating columns of air that descend in a funnel shape from thunderstorm clouds. They should not be confused with willie willies (or dust devils) which are much smaller and not usually associated with storms. A tornado vortex, which can range in diameter from a few metres to several hundred metres, usually whirls clockwise (southern hemisphere) and contains extreme winds that may exceed 450 kilometres per hour with a forward speed of 30 to 100 kilometres per hour. The combined action of powerful rotary winds and low air pressure in the centre can collapse buildings and hurl lethal debris, even large vehicles, through the air. In the USA tornadoes with multiple vortices rotating in a cluster have been observed. Tornadoes are not confined to the USA. Estimates suggest that up to 10% of the world's twisters occur in Australia, but due to their usually small size and our very low average population density, relatively few affect people and property or are actually observed and reported. Nevertheless, tornadoes have caused over 40 deaths and 500 injuries in Australia and hundreds of millions of dollars damage.

TORNADO, PORT HEADLAND, WA, 1970's.

EXTREME WIND GUSTS. In a mature thunderstorm, falling rain and hail drag the surrounding air down, causing a strong down-draught which accelerates as the air cools due to evaporation of rain drops. It spreads out upon reaching the ground, producing a cool gusty wind which 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.

LAND GALES. Land gales are gale force winds (62 kilometres per hour or greater) over the land, and usually affect a much larger area than thunderstorms. They can last for several days (much longer than thunderstorms) and often cause significant damage. Land gales occur when large differences in atmospheric pressure are concentrated over a relatively small distance. This happens between a deep low pressure system and a large high pressure system, or near an intense cold front.

WHERE AND WHEN DO SEVERE STORMS OCCUR?

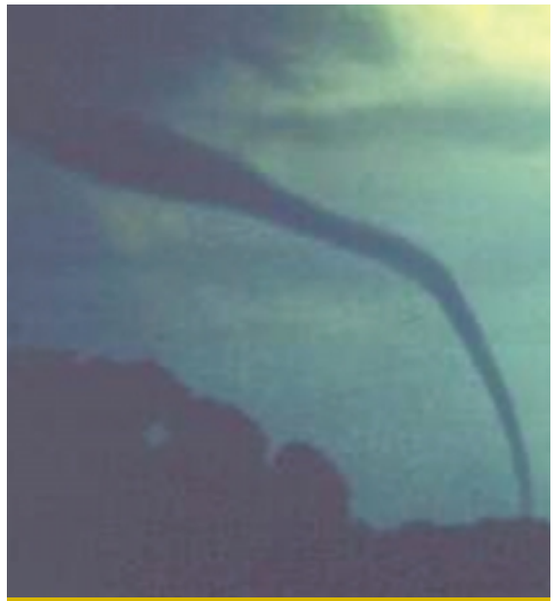
At any time of the year severe thunderstorms can occur throughout Australia. Most strike from September to March when solar energy is greatest, but severe winter storms are common in Western Australia. The frequency of land gales is difficult to specify. In southern Australia, extreme winds tend to occur in winter and spring. In the tropical north, extreme winds usually hit in summer and autumn, often due to cyclones.

Sparse population and lack of observations over much of the continent make severe thunderstorm distribution studies difficult. Records suggest that most occur in a crescent from Brisbane, through coastal New South Wales and Victoria to Adelaide, but it is likely that many severe thunderstorms strike less-populated areas without being recorded. The most damaging individual storms, including tornadoes, have hit south-east Queensland, the central New South Wales coast and south to Sydney.

EFFECTS AND COST

Dangers to People

Statistically, lightning poses a greater threat to individuals than most other natural hazards. On average, it causes five to 10 deaths and over 100 injuries in Australia each year. Deaths and injuries also occur when boats are hit by thunderstorm squalls, trees or limbs fall, buildings are damaged, or debris is hurled about in high winds.



TORNADO, BENDEMEER, NSW, 1972.

Huge Damage Bills

Severe storms occur throughout Australia, and do so more frequently and cause more physical damage (including vehicles, buildings and crops) than any other natural hazard. 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.

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. Familiarise your family with this storm action guide.

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.

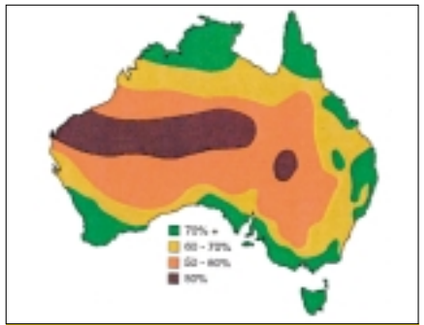
STUDENTS: FIND FURTHER INFORMATION

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



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).

