Australian Disaster Resilience Handbook Collection

MANUAL 7

Planning Safer Communities: Land Use Planning for Natural Hazards

Australian Institute for Disaster Resilience

AUSTRALIAN DISASTER RESILIENCE HANDBOOK COLLECTION

Planning Safer Communities: Land Use Planning for Natural Hazards

Manual 7

Australian Government
Attorney-General's Department

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- **Guideline 7-1** Guideline for using the national generic brief for flood investigations to develop project specific specifications
- **Guideline 7-2** Technical Flood Risk Management Guideline: flood emergency response classification of the floodplain
- **Guideline 7-3** Technical flood risk management guideline: flood hazard
- **Template 7-4** Technical project brief template
- **Guideline 7-5** Technical Flood Risk Management Guideline - flood information to support land-use planning
- **Guideline 7-6** Technical flood risk management guideline: assessing options and service levels for treating existing risk
- **Practice Note 7-7** Considering flooding in land-use planning activities

Handbook 8 Lessons management

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Handbook 10 National Emergency Risk Assessment Guidelines *(plus supporting guideline)*

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Handbook 11 *renamed Guideline 10-1 National Emergency Risk Assessment Guidelines: practice guide*

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Manual 5 *Emergency risk management – applications guide (superseded by Handbook 10)*

Manual 6 *Implementing emergency risk management – a facilitator's guide to working with committees and communities (superseded by Handbook 10)*

Manual 7 Planning safer communities – land use planning for natural hazards (2002, currently under review)

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Manual 24 Reducing the community impact of landslides (2001)

Manual 25 Guidelines for psychological services: emergency managers guide (2003)

Manual 26 Guidelines for psychological services: mental health practitioners guide (2003)
Manual 27 Disaster loss assessment guidelines (2002)
Manual 28 Economic and financial aspects of disaster recovery (2002)
Manual 29 Community development in recovery from disaster (2003)
Manual 30 Storm and water damage operations (2007) (information may not be appropriate to all situations)
Manual 31 Operations centre management (2001)
Manual 32 Leadership (1997)
Manual 33 National Land search operations (2014) (refer to the Land Search Operations Manual website)
Manual 34 Road rescue (2009)
Manual 35 General and disaster rescue (2006)
Manual 36 Map reading and navigation (2001)
Manual 37 Four-wheel-drive vehicle operation (1997)
Manual 38 Communications (1998)
Manual 39 Flood rescue boat operation (2009)
Manual 40 Vertical Rescue (2001)
Manual 41 *Small group training management (1999, archived)*
Manual 42 *Managing Exercises (superseded by Handbook 3)*
Manual 43 Emergency planning (2004)
Manual 44 Guidelines for emergency management in culturally and linguistically diverse communities (2007)
Manual 45 Guidelines for the development of community education, awareness and education programs (2010)
Manual 46 Tsunami (2010)

FOREWORD

The purpose of the guidelines is to demonstrate how integrated land use planning can be used to reduce the impact of natural hazards and, where possible, avoid risk to life, property and environmental systems from natural hazards. The focus is on risk reduction at the interface between communities and the natural environment, and integrating risk reduction into the land use planning process. Land use planning then guides the use of land and can effectively reduce risk and enhance sustainability for areas prone to hazards such as flooding (including storm surge), fire, landslide, earthquake, strong wind and coastal erosion.

Proposed changes to this Manual should be forwarded to the Director General, Emergency Management Australia, at the address shown below, through the relevant State/Territory emergency management organisations.

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PLANNING SAFER COMMUNITIES

The aim of emergency management is safer, sustainable communities in the face of hazards. Emergency management therefore needs to be regarded as an integral part of community decision making. One method of achieving this involves application of emergency risk management. This manual considers application of the emergency risk management process to the land use planning process as it applies to natural hazards. It attempts to develop a nexus between community safety, natural hazards, risk reduction and land use planning.

Natural hazards are a part of everyday life. The interaction between communities and natural hazards can be positive, resulting in sustainable outcomes, or it can be negative, resulting in increased risk to our communities and further natural disasters.

Effective risk reduction goes far beyond attempts to modify natural hazards - it requires careful community planning, education and considered environmental and resource management strategies.

Land use planning can play a key part in reducing current and future community risk. Responsible management of the environment and its resources, and flexible and responsive development can prevent or mitigate negative impacts.

Land use planning requires the balancing of many, often competing, interests: private sector needs, public policy requirements, equity, long-term economic development, environmental conservation, amenity, and community safety and wellbeing.

Implementation of land use policies at the local level is most effective when there is cooperation and collaboration between all levels and sectors of government, an integrated approach to decision making and a transparent partnership between government, the community and the private sector. 'The whole is greater than the sum of the parts' - by integrating community desires and needs, and by working together to balance interests, Australians can achieve the goal of sustainable economic and environmental development and create safer, sustainable communities.

The development of this document has been made possible by funding from Emergency Management Australia (EMA). The Tasmanian State Emergency Service, with Peter Koob as project manager, and EMA formed a steering committee to oversee the project. RJ Graham and Associates were selected as consultants to develop the core of the document. The document was finalised by Jonathan Abrahams and Peter Arnold of Development Group, EMA, with assistance from Hansen Partnership, Melbourne. Consultation was conducted with planning agencies and emergency management agencies in the States and Territories as well as a range of professional bodies.

1 INTRODUCTION

These guidelines have been developed to help communities reduce the risks from natural hazards. The central theme is that natural disasters are caused by interaction between the three inter-related factors of:

- hazards;
- communities; and
- environment.

This interaction means that natural hazard risk reduction is a part of community safety and sustainability, including environmental sustainability. While the guidelines focus on natural hazards, the impact of a natural hazard on a community may occur by a natural hazard impacting on technology, for example critical infrastructure, which in turn impacts on the community. The impact on critical infrastructure (for example, water and sewage, electricity and gas supplies, communications and transportation, and facilities such as hospitals) may be severe and must be considered in the planning process.

PURPOSE

The purpose of the guidelines is to demonstrate how integrated land use planning can be used to reduce the impact of natural hazards and, where possible, avoid risk to life, property and environmental systems from natural hazards. The focus is on risk reduction at the interface between communities and the natural environment, and integrating risk reduction into the land use planning process. Land use planning then guides the use of land and can effectively reduce risk and enhance sustainability for areas prone to hazards such as flooding (including storm surge), fire, landslide, earthquake, strong wind and coastal erosion.

TARGET GROUP

The guidelines have been developed for three main groups.

1. Local government planners and other planning practitioners. They will understand the planning principles - the aim for this group is to introduce the emergency risk management process and demonstrate the value of integrating it into the land use planning process.
2. Emergency managers. They will be aware of the emergency risk management process - for this group the intent is to introduce the principles of land use planning and demonstrate how the emergency risk management process may be integrated with land use planning.
3. People concerned with community safety - the intent for this group is to introduce the principles of emergency risk management and land use planning and how the processes may be combined to form an integrated land use planning process.

GUIDELINES ARE A GUIDE ONLY

The integrated land use planning process proposed in these guidelines should be regarded as a guide only - it is designed to provide a responsible authority with a framework for land use planning, however it must be utilised in conjunction with appropriate State and Territory planning instruments and local government policies. It is not suitable for use in assessing specific development applications and it should not be regarded as a basis for appeal against consent authority decisions.

RESPONSIBLE AUTHORITY

The manual has been written assuming that local council is the responsible authority; that is, council is the strategic planning authority and the consent authority for site specific applications. Where the responsible authority is a State or Territory department or agency the process is similar, with the agencies and people involved different.

PROBLEMS IN LAND USE DEVELOPMENT

Land use planning is not a simple linear process; it is complex and subject to considerable pressure, including possible court action. The land use planning process takes place in a political context. Developers, local government, local communities, State and Federal Governments all influence land use outcomes. The process calls for wide community consultation while being developed, as well as continual monitoring and review throughout the life of the plan. Strategic land use planning is therefore an iterative and evolutionary process.

Role of planners Planners make a major contribution to the process but do not have control over the process. Planners are involved at two levels: first in drafting the land use plan for government approval and second in assessing development applications on the basis of the adopted strategy. However, a development consent authority makes the final decision. This authority could be a council, a specified authority or a Minister, depending on the relevant legislation and control plans.

Development pressure The use of hazard related controls through the planning process may not be well supported by some stakeholders. Developers and landowners may regard such controls as costly and unnecessary interference and as the cause of loss in land value. These parties may seek to degrade or remove controls through local pressure or through legal appeals.

The cumulative impact of land use and environmental change The interactive nature of land use and environmental change (including changes to hazard risk) needs to be recognised. A number of examples involve development on floodplains. These were areas that started as low risk, however as development occurred, the natural environment was significantly modified. Natural floodplains were built on, levees were constructed, channels modified, the hydrology changed and the natural movement of sediments interfered with. These changes have had a cumulative impact and have resulted in increased vulnerability to the flood hazard. Similarly the current development of fringe housing around Australian cities has resulted in increased fire hazard risks, including fuel availability, access and evacuation problems. The problem occurs because each individual development can be shown to involve low risk, enabling controls to be overturned, but the cumulative effect of multiple developments is ignored.

LEVELS OF LAND USE PLANNING

In the general sense, effective land use planning operates at two levels: the strategic level and the site-specific level.[1] At the strategic level it applies to a defined region and considers hazard issues as well as social, ecological, economic and cultural issues. The strategic plan is then used to determine specific controls for particular areas or sites; these will be used to assess each site-specific development application.

[1] See the NSW *Floodplain Management Manual*, section 1.7 for a discussion of the two levels. The Development Assessment Forum *Good Strategic Planning Guide* discusses three levels: Strategic, Development and Operation. For simplicity, this manual will restrict its consideration to two levels of planning.

ROBUST PLANNING

The strategic plan must be robust to ensure development pressure, up to and including legal challenges, is not able to remove or reduce the appropriate site controls. Use of the emergency risk management process helps ensure robustness.

GREENFIELD AND EXISTING DEVELOPMENT

Strategic land use planning may be applied to both new (greenfield) developments and existing developed areas. The process remains the same; the difference is in the starting parameters. With a greenfield area, the responsible authority must decide what is to be done with the whole area, develop a robust strategic plan, zone for the planned outcomes and set conditions for site-specific applications. For an existing developed area, the starting parameters are more complicated and include a comprehensive review of any existing strategic plans and site-specific controls. The review must cover, inter alia: critical infrastructure issues, the rights of property owners, cultural and heritage issues, changes to hazard impact resulting from the development, cost of resulting mitigation and development of controls for future development. The outcomes of the review form part of the planning background for the land use planning process.

COMMUNITIES

Throughout the manual, the term 'community' is largely taken to mean 'a spatially defined group of people, particularly that which exists within a local government area'. However, the complexity of the concept of community must be understood. To illustrate this simply, examples of types of communities include:

- communities of affection or function, based on ethnicity, class or gender;
- communities of competition, where groups form to compete for economic, social or political benefit;
- communities of interest, based on industrial, social or recreational interests; and
- communities of status groupings, based on occupation, income level and type and level of skill.[2]

People may belong to a number of these communities. In emergency management terms, it must also be recognised that 'community' applies to industry, business, schools, services and the like, as well as residents. The concept of community is extremely important when considering the ramifications of community consultation and readers are urged to consult the literature.

MULTI-JURISDICTION PLANNING

For large-scale hazards, such as whole-of-floodplain or bushfire area, a number of jurisdictions or councils may be involved. In such a case, the need for coordinated multi-jurisdictional planning is evident, since a piecemeal approach may result in land use measures in one jurisdiction having an adverse effect on hazard impact or response capability in another jurisdiction.

[2] Marsh, G & Buckle, P 2001, 'Community: the concept of community in the risk and emergency management context', *Australian Journal of Emergency Management*, Vol. 16, No. 1 (Autumn).

THE MANUAL

The manual consists of five main sections that outline the topics of:

- natural hazards and disasters;
- managing risk;
- strategic planning and the performance-based approach;
- the role of land use planning systems; and
- integrating risk reduction into the land use planning process.

2 NATURAL HAZARDS AND DISASTERS

Natural hazards are essentially meteorological and/or geological phenomena that have the potential to create emergency or disaster situations for communities and the environment. The economic, social and environmental losses can be significant and may be magnified if these events repeatedly affect the same areas. Australia is exposed to a range of natural hazards that carry with them varying levels of risk. Land use planning contributes to natural hazard risk reduction and consequently improves community safety and sustainability.

Australian natural hazards, listed in decreasing order of cost for the period 1967-99, include:

- floods;
- severe storms (including tornadoes and hailstorms which may cause wind, rain and hail damage and local flooding);
- cyclones (including damage from both high winds and flooding by sea as a result of storm surge);
- earthquakes;
- bushfires; and
- landslides.[3]

Coastal erosion, which may occur without being associated with a hazard event, must also be considered in the land use planning process.

There are a number of direct and indirect losses associated with natural hazards and natural disasters. These losses include:

- loss of life;
- physical suffering;
- emotional suffering;
- damage to property;
- reduced productivity;
- degraded environment;
- loss of species and habitats;
- damaged infrastructure;
- weakened economy;
- destabilised community coherence, political situations; and
- reduced quality of life.

[3] Bureau of Transport Economics, *Economic Costs of Natural Disasters in Australia:* Report 103, Department of Transport and Regional Services, Canberra, 2001, Table 3.1, p. 35.

2.1 NATURAL DISASTERS - AUSTRALIAN COSTS

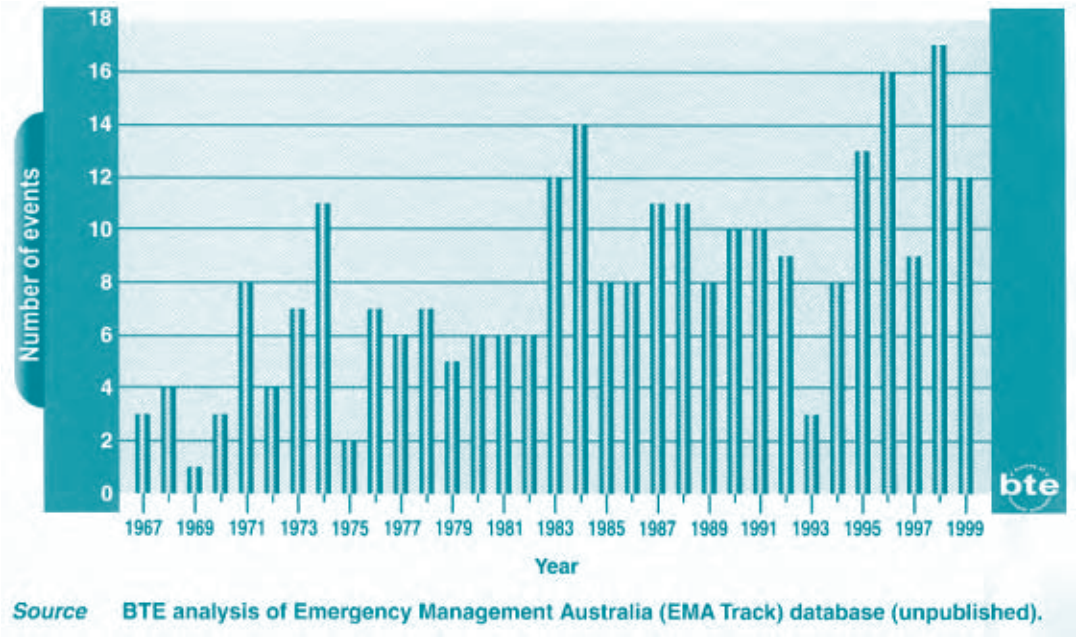
The Bureau of Transport Economics (BTE) has analysed Australian costs in its report Economic Costs of Natural Disasters in Australia. The report is valuable but it does have acknowledged limitations in the data and analysis. The report and its limitations are described in Appendix 1.