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.

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, and 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 every 18 years approximately.

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; and
- considering options for agistment and protecting plant and native species during drought.

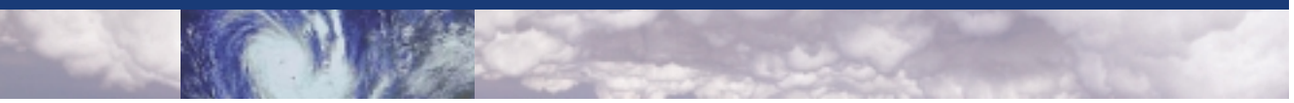
Plans need to be specific to each farm but consistent with regional catchment management plans.

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.

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 drownings (both at sea and during floods), collapsed buildings, or debris which becomes lethal projectiles carried by the extreme winds.

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.

SATELLITE PHOTO OF TC OLIVIA OVER WA, 1996.

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

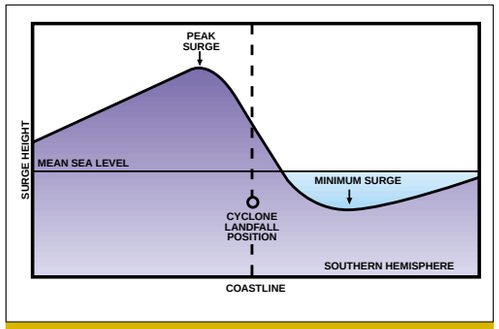
The Central 'Eye'

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.



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

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.

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

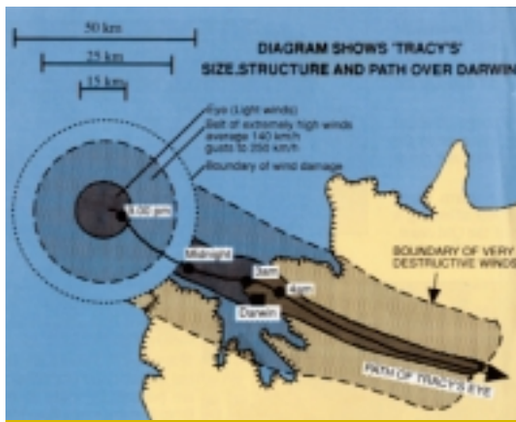
CASE STUDIES

AUSTRALIAN CYCLONES

1. TROPICAL CYCLONE TRACY, NORTHERN TERRITORY, DECEMBER 1974

DECEMBER 20		A low pressure system identified in the Arafura Sea.
DECEMBER 21	9.30 AM	A cyclone warning issued and the name 'Tracy' given.
DECEMBER 22	3.30 PM	Radar in Darwin clearly identifies the eye about 200 km north.
DECEMBER 23	9.00 AM	Heavy rain and wind reported along coast north of Darwin.
	11.00 PM	Cyclone begins to move steadily southward
DECEMBER 24	NOON	Cyclone confirmed as moving toward Darwin.
	12.30 PM	Cyclone warning issued to Darwin residents advising that Tracy should cross the coast early on Christmas Day.
DECEMBER 25	1.00 AM	Destructive winds reported throughout Darwin.
	3.00 AM	Torrential rain and wind gusts of greater than 200 km/h recorded.
	3.10 AM	Wind recorder fails at 217 km/h (estimated gusts of 250 km/h).
	4.00 AM	Tracy's eye directly overhead, calm is felt for about 30 minutes.
	4.30 AM	Extreme winds resume but this time from the opposite direction.

DEATH TOLL AND DAMAGE. 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).



CYCLONE TRACY PATH.

2. TROPICAL CYCLONE WINIFRED, QUEENSLAND, JANUARY 1986

The Category 3 cyclone struck from Cairns to Ingham, destroying 50 homes and damaging hundreds of homes and other buildings. There were three deaths, 20 injuries, and heavy sugar cane, fruit and vegetable crop losses. Total costs were $325 million (1997 values).

3. 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.

4. 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).

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.

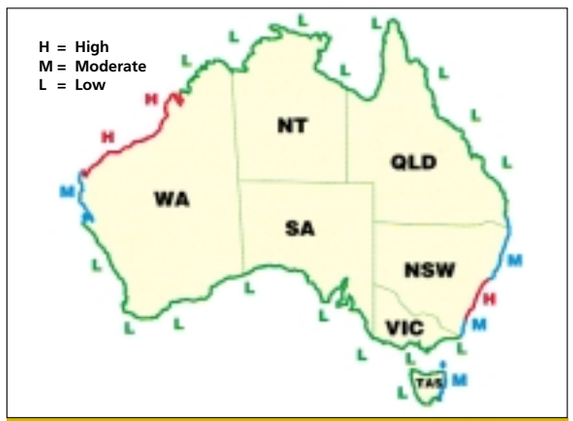
Australian Earthquakes

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.