The report estimates that natural disasters with losses over $10 million have cost Australia $37.8 billion from 1967 to 1999 (in 1999 prices). The average annual cost of these disasters was $1.14 billion. This is strongly influenced by the three extreme events - Cyclone Tracy, Darwin (1974), the Newcastle earthquake (1989) and the Sydney hailstorm (1999). If the costs of these three events are removed from the calculation the average annual cost falls to $860 million, which may be a better estimate for a year without an extreme event.[4]

2.2 EFFECTS IN AUSTRALIA

Over the past 50 years Australia has experienced extensive bushfires, flooding, landslides, cyclones, storm surges, wind storms and, to a lesser extent, earthquakes. Natural hazards threaten loss of life, personal injury, adverse social and economic impacts, damage to property and environmental loss. Figure 1 shows the number of natural disasters in Australia for the period 1967 to 1999.[5] The BTE report did indicate that there is some evidence that the number of disasters per year is increasing.[6]

Figure 1: Number of natural disasters in Australia, 1967-99



Source BTE analysis of Emergency Management Australia (EMA Track) database (unpublished).

2.3 CHANGING IMPACTS OF HAZARD EVENTS

The impacts of natural hazard events can change substantially from year to year depending on the timing, magnitude, intensity and location of natural hazard events, especially with respect to population. Therefore it is important to examine those impacts over the long term to determine whether trends may be identified.

4 *Economic Costs*, p. xvi.
5 *Economic Costs*, p. 27.
6 *Economic Costs*, p. xvii.

- The population of Australia's coastal regions is increasing much more rapidly than the population as a whole - particularly in areas prone to tropical cyclones.[7]
- Australia has experienced high population growth in coastal regions. Many coastal and bushland areas, which are prone to natural hazards, have experienced high levels of development over the past 30 years. Therefore, more people and property have become exposed to hazards and potential vulnerability to disasters has increased.
- The coastal zone and higher rainfall zones have also been the focus for the majority of economic investment in Australia.
- Over 50 per cent of fixed capital investment in Australia is in housing and associated infrastructure. This investment has been concentrated in areas close to the coast and higher rainfall regions.

Loss of life

The BTE report shows no trend with respect to natural disaster deaths. Indeed, the data are extremely variable and strongly influenced by extreme events. With the population trends, there could be an increase in risk - particularly with population growth in hazard-prone areas. If loss of life to natural disaster is to be kept to a minimum in the future communities will need to consider a range of measures, such as:

Risk assessment

- increased understanding of natural hazards, community vulnerability and resilience, and associated risk;

Prevention and preparation

- community awareness and education;
- construction methods and materials;
- type and location of development;

Response and recovery

- early warning systems;
- disaster response and recovery capabilities at the federal, state, regional and local levels; and
- infrastructure capabilities (that is, transport and communication networks) to aid response and recovery efforts.

Figure 2 illustrates the number of natural disaster deaths between 1967 and 1999.[8]

[7] Resource Assessment Commission 1993, *Coastal Zone Inquiry, Final Report,* AGPS, Canberra. The trend for south-east Queensland is described in detail in Granger, K & Hayne, M (eds) 2001, *Natural Hazards and the risks they pose to South-East Queensland,* Geoscience Australia, Ch. 3.

[8] *Economic Costs*, p. 49.

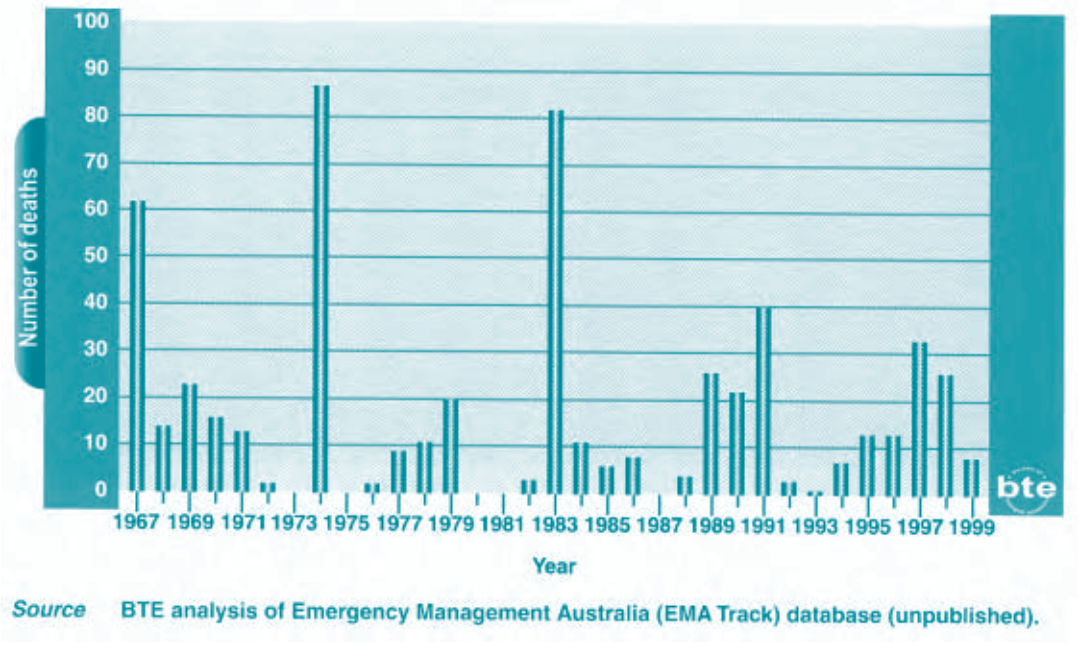


Figure 2: Number of natural disaster deaths, 1967-99

Note: Extreme events include 1967 (Black Tuesday fires), 1974 (Cyclones Tracy and Wanda), 1983 (Ash Wednesday fires), 1989 (Newcastle earthquake), 1991 (Cyclone Fifi), 1997 (Thredbo landslide) and 1998 (floods, Sydney-Hobart yacht race).

Costs of hazards

The BTE report concluded that the annual cost of disasters is highly variable and strongly influenced by extreme events; as a result the report could not assess whether the annual cost is increasing or decreasing over time.[9] The report did indicate that the number of disasters per year may be increasing. If that is the case and in view of global trends and changes in demographics, the built environment and critical infrastructure, the cost of hazard events may increase.

Floods are the most expensive type of disaster in Australia, followed by storms and cyclones.[10] The most expensive types of hazards in each State and Territory are listed below:[11]

- **New South Wales:** floods and storms
- **Queensland:** floods and cyclones
- **Victoria:** floods and bushfires
- **Western Australia:** cyclones and storms
- **South Australia:** floods and storms
- **Tasmania:** bushfires and floods
- **Northern Territory:** cyclones and floods
- **Australian Capital Territory:** bushfires and storms

Table 1 and Figure 3 show the significant costs of natural disasters in Australia over the past 30 years.[12] Major increases in costs have been associated with cyclones, floods and storms.

[9] *Economic Costs*, pp. p. xvi.
[10] *Economic Costs*, pp. 33-35.
[11] *Economic Costs*, p. xvii.
[12] *Economic Costs*, p. 35 (Table 1) and p. 23 (Figure 3).

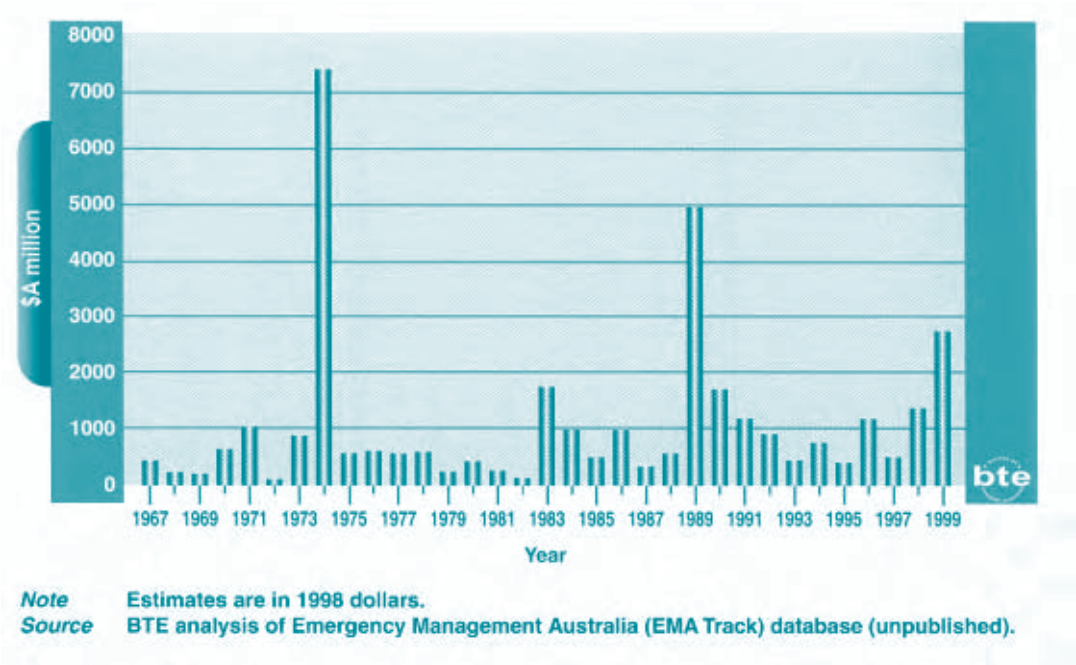
Table 1: Average annual cost of natural disasters by State and Territory, 1967-99

Average annual cost ($ million)

State	Flood	Severe storm	Cyclone	Earthquake	Bushfire	Landslide	Total
NSW	128.4	195.8	0.5	141.2	16.8	1.2	484.1
QLD	111.7	37.3	89.8	0.0	0.4	0.0	239.2
NT	8.1	0.0	134.2	0.3	0.0	0.0	142.6
VIC	38.5	22.8	0.0	0.0	32.4	0.0	93.6
WA	2.6	11.1	41.6	3.0	4.5	0.0	62.7
SA	18.1	16.2	0.0	0.0	11.9	0.0	46.2
TAS	6.7	1.1	0.0	0.0	11.2	0.0	18.9
ACT	0.0	0.1	0.0	0.0	0.0	0.0	0.2
Total	314.0	284.4	266.2	144.5	77.2	1.2	1087.5
Proportion of total [%]	28.9	26.2	24.5	13.3	7.1	0.1	100.0

Note: Figures may not add to totals due to rounding.
Source: BTE analysis of Emergency Management Australia [EMATrack] database (unpublished).

Figure 3: Annual total cost of disasters in Australia, 1967-99



Note Estimates are in 1998 dollars.
Source BTE analysis of Emergency Management Australia (EMA Track) database (unpublished).

There are a number of factors that may be contributing to the costs of natural hazard impacts in Australia and around the world. These include:

- regional and local changes to the environment - changes to the natural environment, such as clearing land for development, can lessen an areas ability to absorb the impacts of natural hazards;
- more people moving into disaster-prone areas - particularly coastal regions;
- more assets - increases the financial vulnerability to natural hazards;
- higher insurance premium costs - impacts on economic costs and changes the cost distribution; and
- global climatic change - seasonal variation and other alterations to the natural environment which have been linked to increases in the frequency and intensity of extreme weather events.

Reducing the cost - Katherine land use planning

An example of the cost savings that may come from applying land use planning is at Appendix 3 - the Katherine Land Use Planning case study.

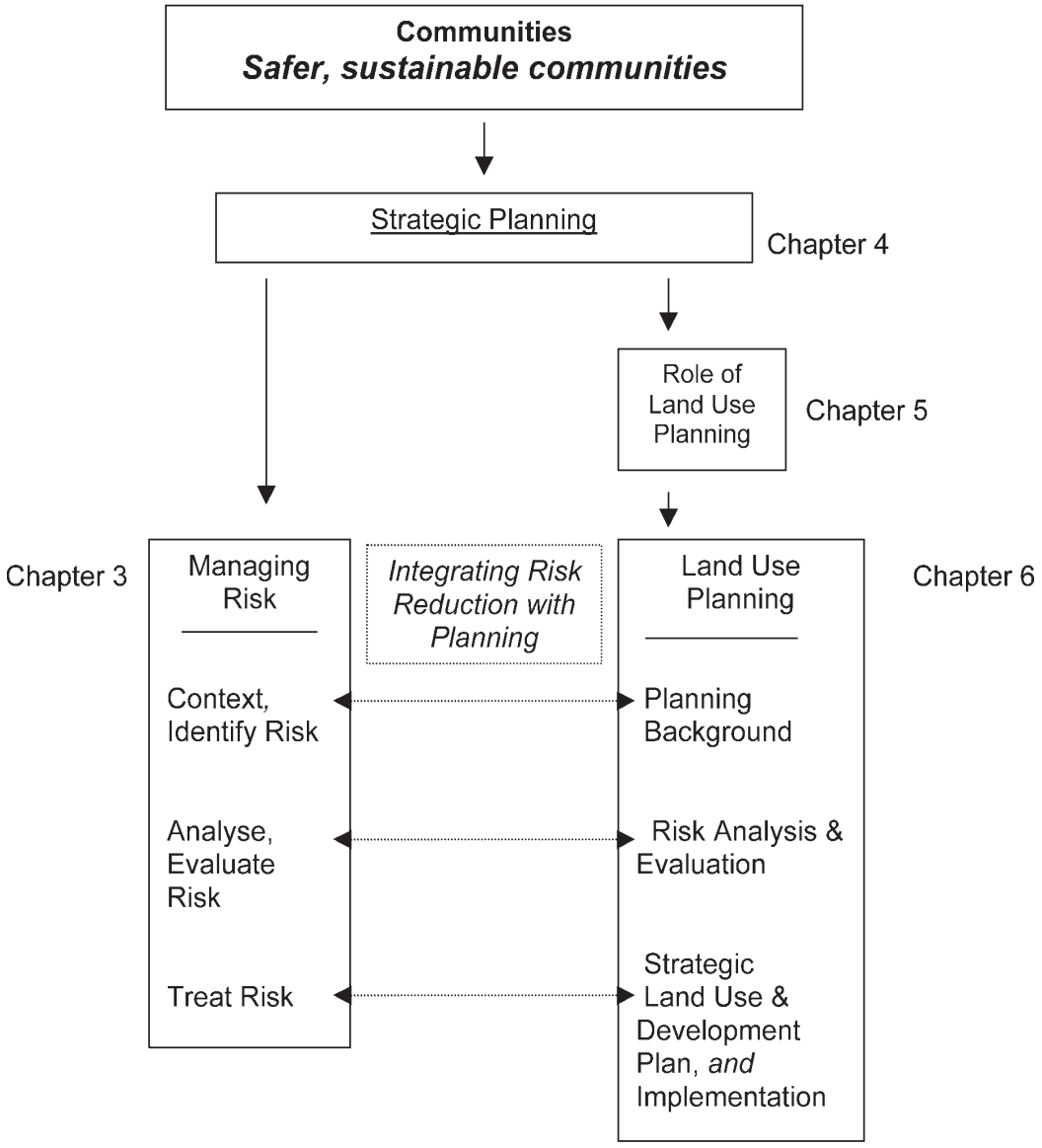
Hazard considerations

The major hazards are flood, bushfire, landslide, earthquake, severe storm and cyclone, as well as coastal erosion. Each has characteristics that determine the applicability of land use planning principles as a treatment strategy for that hazard. Specific hazard considerations are described briefly in Appendix 4. That information is only given to illustrate the utility of land use planning; the information should not be used for specific planning activities; rather, hazard experts should be part of the planning process.

3 MANAGING RISK

The linkages between the processes and approaches covered in the remainder of this manual are illustrated in Figure 4.

Figure 4: Linkages between processes and approaches



3.1 RISK

Risk may be defined as the chance of something happening, in a specified period of time, that will have an impact on objectives. It is measured in terms of consequences and likelihood. In emergency risk management, risk is used to describe the likelihood of harmful consequences arising from the interaction of hazards, communities and the environment. A hazard is the source of risk, while the community and environment contribute the elements that are at risk; that is, are vulnerable. Vulnerability is the balance between susceptibility (the level to which a particular hazard event will affect a community or environment) and resilience (the ability of a community or environment to recover from the impact of a hazard event).

The risk from natural hazards can be managed. This chapter outlines the emergency risk management approach and risk reduction measures, focusing on land use planning.

Natural disasters have been traditionally viewed as single, isolated, cause-and-effect events and as a result support has been given to warning systems, post-disaster relief and structural works to protect property and economic assets.[13] As disasters are becoming better understood, it is clear that disaster losses can be mitigated by examining and appropriately managing the interactions between existing conditions:[14] The types of existing conditions which can be appropriately managed include:

- physical environment - the health of the environment along with geophysical and climatic conditions at the local, regional, national and international levels and the hazards that impact these different levels;
- community - the social and demographic characteristics of communities impacted by natural hazards, such as income, age, mobility, linguistic and cultural diversity and education; and
- built conditions - the quantity, quality and location of buildings and infrastructure, including roads, bridges and communication networks.

Emergency risk management describes risk in terms of the interaction between communities, hazards and the environment.

3.2 FACTORS CONTRIBUTING TO INCREASE IN RISK

Risk to communities can increase due to changes to any one of these variables and their many, and often complex, interactions. The following factors relate to planning and development.

Community understanding

Communities often simply do not understand the risks associated with their region. This problem may be exacerbated by transient populations within the community.

Regional and local conditions

Regional and local changes to the environment can decrease the abilities of natural systems and communities to moderate the impacts of these hazards.

[13] Burby RJ (ed.) 1998, *Cooperating with Nature: Confronting natural hazards with land use planning for sustainable communities,* Joseph Henry Press, Washington, DC, p. 4.

[14] Mileti, DS 1999, *Disasters by Design. A reassessment of natural hazards in the United States,* Joseph Henry Press, Washington DC, p 3 & 107.

Settlement patterns

There are changes in settlement patterns with many people moving to more hazardous areas. Associated with that move are community attitudes that demand particular land use activities and design requirements from a lifestyle viewpoint without due regard to the impact on the environment. Draining or blocking of swamps that serve as natural flood retention basins, interference with natural coastal processes and landforms, and alteration of vegetation can increase the level of risk associated with natural hazards.

Wealth inequality

Inequality of wealth, particularly between regions, makes certain populations more vulnerable to losses from natural disasters. This is particularly the case in economically disadvantaged communities (including many indigenous communities) that cannot afford adequate risk reduction measures and are unable to move to lower risk areas (which often have higher prices).

Development patterns

Development of buildings and associated infrastructure in more hazardous locations and at greater densities makes the potential losses from natural events much greater.

Activity patterns

Many human activities (particularly tourism and recreation) occur in areas that are prone to natural hazards. This may be appropriate in some areas where other urban uses are undesirable.

Past actions

Some responses to past disasters can have the effect of simply delaying or even increasing the impacts of future hazard events. Structural works that provide protection to levels of severity less than the maximum probable event can lead to a false sense of security, as well as encourage development in inappropriate areas and increase the risk of major losses resulting from these events.

Global climatic conditions

The longer-term impact of global warming has been linked to increasing the frequency and severity of certain natural hazards, such as bushfires, cyclones, floods and storm surges, in many areas.

3.3 EMERGENCY RISK MANAGEMENT: A STRATEGIC APPROACH TO MANAGING RISK

Emergency risk management is a process that produces a range of measures to treat community risk, and to increase community safety and sustainability. Emergency risk management uses the steps set out in Figure 5 to determine the level of risk and identify risk treatment measures.[15]

Risk treatments are aimed at reducing risk, as well as responding to, and recovering from hazard events.

Risk reduction measures are increasingly important components of emergency risk management. In this manual, the term ‘risk reduction’ encompasses emergency/disaster prevention and mitigation, hazard mitigation, and disaster reduction.

[15] This section is based on Emergency Management Australia 2000, *Emergency Risk Management - Applications Guide,* EMA, Canberra. The Applications Guide is derived from AS/NZS 4360:1999 *Risk Management.*

Strategic considerations in managing risk

The emergency risk management process requires planning, cooperation, coordination and consultation with all spheres of government, the emergency management sector and the community. This comprehensive strategic approach is required to manage the risks from natural hazards. The characteristics of such an approach are listed below.

MULTI-HAZARD If risk is to be managed properly, all sources of risk must be considered. If a community exists in a situation where more than one hazard exists, risk treatment strategies to deal with all the hazards should be developed.

INCLUSIVE Addressing as many factors that impact on natural hazard risks as possible by examining the characteristics of the community and the natural and built environment.

LONG-TERM Cumulative impacts of natural hazards can be substantial, so it is essential to look at the long-term impacts of natural hazards, development patterns, planning requirements and social changes.

FLEXIBLE Levels of risk from natural hazards can change quickly and unexpectedly, so processes must be easily and readily adaptable to changing situations.

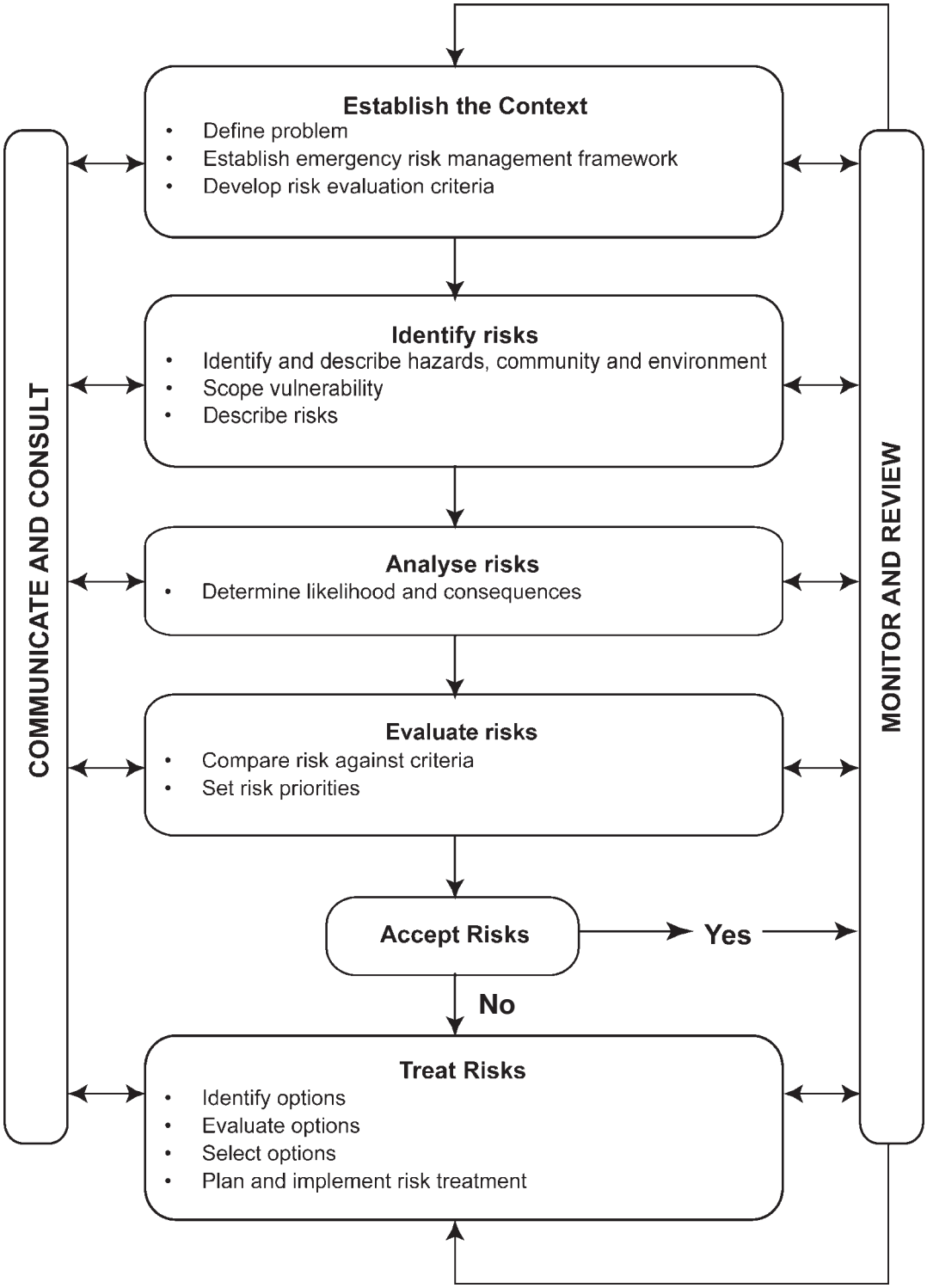
MULTI-PROCESS Risk assessment, prevention, mitigation, preparedness, emergency response and recovery, and monitoring are all-important steps in managing risk.

MULTI-SECTORAL All agencies need to work together efficiently and effectively, in order to share information and coordinate their effort to manage the risk from natural hazards.

ACTION FOCUSED Workable strategies that have practical steps for managing the risks of natural hazards can be developed through public consultation and input from relevant agencies.

EMPOWER INDIVIDUALS AND COMMUNITIES Individuals and communities should be consulted to enable them to make decisions about the way in which risks should be managed. These decisions are based on their risk assessments, which are shaped by past experiences, resources and information, personal beliefs and values, and the way these interact with the strategic planning process.

Figure 5: Steps in the emergency risk management process



Source: Emergency Management Australia 2000, *Emergency Risk Management - Applications Guide,* EMA, Canberra, p. 6.

3.4 THE STEPS TO MANAGING RISK

The main elements of the emergency risk management process are to establish the context, identify risks, analyse risks, evaluate risks (including acceptability of residual risk) and treat risks. Underpinning the process is a requirement for communication and consultation, as well as monitoring and review. The process may be undertaken a number of times to accommodate change and uncertainty. The entire process should be re-entered at any point when the review mechanisms indicate such a need.

Establish the context

There are three activities involved in establishing the context:

- define the problem,
- develop a framework for conducting a risk management project, and
- develop risk evaluation criteria.

The problem is defined by determining the nature and scope of the emergency risk management project. This includes defining the community involved, the kinds of issues (including land use issues) to be addressed and the extent to which the community will implement the project.

Developing the framework includes determining:

- the relevant legislation and policies - national, state, community and organisational,
- the stakeholders - those people and organisations affected by the activity,
- the community objectives - based on community and individual perceptions,
- the political and economic situation, and
- a management structure for the project, encompassing communication and consultation as well as monitoring and review processes.

Risk criteria are needed to make judgements on what the community regards as acceptable and unacceptable risks, thereby enabling risk prioritisation. Community perceptions of risk are established by an iterative process between the community, emergency risk managers and other stakeholders.

Identify the risk

Risk identification is achieved by:

- identifying and describing the hazards - the sources of risk,
- identifying and describing the community and its environment - the elements at risk,
- determining the vulnerability - the balance between susceptibility (the level to which a particular hazard event will affect a community) and resilience (the ability of a community to recover from the impact of a hazard event), and
- describing the risk.

Analyse the risk

Risk is analysed by determining the likelihood of a hazard occurring and the consequences of that hazard event. This is done in both qualitative and quantitative terms. The analysis considers community vulnerability and existing risk management measures with all assumptions clearly stated. The relationship between likelihood and consequences then enables the level of risk to be determined. The level is not an absolute level, but reflects a multifaceted set of criteria that enable societal judgements about the risk to be made.

Evaluate the risk

Risk is evaluated by comparing the risk evaluation criteria with the level of risk. This establishes the priority for the treatment of each risk and/or the acceptability of the residual risk. A particular risk may be accepted when the cost of treatment is considered excessive compared to the benefit of treatment. The process is achieved by consultation with all stakeholders and is subject to review and modification if required.

Treat the risk

Risk treatments are designed to reduce any or all of the vulnerability of elements at risk, the likelihood of risk occurring and the consequences of the event. The process involves identifying and evaluating options, selecting the most appropriate treatment(s) and planning and implementing the treatment program(s). A significant risk treatment measure is land use planning.

Communicate and consult

Communication and consultation are important considerations at all stages of the process and ensure that stakeholders contribute to the emergency risk management process. Consultation is a two-way process that enables emergency risk management planners to be aware of perceptions and to accept input to the process from stakeholders. Consultation ultimately aims at developing partnerships. Communication must be effective to ensure those organisations and/or individuals responsible for implementing treatment measures are given sufficient information about the measures and reasons for their selection.

Monitor and review

Risk is not static. It is therefore necessary to continually monitor the status of the risk being managed and the interaction of risk, community and environment; and to review the risk management processes in place. Continual monitoring enables the process to dynamically adapt to changes in risk as well as changes in stakeholder needs.

3.5 REDUCING RISK

There are a range of actions that can be taken to reduce the risk associated with natural hazards. Managing risk depends on the circumstances in the area which are shaped by a combination of factors. Such factors can include available resources; experiences with hazard events; advanced warning systems and perceived ability to mitigate or prevent natural hazard impacts. These measures fall into four main categories:

- Acceptance of the occurrence of natural disasters and adoption of adaptive strategies that include loss sharing, adjustment to the ways in which resources are used (particularly land, by land use planning) and temporary or permanent migration away from the areas of high risk from natural hazards.
- Education and awareness for key stakeholders. Educating the community, business and industry, and relevant government services on ways to minimise losses associated with natural hazards can influence short-term development and investment decisions, settlement patterns and behaviours before, during and after natural hazard events. If stakeholders understand the risks and have adaptive strategies in place, from which they can choose appropriate actions for variable circumstances, they can prevent or mitigate negative impacts from natural hazard events. One such adaptive strategy is land use planning.

- Implementation of a program of structural works. These may be an important part of an overall strategy to reduce and avoid natural hazard impacts. However, structural works on their own should not be treated as the solution but rather as means to reduce the probability of a natural hazard causing a disaster or to lessen the impact of natural hazard events.
- Adoption of diversified responses, such as using technological methods accompanied by education, land use planning and consequent adjustments, refined warning systems, insurance and readjustments in the design and siting of structures.

3.6 RISK REDUCTION IS LINKED TO SUSTAINABILITY

In both the emergency management and land use planning fields there is increasing emphasis on taking a comprehensive strategic planning and performance-based approach to managing risk associated with natural hazards. Effective risk reduction is about learning how to achieve positive outcomes in a situation where economic, social and environmental factors interact to create the context for appropriate actions. A comprehensive approach uses methods which are aligned with an understanding of natural systems and is compatible with the notion of approaches to ecological and economic sustainability. Hazards are accepted as part of the natural world. By aligning human actions with natural processes, risk can be reduced and avoided.

Ecologically sustainable development

The commitment to sustainable development was formally articulated in the *National Strategy for Ecologically Sustainable Development* (Australian Government 1992). The goal of the strategy is: 'Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.'

The strategy contains the following core objectives of sustainable development:

- To enhance individual and community wellbeing and welfare by following a path of economic development that safeguards the welfare of future generations.
- To provide for equity within and between generations.
- To protect biological diversity and maintain essential ecological processes and life-support systems.

The precautionary principle

The precautionary principle, as adopted by the United Nations Conference on Environment and Development at Rio de Janeiro in 1992, should be applied as part of ecologically sustainable development. The precautionary principle states that:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

The strength of a sustainable development approach to risk reduction is that it helps broaden the perception at the community level and move the focus away from traditional risk reduction measures, particularly physical works.

3.7 STRATEGIC APPROACH TO RISK REDUCTION

A strategic approach to risk reduction or avoidance includes the following measures:

- Maintenance of natural processes to ensure that natural systems contribute to the protection, resilience and rehabilitation of areas affected by hazards.
- Location of elements at risk, such as human settlements, economic activities and infrastructure, away from areas exposed to natural hazards to decrease their vulnerability.
- Development that responds to the site conditions, and in particular the nature of risk, so as to significantly reduce the vulnerability of that development.

4 STRATEGIC PLANNING AND THE PERFORMANCE-BASED APPROACH

The complexity and litigious nature of land use processes and the interactive nature of land development and environmental change, which may lead to increased risk, have been addressed in Chapter 1. To surmount these problems, a strategic approach must be taken to land use planning to ensure the development of a robust and defensible land use plan.

STRATEGIC PLANNING[16]

Strategic planning is a continuous and systematic process where people make decisions about intended future outcomes, how outcomes are to be accomplished, and how success is to be measured and evaluated.[17]

Strategic planning is also an iterative process. As more information becomes available during the planning process one or more previous steps in the process may be repeated, perhaps with a different technique, to obtain better information.

Strategic planning relates to emergency risk management as well as land use planning. With respect to land use planning, the primary role of strategic planning is to plan and shape the environment in ways that will enhance all aspects of community quality of life. Strategic planning is concerned with the medium- to long-term management and conservation of land for the purposes of promoting the social and economic wellbeing of the community and a better environment for present and future generations. It is about ecologically sustainable development.