TSUNAMI HAZARD MAP

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:

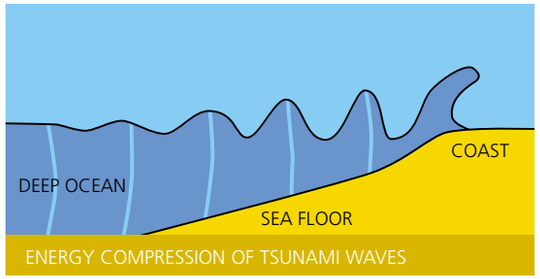
- earthquake waves, and seismographs;
- the San Andreas Fault, and the San Francisco earthquake, 1906;
- the earthquake in Armenia, 1988 or in Kobe, Japan, 1995; and
- compare the Newcastle earthquake, 1989 with major overseas ones in Annex A.

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

FACTS ABOUT TSUNAMIS



Tsunamis are seismic sea waves. They are often incorrectly called tidal waves (rare events linked to tides). A tsunami is a series of travelling ocean waves of extremely long length and period. They can be caused by undersea events like earthquakes, landslides and volcanic eruptions, or by other rare natural events such as ocean meteorite impacts. (Not all undersea earthquakes etc. cause tsunamis). As a tsunami crosses a deep ocean, the length from crest to crest may be 150 kilometres but the height may be under a metre, unfelt by ships nor seen from the air, and may reach speeds up to 1000 kilometres per hour.

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.

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.

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.

TSUNAMI DAMAGE, OKUSHIRI ISLAND, JAPAN, 1993.

TSUNAMI DESTRUCTION, HILO HAWAII, 1960.

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.

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.

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

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; and
- 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; and
- learn more about the geological hazards in your area and become familiar with tell-tale signs of ground movement.

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 10 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.

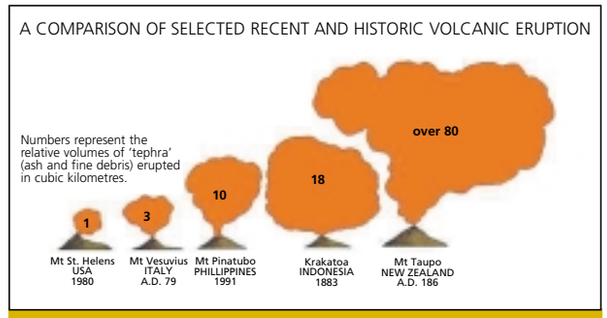
Over 100,000 deaths have been caused by volcanoes worldwide. Volcanoes can cause immense destruction to whole towns, crops, forests and roads, creating many evacuees who must be sheltered, fed and resettled. Lava flows may also block streams, causing floods, mud flows and landslides.

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. Very recently 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 and 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.

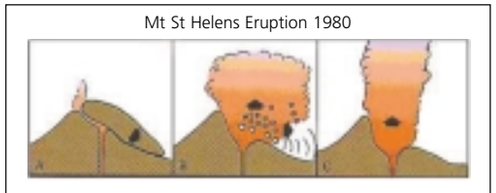
SPECTACULAR LAVA FLOW, KILAUEA VOLCANO, HAWAII, 1980'S.

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.

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 Bombala, Delegate, Nimmitabel and Jindabyne in 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. One building roof collapsed and some sheep perished without feed.

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. More recently, terrorist attacks on the World Trade Centre in New York and the Pentagon in Washington on 11 September 2001 killed thousands of people.

TECHNOLOGICAL HAZARDS AND DISASTERS

Transport Accidents

The worst railway disaster in Austtralia 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, Ukrainia, (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 is 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 but the only t.wo injuries occurred to fire-fighters.

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.

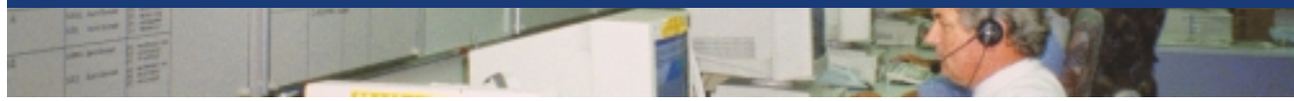
STUDENTS: FIND FURTHER INFORMATION

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

The Commonwealth Government is committed to developing national emergency management capabilities in order to reduce the impact of emergencies and disasters on Australian communities. The Commonwealth Government meets this commitment by assisting the states and territories to develop their emergency management capabilities and by developing interstate and national arrangements and capacity to best manage the risks that disasters and emergencies present to our community.