For land use planning to be most effective it must embrace an integrated approach. Integrated planning takes into account the links between the triple bottom line of environmental, social and economic factors and integrates those in decision making between and within jurisdictions. At this level multi-jurisdiction planning must be considered - the 'think regionally, act locally' principle.

4.1 THE ELEMENTS OF INTEGRATED STRATEGIC PLANNING

Integrated strategic planning is multi-dimensional, where the dimensions embrace three essential elements. Those elements are:

- The **spatial citizenship** dimension embraces the physical, social, economic, environmental, and cultural aspects of life for a particular region. This includes consideration of the elements that comprise a community: that is, housing, employment, recreation, education, health, transport and infrastructure. This dimension also embraces consideration of hazards at a whole-of-region level.
- The **institutional** dimension embraces the need for intergovernmental and institutional cooperation between all three spheres of government (commonwealth, state and territory, and local), the private sector and the community. As such, it ensures that government activities are integrated in their design and delivery at the local or regional level, and that private sector and community needs and aspirations are realistic, achievable and ecologically sustainable within the hazard environment of the locality or region.

[16] This section is adapted from Development Assessment Forum, 2001, *Good Strategic Planning Guide: Strategic Land Use Planning Underpinning Local Government Planning and Development Assessment Systems and Processes*, National Office of Local Government, Canberra.

[17] Westerman, quoted by Development Assessment Forum, in *Good Strategic Planning Guide,* p. 2.

- The **institutional support and local governance** dimension is about ensuring that the lead agency for strategic land use planning has the right organisational structure and power to deliver integrated planning and development outcomes. Once the strategic objectives have been agreed, appropriate institutional arrangements must be put in place to ensure effective communication and coordination continues to take place. The arrangements must include consideration of hazards and mitigation measures.

4.2 THE PRINCIPLES OF STRATEGIC PLANNING

Integrated strategic planning brings together relevant information about an area to address social, economic, environmental and cultural opportunities that are usually identified by the community and its stakeholders. Strategic planning expresses a sustainable, practical vision for the area and is a way of managing conflicts between economic, social, environmental and cultural imperatives. Strategic planning is a dynamic process where the views of planners and their communities are developed together and evolve jointly through time. Strategic planning provides an effective framework within which shorter-term decisions can be made so communities do not move away from their long-term visions for the area.

Strategic planning is therefore about deciding what the ground rules are for developing and/or conserving land and natural resources. It provides the context for planning instruments (statutory instruments and development controls) under which decisions are made to grant approval, conditional approval or refusal. Such decisions are the point at which strategic and policy issues can be effectively linked to local actions. Land use decision-making frameworks that are based on a strategic plan, made in consideration of but in advance of development pressures, will have the greatest chance of success.

The following principles are applicable for integrated strategic planning processes that provide the basis for development planning and development assessment.

- **Identify the spatial area.** For land use planning an area needs to be identified, noting that the area can be local or regional. In some cases strategic planning processes may not be spatially focused, but have a specific focus on a particular problem. If that is the case, the links to development planning and development assessment decision making need to be clearly articulated.
- **Develop a holistic long-term vision.** The long-term can be anywhere from 5 years to 10, 20 or more years into the future.
- **Integrate economic, environmental, social, cultural and equity factors.** These factors are inextricably linked and cannot be considered in isolation of each other.
- **Undertake social and environmental research and analysis.** Information, analysis and understanding are crucial to sound policy development. Seeking out and analysing information will assist the processes of raising issues that may not be readily recognised, presenting arguments, highlighting the impact of particular actions and suggesting alternatives, and drawing conclusions. It also forms the basis of educating communities into a common ground of understanding so as to enable informed participation. One important area of analysis is a land capability study to understand whether or not certain types of development will conflict with known hazards for that region - in other words, what can the land carry without an adverse, possibly cumulative, impact.

- **Respect the capacity of the environment for present and future generations.** Irreversible damage to the environment must be avoided. Where there are real threats of damage, lack of scientific certainty must not be used as a reason for postponing measures to prevent environmental degradation. The environmental ethic demands ecologically sustainable development, that is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.[18]
- **Involve the community throughout the process, and recognise its diversity.** Participatory planning requires time and effort, but any plan must be responsive to the community if it is to have any chance of success. The community must be an integral part of the process for decisions and actions affecting the development and/or conservation of land and natural resources in the community. Therefore the community must participate in strategic planning processes, noting that a good process is likely to modify both the views of the community and the planners.
- **Apply the principle of subsidiarity.** The principle of subsidiarity says that higher levels of government should not undertake what a lower level of government can do for itself. However, local councils must give due weight, in all their activities, to regional, state and national objectives and strategies concerning all aspects of community development.
- **Identify suitable benchmarks and performance indicators for monitoring and evaluation.** The built and natural environments are constantly changing. Benchmarks and performance indicators provide the basis for gathering information that enables the changes to be monitored and evaluated. The benchmarks must be able to evaluate quantitative and qualitative outcomes, and measure progress on all social, environmental and economic factors. State of the environment reporting provides a good example of a benchmark system for natural systems and their interaction with human societies and cultures. Effective monitoring and review ensures the strategic planning process is flexible, dynamic and relevant.

Gold Coast City Bushfire Management Strategy

The Gold Coast City Bushfire Management Strategy was the product of a strategic planning process. It is presented as a case study in Appendix 3.

4.3 LEVELS OF LAND USE PLANNING

Any planning system is basically hierarchical. Strategic planning, the level at which long-term objectives, policies and directions are established, provides the framework for planning at lower levels.

In the general sense, effective land use planning operates at two levels: the strategic level and the site-specific level.[19] At the strategic level it applies to a defined region and considers hazard issues as well as social, ecological, economic and cultural issues. The strategic plan is then used to determine specific controls for particular areas or sites; these are used to assess each site-specific development application.

4.4 PERFORMANCE BASED APPROACH[20]

Up to the 1980s, development plans and codes relied on prescriptive standards, which laid down, in quite concrete (and often numerical) terms, how a development must occur. It was then recognised that there was a gap between the strategic plan objectives and the resulting development code that needed addressing - that gap was performance

[18] This is the goal of the National Strategy for Ecologically Sustainable Development.

[19] The NSW *Floodplain Management Manual,* section 1.7 describes the two levels. The Development Assessment Forum *Good Strategic Planning Guide* discusses three levels: Strategic, Development and Operation. For simplicity, this manual will restrict its consideration to two levels of planning.

[20] The description of the performance based approach is taken from *The User's Guide to Designing and Implementing Performance Based Residential Development*, RAPI, 1996, Section 1. The approach is based on the *AMCORD Resource Manual.*

criteria, and was needed to ensure a high quality development outcome. Site-specific plans now rely more on a performance-based approach.

Performance-based codes are concerned with defining:

- development principles,
- characteristics of good development, and
- performance criteria focusing on outcomes and quality of development.

A performance-based approach involves a number of elements. Each element is structured in three levels:

- **objectives** state what is to be achieved or what the desired outcomes of each element are; they may also include an explanatory statement;
- **performance criteria** are general statements about the means of achieving each objective; while they should, where possible, be expressed in objective, measurable terms, they are not limiting in nature in order to allow different responses; and
- **acceptable solutions** are provided as examples of what may enable achievement of the performance criteria.

While acceptable solutions represent a means of satisfying the relevant performance criteria, it is important that developers and assessors do not regard them as minimum standards. Other solutions should always be considered on merit.

Gold Coast City Bushfire Management Strategy

The Gold Coast City Bushfire Management Strategy is a case study at Appendix 3. It adopts a performance based approach to land development in fire-prone areas.

4.5 SUMMARY

Strategic planning and the performance-based approach are the planning framework for any land use planning process. The framework establishes a management system which can include all stakeholders working within an agreed strategic context. Within this context the performance-based approach ensures an integrated development control process including preparation of development applications and assessment of such applications, with engagement of all key stakeholders.

5 THE ROLE OF LAND USE PLANNING SYSTEMS

There are three elements that influence land use planning systems in Australia. First, each State and Territory has its own planning legislation and its own means of managing its land and resources, including development assessment systems. These form the umbrella under which planning is conducted. Second, there are many Commonwealth instruments that impact on the planning process. Finally, application of building codes is Australia-wide, based on the Australian Building Codes and a number of Australian standards. While these set structural and technical design criteria, they may be varied by local provisions and thus could influence the planning process.

5.1 EVOLUTION OF AUSTRALIAN LAND USE PLANNING

Land use planning needs a sophisticated and integrated approach if it is to effectively contribute to risk reduction. It is responding to increasing demands to deliver outcomes that reflect community standards in the 21st century, rather than the standards of the 1950s and 1960s. Paramount among these outcomes is the capacity to deliver ecologically sustainable outcomes.

Over the last 15 years new approaches have been developed.[21] There has been a strong emphasis on improving coordination between commonwealth, state and territory, and local governments and in reforming the planning system. Reform efforts have focused on:

- sustainable development;
- integration of land use planning, subdivision and building decision making;
- a move away from prescriptive zoning to performance-based planning;
- more sophisticated strategic land use planning;
- inclusion of publicly-owned land into the planning system;
- integrated decision making at the local level; and
- integration of state and national policies into local planning instruments.

These changes have set the scene for land use planning to play a more significant role in risk reduction, noting the need for the changes to be affordable and acceptable to the community.

The primary legislation and regulations in each state and territory specify key objectives to be met and provide a framework for preparation of more detailed strategic planning and development and use control documents. Strategic documents are often expressed as planning policies at either the state, regional or local level.

Planning schemes outline community goals and objectives and develop land use and development controls that support these goals and objectives. Planning schemes usually include ordinances and maps. The ordinances contain policies and controls, such as policies discouraging development in hazard areas. Maps show land use zonings and other overlay controls to limit development in hazard areas.

5.2 PLANNING STRATEGIES

The overall assessment of land capability is an important first step and contributes to all planning strategies. Planning strategies should respond to identified risks by seeking to ensure the maintenance of natural systems, avoiding exposure to risk and support for appropriate design and siting controls.

[21] Graham, RJ 1992, *Better Approvals Practices: A manual for reforming local government approvals systems*, National Office of Local Government, Canberra.

Maintaining natural systems

Strategies which emphasise maintenance of natural systems can be more readily integrated into broader planning strategies. The types of action that can be taken are:

- locating development away from sites where natural processes could be affected by development;
- implementing management practices during and after development to protect particular natural processes;
- maintaining the maximum amount of natural vegetation cover, including ground and understorey vegetation, especially on slopes above 10 degrees;
- protecting actively mobile landforms, such as beach and sand dune systems and unstable cliffs, from vegetation removal, or undertaking structural works to stabilise these landforms;
- using flat, low-lying areas for activities upon which the impact of storm surge, sea level rise, floods or tsunamis will be minimal, such as, open space, agriculture, habitat protection or conservation;
- maintaining natural flow regimes of rivers and ground water systems;
- maintaining the absorptive capacity of soils;
- maintaining or creating wetlands as a means of absorbing peak flows from floods or the effects of cyclones and storm surge;
- maintaining riparian vegetation to protect streams from erosion and changes to stream profiles; and
- implementing risk reduction practices, such as hazard reduction burning, and slope stabilisation, that reflect natural regimes and maintain the risk reduction capacity of the natural environment.

Avoiding exposure to risk

Avoiding exposure to risk is widely used in land use planning. Planning strategies should consider:

- avoiding those areas where development will increase the likelihood of risk and/or the level of impact;
- creating incentives for removing or modifying structures in areas that increase risk; and
- prohibiting ways of doing development that are more likely to contribute to increased risk.

Design and siting controls

Design and siting controls are widely used to reduce the risk of particular elements to impact from natural hazards. Most local governments now implement such methods through a series of design and siting codes. Such codes have focused on bushfires, landslides, earthquakes, cyclones and flooding.

Risk reduction through planning usually involves creating a continuum along which, as risks increase, controls on the use and development of land also increase. This can be achieved in a number of ways, such as:

- prohibiting development in high-risk areas through zoning and overlay controls;
- limiting the types of development allowed in high to moderate risk areas - zoning such areas for recreation or other forms of public uses can reduce the potential impacts of hazard events; and
- in moderate and lower risk areas, establishing and applying appropriate development controls based on the assessed risk. These controls can include minimum elevations, setbacks and lot sizes, as well as maximum densities and site coverage. Development control plans should utilise a performance-based approach.

5.3 BARRIERS TO STRATEGIC APPROACH AND PLANNING CHALLENGES

Societal, economic and political barriers to adopting a strategic approach exist and must be responded to. Similarly, the need to consider regional implications and the possibility of cumulative impact are challenges to the planning process that must also be dealt with. The barriers and challenges are discussed below.

Barriers to strategic approach

The barriers to a strategic approach to risk reduction are primarily social, institutional and attitudinal. Economic and political barriers are also significant. Some of these barriers and suggested responses to them are described below.

Barrier	Response
Often the most attractive and high priced development land has a high risk (for example, land on hillsides with views and land close to the foreshore). The pressure to develop such land is high, and land use planning systems often allow its development or fail to properly manage development that is allowed.	Integrity in the land use planning process is essential. The process should be structured to allow it to resist external pressures and should include provisions for independent/ external audits to ensure compliance with the specified process. A transparent process is needed.
Separation between the spheres of government and the functional areas within governments allow issues to be treated in isolation. Risk reduction has frequently been treated primarily as an engineering issue with a focus on structural measures and technological innovations being used to reduce risk. This problem is often exacerbated by the influence of industry lobby groups.	Strategic planning process involving all government stakeholders, both inter-departmental and across portfolios, must be applied at the highest level and the performance-based approach used, again involving all appropriate stakeholders, in setting development controls.
There is limited public understanding of the complexity of interactions between natural and human systems.	Increased education and awareness in the context of risk assessment and risk treatment for natural hazards is needed. Community involvement in this process is essential.
Many decisions makers are not adequately informed about the nature and potential effect of natural hazards and as a consequence do not build appropriate responses into their decisions. Decision makers also need to be aware of the priorities, constraints and concerns of the public when developing strategies for risk reduction.	Decision makers need to be educated in terms of risk assessment and options for dealing with natural hazards. Comprehensive community consultation is needed to ensure community concerns and aspirations are known.
Natural disasters can be largely unpredictable in terms of their intensity, frequency and location of greatest impact. These factors can lessen the resolve of governments and members of the public to actively manage the risk.	Governments in particular must accept the unpredictability and factor it into the strategic planning process. Continual education of both the community and decision makers is needed to ensure hazard awareness is maintained.

Another key factor is 'culture change' in terms of attitudes to natural hazards and the community's ability to manage them. This need applies to political and other organisations involved in the planning process as well as the private sector and the community.	Such a change can be encouraged through public consultation, education and increased dialogue between the public, the private sector and decision makers.
There tends to be a focus on individual risks rather than including the interactions that occur between some hazard types.	A holistic approach is part of the strategic planning process - that must be applied to risk analysis and evaluation.
There is a tendency to over-rely on the continuing maintenance of precautionary measures by residents, particularly in bushfire-prone areas.	Development control plans should both reduce the need for ongoing management measures and include management programs that cover maintenance plans and their monitoring, both public and resident-based.

Planning challenges

A number of challenges must be met when incorporating risk reduction into land use planning practices. Underlying these challenges is the need to consider regional implications and the possibility of cumulative impact - in the past plans have too often focused on individual and independent issues. Some of the challenges are summarised below.

Challenge	Response
Limited knowledge: Knowledge of the extent and severity of hazards is required before maps of the hazard-prone areas can be developed. This knowledge can be imprecise as it is often based on records of variable quality which rarely extend beyond 100 years. There is also a substantial cost in gathering and documenting information.	Imprecision may be reduced using a number of technological approaches, including satellite imagery and mapping as well as Geographic Information System approaches. To help alleviate the cost issue, strategic planning must adopt a whole-of-region and whole-of-government approach in this situation. However, limited resources in some areas may limit the level of sophistication achievable. Lack of high quality knowledge should not be an excuse for failing to respond to a hazard.
Changing risk: The spatial extent of areas affected by hazards can change significantly over time. The areas affected by flooding, landslides or bushfires can change when human activity changes the environment in which the hazards exist. Events triggered by the hazards themselves can also alter the characteristics of future hazards, community and environment.	The changing risk issue emphasises the need for all levels of land use planning to be iterative, that is continually monitored and reviewed on a regular basis.

Sustainable risk treatment: After the approval process is complete, development control needs to be maintained over the longer term. Too often, controls such as in situ self-delivered water supply in fire-prone areas are allowed to lapse.	The monitor and review process of land use plans should address the sustainable risk problem.
Existing commitments: Much of the land identified on hazard maps is already in private ownership or developed. The rights of owners to occupy and build on their land cannot be easily overridden. Whether such rights extend to developers who intend to sell the property is a different issue, noting that the main proponents of development are often those with only a short-term interest in that development. Also, many people have short memories of disasters which can lead to resistance to placing controls over the development of land because of natural hazards.	Integrity and consistency in the planning, application and enforcement of statutory controls is needed to resolve existing or perceived rights. This and the short memory issue are assisted by a continuing community education process. Property development rights require balancing against overarching community concerns including potential risk to life and other long-term societal costs.
Legal issues: Australian planning systems are a means of setting out the rights and responsibilities of developing and using land. Planning instruments are legal documents and often depend upon legal interpretation to operate. However, objective-driven strategic plans are difficult to express in legal terms since they are not prescriptive, equally they do not lend themselves well to legal interpretation. Further, hazard maps can be imprecise and therefore inappropriate for making legally-binding decisions.	Planning instruments should be constructed in an appropriate manner to resolve the imprecision problem. The plan also needs to be sufficiently robust to withstand legal challenge. If the imprecision of hazard maps is great enough to continue to cause problems in legal interpretation, the area may need to be re-surveyed to the required level of precision.
Lack of integration: The impacts of natural hazards may be mitigated through planning, building, development and environmental controls. While appropriate connections may exist between the elements of a plan, there may be a lack of consistency between consent authorities in the application of the elements during the assessment process. The need for an integrated approach is important where an area crosses jurisdictional boundaries and/or where cumulative impacts may occur.	Ensuring that such controls work well together requires an integrated and holistic approach. This must start at the strategic planning process and be carried forward through all levels of planning and development controls. Cross-jurisdictional issues and cumulative impact issues must be considered.

Effect of risk reduction: Risk reduction measures may increase the impacts of particular hazard events which exceed their design thresholds. For example, structural mitigation measures are generally designed to withstand events up to a defined probability of occurrence. Any event exceeding the design event means the protection is lost and the impact in some cases may be more severe than if the measure had not been implemented. Structural methods of risk reduction can also create a level of complacency towards natural hazards that leads to inappropriate developments in high risk areas, such as behind levees.

Design thresholds should be set at an appropriate level for the hazards and communities involved, accepting the need to balance risk, economic, social and environmental issues. If residual risk is judged too great, a different approach altogether may be needed. Complacency may be treated through continuing community education.

5.4 RISK REDUCTION THROUGH LAND USE PLANNING

Successful land use planning for reducing the risk of natural hazards on communities and the environment incorporates the elements of:

- recognising community safety as a major theme of the planning process;
- developing a culture of risk reduction in land use planning;
- adopting risk management objectives and approaches at the strategic planning stage;
- using risk management planning strategies as a guide to public investment programs designed to reduce risk;
- creating site-responsive and community-responsive planning controls and design;
- shifting from a focus on impact of harmful events (disasters) to managing the risks (interaction between hazards, community and environment) that may cause these events;
- applying risk management approaches when reviewing redevelopment proposals, such as upgrading existing development to current standards, (for example, increasing a building's elevation in flood-prone areas); and
- incorporating risk management standard AS/NZS 4360 as part of core management methods.[22]

Land use planning also needs to balance risk against cost of mitigation. Part of this is the importance of ensuring that communities realise the implications of not treating risk.

Most states and territories have introduced reforms for applying risk management in land use planning. Elements include:

- strategic planning framework, providing policy guidance for land use and development;
- performance based rather than prescriptive development control systems;
- integrated development approval processes relating to subdivision, planning and building;
- sustainable land use and development outcomes that are consistent with improved environmental management; and
- increased public participation, monitoring and review in planning processes.

[22] EMA has developed training in emergency risk management and produced two manuals: *Emergency Risk Management: Applications Guide* and *Implementing Emergency Risk Management.*

Planning legislation, development controls and strategic planning documents in Australia's states and territories are tabulated at Appendix 2.

5.5 CASE STUDIES

Throughout Australia new planning strategies are being adopted to effectively mitigate the impacts of natural hazards. Several such strategies are included as case studies in Appendix 3. The case studies address many of the key elements of planning reform: strategic approach; performance-based controls; integrated perspective; sustainability and public participation. They also demonstrate how the barriers to the strategic approach and planning challenges may be overcome. They are summarised below.

Shire of Yarra Ranges Landslip Study identifies risk categories for landslip in the Yarra Ranges. Planning and developmental controls for specific sites are guided by this risk mapping for landslip as represented by the Erosion Management Overlay for the area. This document is a good example of providing a strategic framework for hazard mitigation.

Hobart City Council Land Instability Assessment Schedule requires a land instability investigation report as part of the application process for all development sites. These detailed reports describe potential hazards for sites and then assess the likely impacts of such hazards on proposed development. This document takes a detailed performance-based approach to land development in unstable areas.

Adelaide Hills Bushfire Management Plan Amendment Report aims to reduce risk to life and damage to property from bushfires. This document draws on existing expertise in terms of fire prevention and environmental processes. Geographic Information Systems bushfire hazard maps are a key basis of this approach. Issues relating to sustainability of the environment, such as supporting the maintenance of native vegetation, are also a foundation. Great technical expertise, combined with local knowledge, underlies this recommended approach.

Gold Coast City Bushfire Management Strategy and its associated guidelines act as a guide to appropriate development in bushfire risk areas. Applications for development in these risk areas are evaluated against the guidelines for meeting development requirements in potential bushfire hazard areas. Risk reduction and sustainable development are integrated into the strategy as are a number of factors that impact on the workability of such strategies.

Katherine Land Use Planning Case Study examined the effect of land use planning on the impact of a severe flood. In recognition of the flood risk in Katherine, the Northern Territory Government decided that post 1980 development in Katherine would occur on higher land at Katherine East. In 1980, the Government approved a floodplain management policy that required floor levels of housing in flood-prone land to be a minimum of 350 millimetres above the level of the flood used to define land liable to flooding. The experience of the 1998 flood has shown that using land use planning to reduce the exposure to flooding in Katherine was an effective flood mitigation measure.

6 INTEGRATING RISK REDUCTION INTO THE LAND USE PLANNING PROCESS

An integrated approach to land use planning provides a means of improving risk reduction while addressing requirements for community safety and sustainability. The approach links strategic and statutory planning as part of a wider approach that embraces risk management and the setting of strategic directions in establishing a strategic land use plan.

It must be noted that risk reduction here means reducing risk to community safety. This process is not about reducing corporate risk or reducing consent authorities exposure to liability.

6.1 PLANNING PROCESS STAGES

Figure 6 sets out a process for integrated land use planning. There are three stages to the process:

- establishing the planning background;
- developing the planning strategy and the strategic land use and development plan; and
- developing the implementation program.

Communication and consultation, monitoring and review are applied throughout the integrated planning process.

6.2 PLANNING BACKGROUND

The planning background encompasses the first two stages of the emergency risk management process, that is:

- establish the context, and
- identify the risks.

Goals and objectives

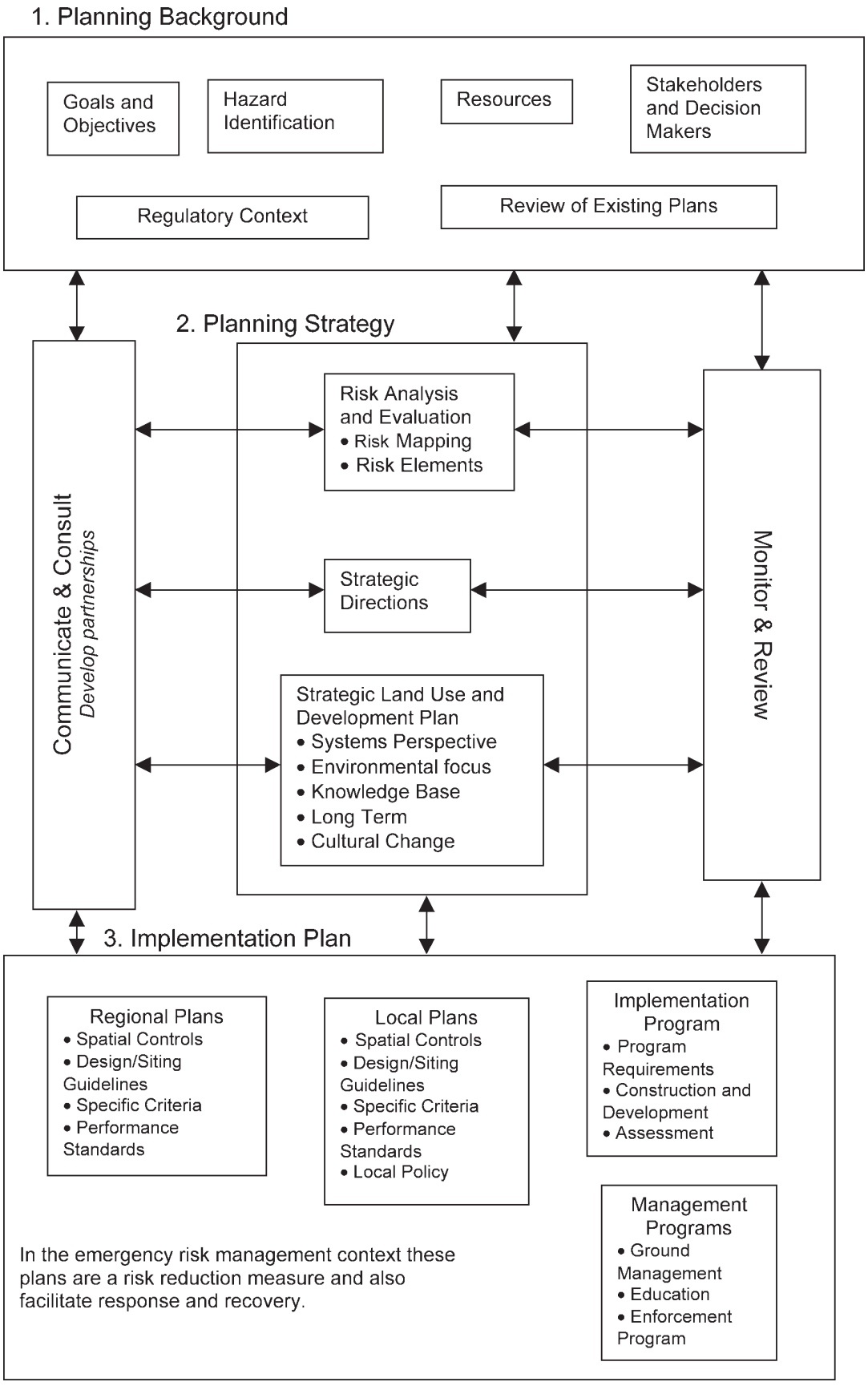
Planning goals and objectives are derived from people's aspirations for their living environment and quality of life, taking into account economic, practical and environmental constraints. These goals and objectives provide direction for legislative and policy requirements at the local, regional, state, national and international levels.

Goals are general statements of intent for the future planning and development of land areas. Objectives provide more specific direction on particular matters.

Risk reduction is an issue that requires its own set of goals and objectives as part of broader community goals and objectives. The nature and content of these goals and objectives will vary from place to place in response to the nature and level of risk associated with the potential impacts of natural hazards. An overall goal of reducing natural hazard impacts on life, property and environment underlies area-specific objectives.

Objectives need to be well founded and as specific as possible. For example, whilst an objective of 'reducing the potential for loss of life and damage to property and the environment from natural hazards' would be acceptable to most people, the specification of what it means, in terms of development and community costs, is not clear. Specific objectives need to be developed, such as:

Figure 6: Integrating risk reduction into the land use planning process



- Development must not occur in areas of high or extreme risk.
- Development should not result in an increase in susceptibility or an increase in vulnerability to impacts from natural hazards.
- No interference with natural processes is to occur in order to reduce risk.
- No building, development or works will be allowed unless it can be shown that the potential risk from natural hazards been reduced to an acceptable level.
- In areas prone to hazards, specified design and siting standards must be met in the construction of buildings in order to reduce risk.
- Risk reduction strategies will be incorporated into the use of resources within the planning area.

Hazard identification

A key consideration for managing risks posed by natural hazards is understanding the dynamic relationships between natural hazards, communities and the environment. These relationships are analysed in detail in emergency risk management studies. Information should be drawn from any such studies which have been conducted in the area. The natural elements that may combine to create hazards include:

- climate;
- geology;
- soils;
- vegetation cover;
- slopes;
- land forms; and
- hydrology.

Other key considerations are:

- the built environment;
- community awareness;
- the history of hazard events in the region; and
- the potential for long-term changes to risk such as climate change and land use change.

Consideration of all these factors enables potential hazards to be clearly identified.

Resources

A community's abilities and resources to meet identified goals and objectives need to be identified. It is necessary to understand the physical, economic, social and human resources of the planning area, that may be utilised to:

- assess the risk;
- develop community understanding of the risk; and
- develop treatment of the risk.

The resource background consists of investigation into:

- patterns of resource development;
- resource aspects of interactions between human activity, hazards and the environment;
- identification of resource issues to be addressed as part of the planning process;
- current demography and trends;
- settlement patterns
- built environment;
- infrastructure development; and
- environmental, cultural and built heritage issues.

Further background could include documenting the possible interactions between human activity, land use, development, environment and the relevant hazards. This would include an assessment of past emergencies and risk reduction practices and their relationship to achieving sustainable outcomes and any issues relating to risk reduction that must be addressed as part of the planning process.

Stakeholders and decision makers

Community stakeholders and decision makers can have a profound impact on the interactions between hazards, communities and the environment. Understanding the potential impacts of people and their organisations requires a detailed understanding of their behaviour, aspirations and motives. Factors affecting human behaviour in relation to natural hazards can include:

- **economic** — wealth distribution, disposable income;
- **personal** — experiences with natural hazards, belief systems and motives; and
- **locational** — proximity to hazard areas.

The decision makers and those who will conduct the planning process, must engage all areas of expertise: local government executives and planners, environmental specialists, engineers, financial planners and emergency services, to name a few.

Regulatory context

All states and territories have a suite of policies applicable to land use planning - some are advisory and others are statutory. This regulatory context is derived from the legislation, regulations, codes and roles and responsibilities applicable to risk reduction in the planning area.

Legislation: Planning legislation that contains goals for community safety or sustainable development provides a context for risk reduction. Other legislation that may be relevant to planning and risk reduction includes legislation for building, emergency management, local government, environment protection, fire management, flood protection, environmental health, nature conservation and conservation of the built heritage.

Policies: All states and territories have developed policies that impact on planning and natural hazards. They may include fire management, flood management, landslide management, coastal protection, protection of biological diversity, agricultural land protection, wetlands protection, water quality management and management of urban expansion.

Codes of practice: Codes of practice relevant to planning and risk reduction have been adopted at national, state and local level, albeit not comprehensively.

The regulatory context provides a framework for development of risk reduction objectives. However, it must be understood that while they are a part of the planning issues, they are not the sole determinant or control factor. Many of the above documents deal with risk reduction as part of broader considerations.

Review of existing plans

In many cases, the land use planning process will take place in an environment that has, in whole or in part, already been subject to one or more previous planning processes. A review of these plans is an essential part of the planning background.

6.3 PLANNING STRATEGY

In developing a planning strategy, a number of basic principles should be considered:[23]

- Applied in isolation, neither planning nor construction standards are likely to effectively or economically reduce risk by a significant amount. The greatest impact is achieved when they are used together and integrated into an overall strategic approach.
- In considering exposure to hazard, the intended use of development must be taken into account, especially where that development is significant to overall community safety. Rather than an across-the-board threshold, thresholds should be graded according to the importance of the element. For example, exposure to the risk associated with natural hazards should be graded for the following facilities:
  - critical facilities, such as hospitals, emergency control centres, mainline electricity availability and fire stations, should be available at all times;
  - sensitive facilities, such as shelters and evacuation centres (schools, church halls) and economic centres (supermarkets), should be available in the aftermath of an emergency; and
  - facilities that represent a potential hazard (such as chemical storage) should be adequately protected.