Located within the Federal (or Commonwealth) Attorney-General's Department, Emergency Management Australia (EMA) is responsible for the day-to-day management of this Commonwealth function. EMA promotes an emergency risk management approach incorporating prevention, preparedness, response and recovery activities.

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/territory Emergency Services, with personnel trained to help communities in trouble. The Red Cross, St John Ambulance Brigade, 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

In February 1974, Federal Cabinet approved establishment of the Natural Disasters Organisation (NDO) as a special agency within the Department of Defence in Canberra. NDO absorbed Civil Defence functions and coordinated Commonwealth physical assistance to the eight states and territories (and now also to our neighbours overseas) during disasters and assisted in improving their disaster management capabilities. The first disaster response operations by NDO included a major bushfire in western New South Wales and cyclone Tracy at Darwin in December 1974. Since then there have been numerous operations of varying size and duration every year. On 1 January 1993, NDO changed its name to EMA, mainly to reflect the fact that it was involved in more than just natural disasters. In November 2001 EMA was relocated to the Attorney-General's Department.

Mission and Role

EMA's mission is to provide national leadership in the development of measures to reduce risk to communities and manage the consequences of disaster. At the Commonwealth level, EMA is responsible for emergency management policy and provides a strategic coordination role.

Disaster Response Plans

The ability to respond to emergencies requires careful planning. General contingency plans are in place to meet state and territory requests for Commonwealth Government assistance arising from any type of disaster. These plans include the Commonwealth Government Disaster Response Plan, which details procedures for provision of Commonwealth Government assistance through EMA in the event of a disaster in Australia.

EMA also maintains a number of hazard-specific response plans. These include plans for coordinating actions related to the re-entry of radioactive space debris, managing the reception of persons evacuated to Australia due to disasters or civil unrest in neighbouring countries, and for responding to accidents involving ships carrying nuclear waste material near Australia.

National Emergency Management Coordination Centre

EMA is responsible for coordination of disaster assistance provided by the Commonwealth Government. Such assistance results from a formal request from a state or territory if its 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 Commonwealth Government agency including the Australian Defence Force.

During disasters, EMA manages provision of assistance from the National Emergency Management Coordination Centre at EMA's Canberra office. EMA works closely with staff from other government departments, defence personnel, and agencies within the affected state or territory.

EMA NATIONAL EMERGENCY MANAGEMENT COORDINATION CENTRE.

Emergency Management Education and Training

Education and training activities are undertaken at the EMA Institute at Mt Macedon in Victoria.

The institute's role includes the identification and development of best practice in emergency management, and the development and delivery of accredited educational and training activities which are derived from National Emergency Management Competency Standards.

The institute provides activities in selected aspects of disaster management training and education under the National Emergency Management Training and Education Program. This involves the conduct of residential courses at the Mt Macedon campus and extension courses throughout Australia.

ANNEX A

SELECTED DISASTERS IN AUSTRALIA 1945 TO DEC 2000

Disasters which caused at least 12 deaths or 50 injuries or $200 million total estimaed costs (1997 values)

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	–	–
May 1947	Land Transport – Train	Qld – near Dayborough	16	38	–
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
Jan 1960	Aviation	NSW – near Tamworth	13	–	–
Jun 1960	Aviation	Qld – Mackay	29	–	–
Nov 1961	Aviation	NSW – Botany Bay, Sydney	15	–	–
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	–

DATE	DISASTER CATEGORY	LOCATION	DEAD	INJURED	EST. COST
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
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)	Southern Qld & Northern NSW	–	–	1,220
April 1974	Flood	NSW – Sydney	0	12	415
May 1974	Severe Storm	NSW – Sydney	0	10	290
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	–
Nov 1979	Severe Storm	SA	0	120	55
Feb 1980	Cyclone – 'Dean'	WA – Pilbara region	0	7	220
Feb 1980	Aviation	NSW – Sydney	13	–	–
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
Jul 1986	Mining	Qld – Moura	12	–	–
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

DATE	DISASTER CATEGORY	LOCATION	DEAD	INJURED	EST. COST
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
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
Aug 1991	Structure Fire	NSW	12	–	–
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

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 - ie 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 ordinary 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, eg 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 information on Australia's major natural hazards can be obtained from the following state/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

Further information relating to earthquakes, tsunamis and volcanoes can be obtained from the Geoscience Australia web site at http://www.ga.gov.au. For more information about cyclones, severe storms or floods, visit the Bureau of Meteorology web site at http://www.bom.gov.au.

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