  This principle is made noting that uses can and do change.
- Current risk thresholds must be applied where a change of use or purpose is proposed for existing development. Outdated thresholds should not be simply inherited. For example:
  - rezoning of an area must be done under current planning standards; and
  - where a critical, sensitive or hazardous facility, such as a major hospital, is to undergo significant modification or redevelopment, current planning standards should be applied.
- A comprehensive range of event probabilities, up to and including the maximum probable event, must be included in the risk modelling process. This is especially important for inundation hazards.
- Risk modelling and design thresholds must be reviewed and updated as part of the strategic planning review and update process. Outdated modelling can almost be worse than no modelling.
- Standards for risk modelling and mapping must be established and those standards made subject to periodic review and update. There should also be a corresponding accreditation process for professionals undertaking such work.
- Where uncertainty exists, for example, with climate change, a precautionary approach should be established in applying risk thresholds. The precautionary principle states that: *Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.*
- Risk models and the assessments they produce are only useful if they are accepted by those who must implement and enforce planning controls as well as those who are affected by the controls.

Risk analysis and evaluation

Risk analysis and evaluation directly relate to the same two stages in the emergency risk management process.

[23] Adapted from a presentation by Ken Granger, Geoscience Australia, to the Queensland State Planning Policy workshop, 23 October 2001.

Risk analysis and evaluation are used to progress towards meeting the goals and objectives identified in the 'planning background'. Consideration needs to be given to the impact developments may have on social, economic and environmental factors. In this context, identifying conflicting land uses and determining land capability is a key to developing a proper risk analysis.

RISK MAPPING brings together data on hazard exposure, the elements at risk and the context within which land use policies are to be developed. Maps can be produced, to a variety of scales, to indicate the level of risk either from individual hazards or from a range of hazards. Many settled areas of Australia have been mapped for bushfire and flood risk. Geographic Information Systems and other spatial mapping techniques are becoming important tools in this area.

Risk mapping provides a spatial overview that indicates hazard distribution by type, intensity and frequency. The risk levels are usually descriptive and are only indicative of actual risk (for example, high, medium and low). They can act as a trigger in identifying sites that require a more detailed analysis of the risks from natural hazards. Emergency risk management studies should be utilised to inform this process.

Case studies The Shire of Yarra Ranges Landslip Study and the Adelaide Hills Bushfire Management Plan Amendment Report (at Appendix 3) contain examples of the use of spatial data in land use planning.

RISK ELEMENTS Communities contain different elements that contribute to risk. Risk elements include:

- **population:** investigate numbers, social and economic characteristics, density, location, economic and social activities;
- **buildings:** look at type, location, size, use, density of development, siting and design in relation to hazards, methods of construction and materials used, and heritage value;
- **land use activities:** including the proposed use, possible future changes in land use and land use activities in proximate areas;
- **infrastructure:** including roads, railways, ports, power supply, telecommunications, water supply, sewage disposal, etc.; and
- **environment:** including biodiversity, habitat, landscape and scenic values.

ACCEPTABLE RISK Risks from natural hazards must be considered in a broad community and regional context so that acceptable levels of risk can be established - the process equates directly to the emergency risk management process. Planners can outline, for decision makers and the community, the potential consequences of using or developing resources in areas at all levels of risk. The level of acceptable risk has to be established through an informed consultative process. Determining risk acceptability is central to the allocation of resources to risk reduction.

The community will have different values about different areas. Part of the strategic planning process is to determine and shape those values, particularly for hazard-prone areas. The acceptable level of risk established through a consultative process must be based on a thorough understanding of potential consequences associated with these levels of risk. In addition, the acceptable level of risk will vary according to the context in which that assessment is made by the community and agencies. Where short-term interests are involved (such as a developer) the acceptable level of risk is likely to be considered

higher than where longer-term interests are being considered (such as an owner-occupier). The planning process must not neglect the needs of the end user.

Establishing acceptable risk levels for different localities in the planning area is also necessary for identification of a set of risk reduction objectives and priorities for resource allocation.

The possibility of the cumulative impact of development proposals should be investigated as part of the risk analysis process.

The information produced through risk evaluation and analysis should be taken forward to the strategic planning stage. It provides valuable input into identifying:

- future settlement directions;
- type of land use and regulatory instruments needed to manage development to reduce risk; and
- areas of existing settlements vulnerable to disasters that may need mitigation measures.

Case studies The case studies in Appendix 3 all utilise risk analysis and evaluation to determine the strategic directions for the communities involved.

Strategic directions

Communities set strategic directions to guide their planning goals and objectives. The strategic directions may take the form of statements which would cover such matters as:

- land development;
- infrastructure;
- environmental protection;
- community safety (risk reduction or avoidance);
- economic development;
- sustainable development;
- community development;
- open space and recreation; and
- landscape management.

Considerations about the effects of different development options, including community safety, on the environment and on the economy of the planning area should be assessed and built into an overall planning strategy.

Risk reduction strategies have to be aligned with other strategies to ensure they all support the overall objective. This process allows other strategic directions to be assessed against the need and requirements for risk reduction.

Strategic directions for risk reduction will influence and be influenced by strategic directions identified for other matters. For example, the planning and provision of infrastructure will be influenced by goals and objectives to reduce risk, and vice versa.

Strategic planning must also recognise that actions to reduce or avoid risk associated with one type of hazard may increase the level of risks for other hazards - the objectives must take a consistent approach to assessing risk and determining priorities for risk reduction or avoidance.

Strategic land use and development plan

The strategic land use and development plan is the strategic plan that brings together all the goals, objectives and strategic directions into a comprehensive and unified whole. It sets out planning and development strategies, including risk reduction (risk treatment in the emergency risk management process), for the planning area. It provides guidance on the development of implementation programs for all components of the strategy.

The overriding purpose is to achieve sustainable outcomes through the development process. To achieve sustainable outcomes the following principles should guide strategic plan development.

SYSTEMS PERSPECTIVE Adopt a systems perspective that is based on the interrelatedness of the natural, social and economic environments and processes.

ENVIRONMENTAL FOCUS Take an environmental focus by endeavouring to understand natural processes that influence the risk of natural hazards and then developing initiatives that respect and support these processes. Adhere to the goals and principles of ecologically sustainable development.

KNOWLEDGE BASE Accept that change often happens in unpredictable and non-linear ways. This necessitates adopting dynamic and responsive methods to maintain the currency of the knowledge base; this implies regular review of the strategy.

LONG TERM Adopt strategic approaches based on medium- and long-term solutions closely linked to the operation and time scales of natural processes. These will address specific projects for development or re-development. This will not remove the need for general remedial treatments in the shorter-term.

CULTURAL CHANGE Accept the need to change underlying cultural and social attitudes to human-environment relationships, including hazards. Particular emphasis should be given to holistic approaches that look at social, environmental and hazard interactions over the short- and long-term.

6.4 IMPLEMENTATION PLAN

Implementation programs need to work effectively within the complex and dynamic nature of community-environment interaction. Such programs tend to consist of four elements - site-specific plans at varying levels which continue the risk treatment stage of the emergency risk management process. These elements are:

- regional plans;
- local plans;
- implementation programs; and
- management programs.

These elements contain the tools used to implement the strategic land use and development plan. They set out specific methods to be used and ensure that all the actions and programs of the responsible authority are directed towards achieving the desired outcomes. They enable different departments, sections or organisations working towards shared goals and objectives to create programs and requirements that complement and support each other.

Regional plans and local plans

Regional and local plans have different roles in the implementation process, though they use similar tools. The framework for these plans is set by state and national policies and instruments. Regional and local plans are statutory instruments to allow the responsible authority to control the use and development of resources. They use planning tools to assist in risk reduction. Such tools include:

SPATIAL CONTROLS set limits to the type and extent of development that can happen in particular areas. These controls may take the form of prescriptive zones, overlays with associated controls or reference to resource documents.

DESIGN OR SITING GUIDELINES are widely used by planning authorities throughout Australia and cover siting of buildings, design and access to subdivisions, environmental management requirements, building codes in high risk areas, and construction criteria in areas of risk.

SPECIFIC CRITERIA Planning instruments can also include criteria aimed at producing specific outcomes for particular developments, for example, distance set-backs, types of materials to use and siting specifications in relation to hazards.

PERFORMANCE STANDARDS In recent years there has been an increasing dependence on performance standards for design and siting. Here the intent is to specify a goal or objective to be met in development.

LOCAL POLICY contributes to the framework for developing local plans. It is intended to reflect the aspirations of the community within the context of regional and state or territory policies.

A combination of these tools should be used in planning instruments which govern the assessment of development proposals. Development proposals should:

- respond to the site conditions, operating natural processes and the wider ecological, social and economic context;
- show how the proposal can meet the objectives and desired outcomes for risk reduction while maintaining sustainability; and
- demonstrate how the proposal is intended to be implemented.

Implementation program

The key throughout the implementation program is the integration between planning, statutory instruments and other regional or local strategic and management processes. The implementation program then links the application of the statutory planning instruments to specific mitigation works, as well as public and private sector development.

PROGRAM REQUIREMENTS Examples of desired outcomes that could influence an implementation program include:

- certain development must not occur in areas of high or extreme risk;
- development should not result in an increase in susceptibility or an increase in vulnerability to impacts from natural hazards;
- areas of high conservation value should not be adversely affected in order to reduce risk;

- no significant interference with natural processes should occur in order to reduce risk;
- no building, development or works should be allowed unless it can be shown that the potential risk from natural hazards has been reduced to an acceptable level;
- in areas prone to hazard events, specified design and siting standards must be met in the construction of buildings in order to reduce risk; and
- risk reduction should be incorporated into strategies using resources within the planning area.

It is important that any works program is approved through the statutory planning process so its impacts can be assessed in relation to the strategic plan and risks to the community.

CONSTRUCTION AND DEVELOPMENT Appropriate techniques should be used for all works to ensure statutory and risk reduction requirements are met. Construction of protection works, creation of open spaces, development of artificial wetlands, use of appropriate construction techniques, and restoration and rehabilitation of areas or sites critical for risk reduction, can all be part of an authority's program for risk reduction derived from the strategic plan. Similar concepts should be applied to private sector development.

ASSESSMENT All works and development programs should be assessed for their contribution to risk reduction and their potential to impact on community risk. Before implementation, works can be assessed using a risk analysis and evaluation approach; post-implementation works should be monitored continually. Inappropriate or unacceptable works which increase risk or do not contribute to risk reduction can be modified to ensure the risk reduction objectives of the strategic plan are satisfied.

Management programs

Public authorities can also implement a number of management programs to contribute to risk reduction. These can include the options listed below.

GROUND MANAGEMENT is required to ensure that areas maintain their capacity to reduce risks, for example, maintenance of drainage channels and storm water systems, fire hazard reduction, wetland maintenance, vegetation management, and access to and egress from high risk areas.

EDUCATION of people in hazardous areas and training of staff and communities about the need for and the techniques of risk reduction helps to lower risks. This education should cover the design and siting of buildings, on-site management of vegetation on private property, building and structure maintenance, and training to deal with emergencies when they occur.

ENFORCEMENT PROGRAMS Development proposals may be approved subject to certain risk reduction conditions being met. It is then essential that those conditions be enforced. Risk reduction measures that need to be implemented as part of a development, must be included on permit conditions. Furthermore, these works need to be inspected periodically to ensure they are being maintained in accordance with their permit requirements.

6.5 CONSULTATION AND REVIEW

Underpinning the integrated land use planning process is a requirement for communication and consultation, as well as monitoring and review. The process is iterative and should be re-visited whenever the review mechanisms indicate such a need.

Communicate and consult

A critical element in land use planning and risk reduction is obtaining input from relevant statutory agencies, people with expertise in the field and the wider community. The consultation process has to be two-way in terms of sharing information between community members and decision makers. Any plan must be responsive to community views and attitudes if it is to succeed.

There are often conflicting views about risk reduction between community members and between community members and decision makers. The community consultation process can help people understand the economic, social and environmental costs of not taking appropriate action to reduce risk. The process will not necessarily result in consensus, but it is critical in informing the deliberative judgement required throughout the whole land use planning process. It should be noted, however, that consensus is not necessarily the best outcome.

Monitor and review

Another critical element in land use planning and risk reduction is monitoring and reviewing plans. Plans need to be living documents if they are to meet their goals and objectives. Monitoring should occur on a continual basis and can include the number of new housing permits issued, assessment of areas that are growing the fastest, and other trends in development which can have profound impacts on the community and natural hazard risks. The potential for cumulative effects should be reviewed on a regular basis.

Two key questions to be addressed during the review are:

- In light of permitted development, is the strategic land use and development plan still valid?
- Has any cumulative impact started to occur as a result of permitted development?

There is a role for ‘State of the Environment’ reporting in this process.

Regular community meetings should be conducted to review plan goals, objectives and progress against the plan. Any revisions to the plan identified and agreed by the community and decision makers should implemented.

A critical time for review of plans is during the response and recovery stages to an event. A quick land use planning process may need to be applied to situations such as temporary accommodation or re-settlement, particularly in remote areas. Furthermore the recovery phase offers the opportunity to re-address the whole land use planning issue.

6.6 EFFECTIVE RISK REDUCTION

Statutory plans may also include a number of elements to make risk reduction more effective. These include:

1. placing performance conditions on developments to ensure risk reduction works are carried out and maintained;
2. limiting the time period during which a permit is valid with a proviso that a new permit can only be issued if conditions on approvals are implemented - this helps ensure ongoing compliance;
3. direct reference to supporting documents to assist in planning for risk reduction (for example, community emergency risk management studies);

- requiring referrals to other agencies with expertise in risk reduction for advice and comment on proposals;
- requiring all public and private landowners to comply with planning scheme requirements so an integrated approach to risk reduction can occur;
- integrating approvals for land use, subdivision, development, building and infrastructure provision so risk reduction issues may be addressed for whole developments rather than just individual components; and
- requiring ongoing site management to ensure risks do not increase over time.

4. requiring risk assessment to be part of an application.

Case studies The case studies at Appendix 3 contain examples of effective risk management planning initiatives.

6.7 THE FINAL PRODUCT: AN INTEGRATED LAND USE PLAN

An integrated approach to land use planning can accommodate a full range of risk reduction techniques. The key is ensuring that the 'culture' of risk reduction is built in to plan preparation, community consultation, specification of criteria and implementation of the plan. All parties involved in preparing and operating the plan need to take risk reduction into account in documentation, assessment and decision making.

Risk reduction cannot be regarded as a separate activity with its own set of rules and requirements. People who prepare plans and those who implement them should work with the community to optimise the risk reduction program.

Whenever any policy or program action is being considered the issue of risk reduction must be taken into account. Risk reduction considerations should be built into the planning and implementation process and the implications of outcomes of any policy or program actions for community safety and sustainability must be assessed, understood and communicated to community stakeholders and decision makers.

Many traditional planning approaches dealing with natural hazards focus on the areas directly affected. To be truly effective, a planning process that integrates risk reduction has to consider both the effects of the hazard and the consequences of actions that may influence the frequency, severity and extent of the exposure to hazards in the wider planning area. Vegetation management in catchment areas; the location of buildings, infrastructure and other structures; the practices construction and management authorities use; construction of flood mitigation works; and many other matters all have to be addressed as part of the risk management planning process. In turn, the effects of risk reduction works or practices need to be considered in the broader context of other matters of concern to the plan - sustainability, economic development and social equity.

A good plan will integrate risk reduction into the process, not merely treat it as another issue to be addressed in special circumstances.

7 CONCLUSIONS

The integration of natural hazard management with land use planning is a challenging process. It goes well beyond adding a few risk reduction policies and criteria into a statutory scheme. It makes risk reduction a core issue for planning, developing appropriate strategies and building planning instruments to reduce risks to the safety and sustainability of communities. Land use planning can mitigate many of the impacts of natural hazards by adopting a strategic approach. The land use plan can provide the means to ensure that diverse programs are integrated so they achieve overall community goals and objectives, including reducing natural hazard risks.

APPENDIX 1

ECONOMIC COSTS OF NATURAL DISASTERS IN AUSTRALIA

The BTE[24] report, Economic Costs of Natural Disasters in Australia, is recognised as the first attempt to make an authoritative assessment of the subject. However, the report notes that there are limitations in its assessments and methodology. The following extract from the executive summary of the report describes the background to the report and its limitations.

EXECUTIVE SUMMARY

Natural disasters affect every State and Territory in Australia and impinge directly on the everyday lives of residents in vulnerable communities. Although communities usually have well-developed plans for responding to natural disasters, mitigation measures have generally received less attention.

Good information on the costs of natural disasters is required to assess the effectiveness of expenditure on mitigation measures. In response to the need for better cost information, the National Emergency Management Committee endorsed the project leading to this report. The key objectives of the project were to establish the costs of natural disasters in Australia over time, to examine the trends in these costs and to develop a model for costing future disasters. A working group (the Disaster Mitigation Research Working Group chaired by the Department of Transport and Regional Services) was established to oversee the project.

The term 'natural disaster' covers a wide variety of disaster types. For the purposes of the project, a natural disaster was classified as any emergency defined by the Commonwealth for the purposes of the Natural Disaster Relief Arrangements which are administered by the Department of Finance and Administration. As a result of this classification, the analysis was limited to floods, storms (including hailstorms), cyclones, tsunami, storm surges, bushfires and earthquakes. Landslides were also included, as they are included in the Natural Disaster Relief Arrangements when they are consequential to an eligible event.

The focus of the study was on national economic costs, as a national approach was necessary to achieve the project's objectives. A local or regional approach may be more appropriate for an assessment of individual disaster mitigation measures.

Availability of data

Australian data used for the analysis were derived from a database maintained by Emergency Management Australia (EMA). Although the BTE considers the EMA database as the best currently available in Australia for purposes of the project, it has limitations:

- The heavy reliance on media reports limits the accuracy of the database.
- Some of the earlier events that occurred in Australia, especially smaller ones, are not likely to have been recorded, as they were not reported in the media.
- The method of estimating total costs as multiples of insurance costs can lead to significant inaccuracies.
- Cost estimates contained in the database were found to have not been properly indexed to 1998 dollars. However, the low inflation levels experienced over the past three to four years would have had little impact on the cost estimates.

[24] Now the Bureau of Transport and Regional Economics.

Although the EMA database contains records dating back to the 1800s, it is only since 1967 that reliable insurance data, on which the most reliable cost estimates in the database are based, became readily available. Therefore, for the study, records of events prior to 1967 were not included. However, care is still required, as events early in the study period may not have been reported and recorded in the database.

The analysis in the report was limited to events having an estimated total cost greater than or equal to $10 million each, excluding the costs of deaths and injuries. The BTE believes the use of this threshold does not substantially affect the conclusions reached.

Framework for estimating costs

It was difficult to make a conclusive assessment of the trends in disaster costs due to limitations of the data. A framework for estimating the economic cost of natural disasters, which should facilitate future estimations of disaster costs, was developed. Although drawing heavily on flood literature, the framework should be suitable for use in determining the cost of all disaster types. Nevertheless, the unique character of each disaster means that the framework should only be used as a guide, rather than an exact model to determine the cost of any particular disaster.

The objective of this report was to identify the economic costs related to an event, rather than the financial cost. Economic costs are focused on the additional resources used by the Australian community as a result of a disaster. Financial analysis is concerned with the financial impact on the individual or the entity directly affected by the disaster. In estimating the economic costs of disasters, caution needs to be exercised to avoid double counting of costs and to ensure the use of appropriate economic values of assets.

Classification of losses

Generally, the method used to estimate the costs of a natural disaster is to categorise the losses into tangible and intangible losses, which are further sub-divided into direct and indirect losses. The BTE's approach was to analyse the costs in three broad categories - tangible direct, tangible indirect and intangible (comprising the direct and indirect intangible cost). Direct costs, which are the easiest to classify, are losses that result from the physical destruction or damage to buildings, infrastructure, vehicles and crops.

Indirect costs, which are more difficult to estimate, are costs incurred as a consequence of the event occurring, but not due to the direct impact. One area of contention is the costing of the disruption to business. The cost of lost business is often included in the estimated cost of a disaster. The impact of a disaster can be devastating for businesses directly affected by that disaster, and local communities can suffer as a consequence. However, when examining the impact of the disaster from a national perspective, business disruption costs typically should not be included. This is because business disruption usually involves a transfer between producers, without a significant loss in national economic efficiency. There may be occasions when the transfer between producers involves additional costs, which would be a valid indirect cost of the disaster. Business disruption costs would be included if the event affected the nation's economy through an increase in the level of imports or a decrease in exports.

The intangible cost category attempts to capture all losses not considered as a direct or indirect tangible cost. Intangible costs are typically those for which no market exists. These costs are difficult to estimate, as there is no systematic or agreed method available to measure them. The largest impact is normally found in the residential sector, which includes health effects, household disruption and loss of memorabilia. Although presently available methods are generally poor at reliably estimating many intangible costs and benefits, they should not be ignored in assessing mitigation proposals.

APPENDIX 2

OVERVIEW OF PLANNING INSTRUMENTS IN AUSTRALIA

Table 2 lists key planning legislation, development controls and strategic planning documents in Australia's states and territories. The Table is included to demonstrate how the risk management and planning issues addressed in the manual relate to specific instruments in the states and territories.

It should be noted that both the web sites and the instruments may be subject to change in the longer term. However, the planning agencies cited in Table 2 regularly update their web sites, which can provide a wide range of information on current and pending planning controls. The web sites for the states and territories are a good source for new planning initiatives.

As well as the state and territory legislation, there are intergovernmental agreements and a large number of Commonwealth Acts, Regulations and Instruments that need to be considered in the land use planning process. Examples include:

- the Inter-Governmental Agreement on the Environment, signed in 1992 by the Commonwealth Government, State and Territory Governments and the Australian Local Government Association;
- the Native Title Act 1993, amended in 1998 - planning authorities have an obligation to comply with the Act in areas where native title exists or may exist; and
- the Environment Protection and Biodiversity Conservation Act 1999, which established a Commonwealth administered environmental assessment and approval system operating in addition to but separate from state and territory systems.

Information on Commonwealth instruments is available through the Development Assessment Forum at <www.daf.gov.au.reports.htm>. This contains:

- Commonwealth Planning Instruments - a database of all Commonwealth Acts, Regulations, Agreements, Policies and the like that impact upon planning and development assessment systems and processes.
- State of Play — a report that compares planning systems in Australian states and territories.

Many of the Acts and Regulations, and some of the planning instruments, are available in full through the Australian Legal Information Institute site at <www.austlii.edu.au>.

Table 2: Overview of planning instruments in Australia

State/Territory	Primary planning legislation	Primary strategic planning document	Primary development and land use control document	Operating documents
ACT www.palm.act.gov.au	*ACT Planning and Land Management Act 1988* (Commonwealth legislation) *Land (Planning and Environment) Act 1991* (ACT legislation)	National Capital Plan Territory Plan Canberra Spatial Plan	National Capital Plan Territory Plan Designing for High Quality Sustainability	Territory Plan Master Plans Development Control Plans (refer to National Capital Plan)
New South Wales www.duap.nsw.gov.au	*Environmental Planning and Assessment Act 1979* *Environmental Planning and Assessment Regulations 2000*	Regional Environment Plans State Environmental Planning Policies	Local Environment Plan Planning for Bushfire Protection Floodplain Management Manual	Development Control Plans
Northern Territory www.lpe.nt.gov.au	*Planning Act 1999*	Northern Territory Planning Scheme	Northern Territory Planning Scheme	
Queensland www.ipa.qld.gov.au	*Integrated Planning Act 1997* *Integrated Planning Regulations 1998*	Local Government Planning Schemes	Planning Scheme Regional Frameworks	
South Australia www.planning.sa.gov.au	*Development Act 1993* *Development Regulations 1993*	Metropolitan Planning Strategy Country Planning Strategy	Development Plan	
Tasmania www.rpdc.tas.gov.au	*Land Use Planning and Approvals Act 1993*	Municipal Strategic Plan	Planning Scheme	
Victoria www.doi.vic.gov.au	*Planning and Environment Act 1987* *Planning and Environment (Planning Schemes) Act 1996* Planning and Environment Regulations 1998	State Planning Policy Framework Local Planning Policy Framework (Municipal Strategic Statement and Local Planning Policies)	Planning Scheme	State Planning Policy Framework; Local Planning Policy Framework; Zones; Overlays; Particular and General Provisions; and Incorporated Documents
Western Australia www.planning.wa.gov.au	*Town Planning and Development Act 1928* (as amended) Town Planning Regulations 1967 *West Australian Planning Commission Act 1985* *Metropolitan Region Town Planning Scheme Act 1959*	State Planning Framework (which includes): • Statements of Planning Policy • Regional Strategies • Regional and Sub-Regional Structure Plans • Strategic Policies • Operational Policies	Town Planning Scheme Metropolitan Region Scheme	Development Control/ Operational Policies

APPENDIX 3

CASE STUDIES

1. Shire of Yarra Ranges Landslip Study
2. Hobart City Council Land Instability Schedule
3. Adelaide Hills Bushfire Management Plan Amendment Report
4. Gold Coast City Bushfire Management Strategy
5. Katherine Land Use Planning

Case study 1: Shire of Yarra Ranges Landslip Study

Background

The Shire of Yarra Ranges is located east of Melbourne. It has an enviable reputation for its natural beauty and numerous tourist attractions (for example, the Dandenongs, Yarra Valley, Healesville Sanctuary and Puffing Billy).

Landslip is a fact of life in the Shire of Yarra Ranges. Approximately 11 per cent of the Shire's rateable properties have been identified as being highly susceptible to landslip.

The underlying geology and steep slopes are the principal causes of landslip in the Shire. The types of landslip that occur include falling boulders, debris flows, slow long-term earth movements, small landslips up to the size of a residential block and large landslips involving entire hillsides.

Poor hillside and land development practices, such as excessive cutting and filling, uncontrolled water run-off, or uncontrolled removal of vegetation, is known to increase landslip potential. Development is known to induce landslips even where there was no evidence of such failures in the past.

The Shire has developed a uniform classification of landslip risk, together with development control criteria to meet the needs of those who wish to develop land potentially affected by landslip.

Approach

A specialist geotechnical engineering firm conducted a landslip study in 1998-99 and produced a computerised map of the Shire identifying six categories of landslip risk. The study classified every site in the Shire into one of these categories:

- **Exempt (Ex):** flat land, unlikely to be any instability, no impacts.
- **Low (L):** landslip unlikely even though the land is gently sloping.
- **Medium risk (M0):** construction requires compliance with guidelines.
- **Medium risk (M1):** construction requires compliance with guidelines.
- **Medium risk (M2):** slopes 20 per cent requiring a mandatory planning permit and site-specific geotechnical assessment.
- **High risk (H):** at risk of landslip without any development. Planning permits can only be issued where a geotechnical investigation shows risk is acceptable. There may be circumstances where a planning permit cannot be issued.

The survey identified 11 per cent of the Shire's rateable properties being in the high risk and medium risk categories.

The Shire has implemented planning controls in the Yarra Ranges Planning Scheme that ensures new development takes into account the potential of landslip risk. The planning controls require property owners to adopt improved hillside development practices.

The Yarra Ranges Planning Scheme applies the *Erosion Management Overlay* to land which has been identified as having high (H) or medium risk (M2) landslip risk and asserts that any development within these areas is subject to a thorough geotechnical assessment.

A planning permit is required for buildings and works, subdivision and vegetation removal on land affected by the *Erosion Management Overlay.* An application must be accompanied by geotechnical information that describes the geotechnical and geomorphological characteristics of the site, its susceptibility to landslip or subsidence and the likely effect of the proposed buildings or works on the site and surrounding land.

Main development controls in areas of risk include:

- submitting a site-specific assessment from a qualified geotechnical engineer if the site is categorised M2 or H;
- limiting changes to the natural landscape;
- controlling surface and subsurface water, and where possible moving it off-site;
- retaining and increasing vegetation;
- constructing all footings in accordance with the Australian Building Code and engineer's advice; and
- providing approved engineer-designed cuts, fills and retaining walls.

During the extensive community consultation process undertaken in conjunction with the landslip study, the Shire has developed fact sheets on landslip. The fact sheets include construction guidelines for development in each of the landslip categories.

Main benefits

The *Erosion Management Overlay* has the following benefits with respect to incorporating risk reduction in land use planning:

- performance-based development assessment approach and site-specific assessments;
- mapping of hazard exposure; and
- increased community awareness about hazard risks.

Sources

Ritchie, L. & Hunt, G. 2001, 'Landslips - a moving story (a Municipality's perspective)', *Australian Journal of Emergency Management,* pp. 28-32.

Shire of Yarra Ranges 1999, *Landslip Fact Sheets, Numbers 1 to 10,* Yarra Ranges Planning Scheme.

Case study 2: Hobart City Council Land Instability Assessment Schedule

Background

In many parts of Tasmania, more and more steep land is being developed for a range of residential and other activities. Consequently, the potential for landslip and accelerated erosion and sedimentation is increasing.

Approach

In recognition of the increasing pressure to develop steep land in its municipal area, Hobart City Council, in conjunction with Mineral Resources Tasmania, developed a draft *Land Instability Assessment Schedule* to apply to the assessment of development sites with potential for land instability. The schedule has since been embraced by other Councils preparing draft planning schemes.

The Schedule's objective is:

> To ensure that land is capable of supporting any proposed development and that any proposed development will not cause or accelerate land instability on a particular site or adjacent land.

In order to meet this objective, a land instability investigation report is required to be submitted with a development application when the slope of the development site exceeds the threshold slope angle stipulated for the relevant geology type. Threshold angles are stipulated for all geology types found within the planning area.

A land instability investigation looks at a number of aspects, including:

1. Addressing all potential hazards specified as being relevant to the geology type. Hazards to be addressed may include:
   - (a) potential for landslip;
   - (b) potential for erosion;
   - (c) potential for foundation movement due to:
     - (i) reactive soils; and/or
     - (ii) soil creep; and/or
     - (iii) low cohesion of soil particles; and/or
     - (iv) compaction of soil particles;
   - (d) potential for waterlogging and/or flooding;
   - (e) potential for river bank collapse;
   - (f) potential for instability due to presence of unconsolidated sediments (for example, boulder beds, talus, deep soil profiles, sandy clay beds); and
   - (g) potential for vegetation removal to cause instability.
2. Classifying the site in accordance with AS 2870 - 1996 *Residential slabs and footings — construction* and make recommendations for the type and design of drainage methods and structures, and building/structure foundations.
3. Classifying the potential hazard (that is, low, medium, or high) by providing opinion on the level of risk, whether the site is capable of supporting the proposed development and whether the development is likely to cause instability on any other land.

4. Including evidence that the qualified person holds adequate and current professional indemnity insurance cover for the nature and extent of any necessary investigations.
5. Complying with the minimum requirements of AS1726 —1993 *Geotechnical investigations.*

Where the land instability risk has determined that the site is capable of supporting the proposed development and will not cause instability on any other land, any recommendations for mitigation and management measures are to be transposed into conditions for planning approval provided the application is ultimately approved.

Main benefits

The *Land Instability Assessment Schedule* has the following benefits with respect to risk reduction and land use planning:

- a performance-based development assessment approach;
- enables development on land not exceeding the threshold slope angle to be more rapidly approved;
- development assessments that consider multi-hazard risk, for example, geotechnical assessment, may be required to address one or more of the following risks: potential for landslip, erosion, foundation movement, waterlogging/flooding, river bank collapse, and impact of vegetation removal; and
- clear and precise assessment requirements, such as the requirement for land instability investigations depending on the threshold slope angle for different geology types.

Source

Hobart City Council 2001, *Draft Schedule Land Instability Assessment.*

Case study 3: Adelaide Hills Bushfire Management Plan Amendment Report

Background

The South Australian development system incorporates Development Plans which seek to promote the provisions of the State Planning Strategies. Development Plans are statutory documents used in assessing actual development proposals. Development Plans contain policies dealing with bushfire, flooding, sea level rise and other hazard issues.

A Ministerial *Bushfire Management Plan Amendment Report* (PAR) has been approved, providing a basis for assessing development proposals against criteria intended to reduce risk to life and damage to property from bushfire in the Adelaide Hills.

People continue to be attracted to developing land and building homes and tourist accommodation within Adelaide. This brings more and more people into the Adelaide Hills which, by virtue of its physical characteristics in combination with particular weather conditions, is recognised as a bushfire-prone area.

Approach

The intent of the PAR is to introduce a set of updated and refined bushfire management objectives and principles of development control that apply to the bushfire-prone areas in the Adelaide Hills. This Plan clearly defines, in map form, the bushfire-prone area and delineates the area where Councils are required to consult with the Country Fire Service of South Australia (CFS) when assessing development applications.

Some of the key components of the PAR and associated Regulations include :

- Acknowledgment of CFS expertise in aspects of bushfire planning matters and establishing the CFS as a formal referral agency. Residential and tourist accommodation development applications located within the referral areas will be referred to the CFS and Councils are to have regard to CFS advice. This initiative will provide consistency in the way Councils refer applications and use the resultant information.
- Geographic Information Systems Bushfire Hazard Maps, based on bushfire intensity classes derived from weather parameters, fuel cover types and topographic slope, define 'high hazard' areas. High hazard areas are those which would generate 4000 kilowatts per metre of fire front which is regarded as the limit of control for conventional firefighting strategies. This criterion was the basis of defining interim CFS Referral Areas. Local knowledge of CFS and Council officers and consideration of an area's future development potential was used to refine the boundary.
- Requirements of a more technical nature, such as those relating to firefighting hardware and specific building construction requirements, have been removed from the existing Development Plans, and are instead contained within a new Minister's Specification and Australian Standard AS 3959.
- The PAR demonstrates understanding that native vegetation retention and bushfire protection are related matters. The principle of development control for native vegetation retention requires that buildings be sited in cleared areas to achieve the necessary measure of safety rather than locating the building on a site too close to the native vegetation, thus leading to its eventual removal.

The additional principles of development control to be introduced by the PAR address:

- allotment layout and design;
- public roads;
- private access tracks to residential and tourist accommodation buildings;
- access to dams and open water supplies;
- siting of residential and tourist accommodation buildings; and
- landscaping associated with residential and tourist accommodation buildings.

Main benefits

The Ministerial *Bushfire Management Plan Amendment Report* has the following benefits with respect to risk reduction and land use planning:

- consistent and uniform bushfire protection policies across the affected development plans;
- mapping of hazard exposure; and
- inclusion of strategies that maintain natural processes, for example, maintaining the maximum amount of natural vegetation cover, including ground and understorey vegetation.

Source

Minister for Transport and Urban Planning 2000, *Bushfire Management Plan Amendment Report by the Minister.*

Case study 4: Gold Coast City Bushfire Management Strategy

Background

Existing measures did not constitute an integrated planning strategy and did not enable Council to adequately fulfil its responsibilities for bushfire management within the municipality. Issues relating to potential bushfire hazard areas and bushfire management are currently addressed in the Albert Shire Planning Scheme relating to development in rural areas and the 'Bushfire Risk Area' identified within the Springbrook Structure Plan.

The Gold Coast City Bushfire Management Strategy Taskforce, together with consultants, Ecograph, developed the *Gold Coast City Bushfire Management Strategy*, in April 1998. The strategy recommends actions that affect Council administration, and the operation of all fire management agencies within the City and the community. It promotes development of a planning strategy to assist in land use and land management decision making for bushland areas within the City.

The *Guidelines for Meeting Development Requirements in Potential Bushfire Hazard Areas* has been developed from the strategy and helps development proponents meet Council development requirements where they propose to undertake development in potential bushfire hazard areas (PBHAs). The guidelines are applicable until the review of the Gold Coast Planning Scheme is completed.

Approach

When planning approval for a proposed development is sought in a potential bushfire hazard area of the City (as identified on a Gold Coast Potential Bushfire Hazard Map), the development proposal is assessed against the *Guidelines for Meeting Development Requirements in Potential Bushfire Hazard Areas*. On the Gold Coast Potential Bushfire Hazard Map, land is identified as having a high, medium or low potential bushfire hazard rating. The potential hazard is calculated as follows:

Potential hazard = Slope rank + Aspect rank + Vegetation rank + Fire history rank

The outcomes sought for development in each of the areas is:

- High — wherever possible, development in these areas should be avoided or, if approved, subject to conditions which aim to mitigate potential bushfire hazard.
- Medium — development in these areas is likely to be subject to a number of requirements aimed at mitigating potential bushfire hazard and protecting the safety of residents.
- Low — these areas do not warrant special planning controls. Rather the focus is on ensuring community awareness and providing advice to residents. The strategy seeks to ensure that appropriate protection is available through appropriate firefighting infrastructure.

In order to achieve these development objectives, Council has defined a number of requirements that development proposals are required to meet. Council may vary the development requirements following determination of potential bushfire hazard at the site level.

The requirements apply whenever development is proposed on sites which are either wholly or partly within areas identified as having a potential bushfire hazard. Table 3 summarises the requirements.

Table 3: Development requirements for potential bushfire hazard ratings

Development requirement	PBHA rating		
	Low	Medium	High
Appropriate land-use		1	2
Submission of a Fire Management Plan		2	2
Appropriate subdivision design	1	2	2
Appropriate house site location		2	2
Provision of firefighting infrastructure	2	2	2
Input of local fire brigade	2	2	2
Appropriate building construction	1	2	2
Provision of adequate private water supplies	1	2	2
Appropriate clearing and landscaping	1	2	2
Improved community awareness	2	2	2

[1]Advisory only
[2]Those where development requirements apply. In high PBHAs more stringent requirements are likely to exist in respect of subdivision design, house site location, provision of firefighting infrastructure, building construction, provision of private water supplies, and clearing/landscaping.

Main benefits

The Bushfire Management Strategy and the development guidelines have the following benefits with respect to risk reduction and land use planning:

- a performance based development assessment approach;
- opportunities for a site-specific analysis to assess the potential bushfire hazard particular to the site;
- integration of risk reduction and sustainable development in the development guidelines;
- mapping of hazard exposure;
- clear and precise strategic objectives, for example, in high PBHAs 'development in these areas should be avoided, or if approved, subject to conditions' and 'The street and road layout of developments must be designed so as to mitigate any potential bushfire hazard';
- recognition of risk-reduction practices, for example, hazard reduction burning, that reflects natural regimes and maintains the risk reduction capacity of the natural environment; and
- emphasis on risk reduction rather than on protecting property in risk areas, for example, high PBHAs are areas where development is not allowed, and buildings in high and medium PBHAs should be designed and constructed to reduce fire risk.

Sources

Gold Coast City Council 1998, *Bushfire Management Strategy*.

Gold Coast City Council 1999, *Guidelines for Meeting Development Requirements in Potential Bushfire Hazard Areas*.

Case study 5: Katherine Land Use Planning

Background

Katherine is 314 kilometres south-east of Darwin. It is the major commercial centre for a large area of the Northern Territory, with a population of 9959 at 30 June 2000 (Northern Territory Government 2001). Located in the tropics, Katherine has an annual rainfall of 1068 millimetres. It lies on the Katherine River, a major tributary of the Daly River. The Daly River discharges into the Timor Sea at Anson Bay about 300 kilometres north-west of Katherine and south of Darwin.

Since December 1897, eight floods in Katherine have exceeded 17 metres on the old railway bridge gauge and one was very close to 17 metres.[25] The most recent flood, in 1998, reached a peak level of 20.39 metres and is the largest Katherine flood on record. Studies after the 1998 flood resulted in a revised flood height average return interval, with the 1998 flood estimated to have had an average return interval of about 155 years.

Approach

In recognition of the flood risk in Katherine, the Northern Territory Government decided, in 1980, that future development in Katherine would occur on higher land at Katherine East, about 2 kilometres east of the CBD. Also in 1980, the Northern Territory Government approved a floodplain management policy that required floor levels of housing on flood-liable land to be a minimum of 350 millimetres above the level of the flood used to define land liable to flooding.[26]

The flood of 1998 was the first substantial flood since 1957 to extensively flood inhabited parts of Katherine. During the 1998 flood, almost all residential, commercial and industrial properties in the town area were flooded. Properties in Katherine East escaped inundation. Road access to Katherine, including Katherine East, was cut off. There was substantial damage to the CBD and subsequently several businesses failed.

The freedom from inundation of houses in Katherine East provided an opportunity to investigate the benefits of land use planning as a flood mitigation measure. The use of land use planning to reduce the exposure to flooding in Katherine provides a useful example of the effectiveness of planning as a flood mitigation measure.

The costs of developing Katherine East compared with alternative sites were not large. The Stuart Highway adjoins the Katherine East area so road access costs were minimal. The major costs were in additional electricity and water supply, but were not large. The benefits are estimated to be substantial.

Bureau of Transport and Regional Economics study

The Bureau of Transport and Regional Economics estimated the benefits of reduced flood damage of developing Katherine East as part of a larger study of flood mitigation. The focus of the analysis was to estimate the damage to houses avoided by building in Katherine East rather than an alternative site near the existing development.

Development in Katherine East is mostly residential - commercial development is limited to a small retail complex and a motel. Other developments include four schools, a child care centre, Department of Education residential facility, and a police, fire and emergency services complex.

[25] 17 metres is the moderate flood warning threshold level.

[26] The floodplain management policy defines flood-liable land as 'land that would be inundated as a result of a flood that is the greater of either the highest on record or that which has a statistical chance of 1 per cent of occurring in any one year'.

The Bureau of Transport and Regional Economics estimated both the direct and indirect damage costs avoided by development of Katherine East. Costs were estimated separately for residential, commercial and public buildings. Indirect costs estimated included: clean-up, emergency accommodation, emergency services and business disruption. The total savings attributable to developing Katherine East are shown in the table below. Savings are less in a probable maximum flood because Katherine East itself would be flooded, causing significant damage. The costs avoided are estimated to be equivalent to annual savings or reduced average annual damage of $560 000.

Table 4: Total potential costs avoided - Katherine East

Annual Exceedance Probability	Direct ($m)	Indirect ($'000)	Total ($m)
5%	0.051	36	0.086
2%	8	941	9
1%	24	4497	29
Probable Maximum Flood	12	7282	19

Note: Cost estimates are in 2001 prices. Figures for direct and total costs are rounded to nearest million dollars. Figures may not add to totals due to rounding.
Source: Bureau of Transport and Regional Economics analysis.

The analysis has not included estimates of intangible losses avoided by building at Katherine East. Experiences by Katherine residents during 1998 and flood victims elsewhere are strong indicators that intangible costs can be huge. The avoidance of these intangible costs alone might very well be sufficient to justify the decision to focus future development on Katherine East.

Overall, given the limitations of available data, the benefits of the decision to develop Katherine East are likely to be underestimated in this analysis. Although no information is available on the additional costs of developing Katherine East compared with alternative development sites, the evidence based on tangible costs suggests that the benefits will have exceeded the costs.

Source

Bureau of Transport and Regional Economics 2002, *Benefits of Flood Mitigation in Australia.* Report 106, BTRE, Canberra.

APPENDIX 4

HAZARD CONSIDERATIONS

Note: The hazard considerations as described below are a brief introduction only; further materials on hazards are listed in the References. The considerations, as described here, should not be used for planning purposes. Appropriate authorities should be involved as part of the planning process.

With large scale/area hazards, particularly flood and fire, three types of risk need to be considered:

- **existing** — refers to developments already existing in a hazard-prone location;
- **future** — refers to developments that may be built in a hazard-prone location; assessment of proposals also needs to consider the cumulative effects of small proposals that may not, in themselves, contribute to risk; and
- **residual** — refers to risk associated with development that caters for a certain level of hazard, but not the potential maximum hazard.

Also, treatment of risk associated with large scale/area hazards requires coordination between all the different parties involved. Fire and flood are seldom confined within discrete local government boundaries, so inter-jurisdictional cooperation in the planning process is essential.

With many hazards, land use planning has the potential to prevent a hazard from impacting on a community; it is also less costly than remedial measures implemented after development is completed.

FLOODS

The material in this section has been sourced from Agriculture and Resource Management Council of Australia and New Zealand 2000, *Floodplain Management in Australia Best Practices Principles and Guidelines.*

Factors affecting the flood hazard

Factors affecting the flood hazard and disruption caused by flood are:

- flood behaviour (severity, depth, velocity, rate of rise, duration);
- topography (access, evacuation routes, islands);
- population at risk (number of people, number of communities, type of land use, flood awareness); and
- emergency management (forecasting, flood warning, response plans, evacuation plans, recovery plans).

Land use controls are essential to ensure that land use on flood-prone land is compatible with flood risk if the rate of growth in future flood damage is to be reduced. Once flood-related planning measures have been finalised, flood-related zonings need to be formalised and the measures incorporated into the statutory planning instruments. Zonings need to be defined so that requirements based on cumulative effects can be adequately applied to individual proposals that may, in isolation, have minimal impact.

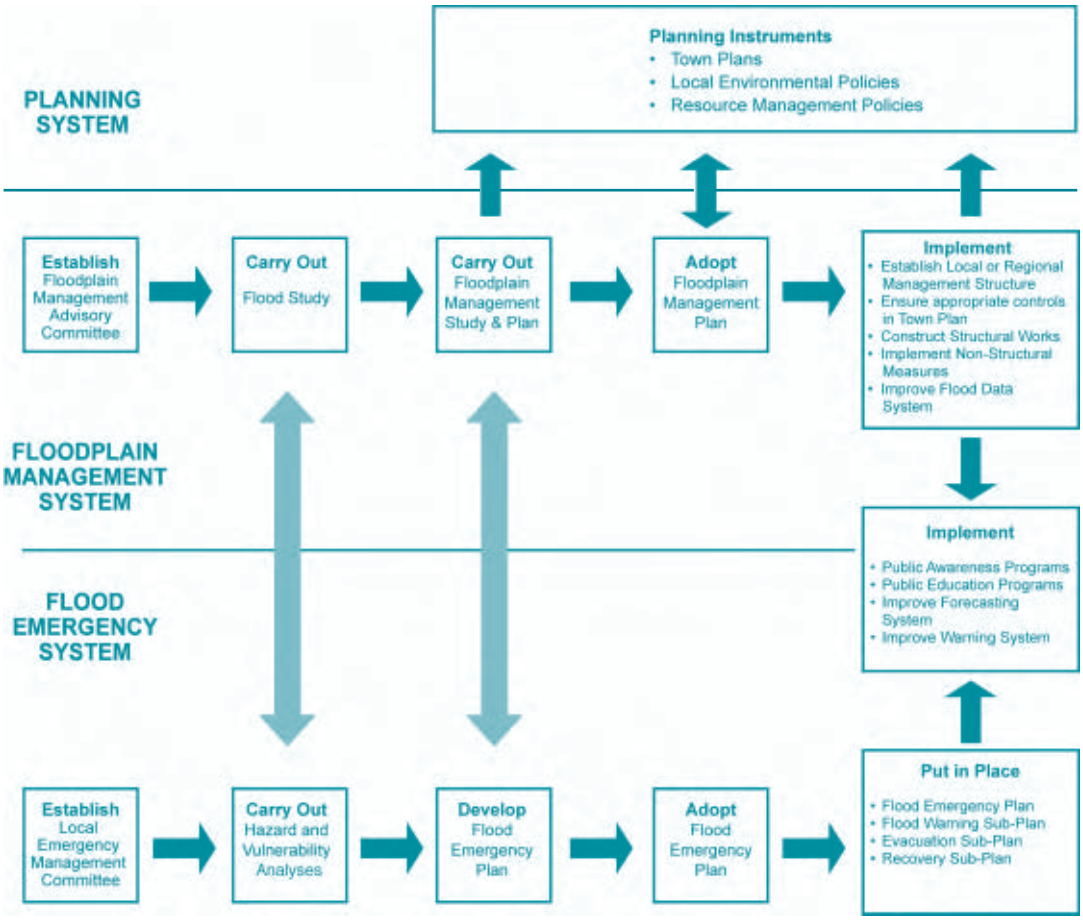
Approach

An effective floodplain management system and flood emergency plan requires the coordination and integration of the following three systems:

- statutory planning system;
- floodplain management system; and
- flood emergency system.

Figure 7 shows a flow chart for floodplain management in Australia.

Figure 7: Relationships between the statutory planning, floodplain management planning and flood emergency planning processes



Floodplain management process

Best practice for the floodplain management process needs to include:

- public consultation at all stages of the process;
- a suitable planning horizon (20-30 years) that encompasses and assesses opportunities for significant land use change and redevelopment of existing urban and rural areas;
- plans made in view of the multi-objective nature of floodplain management;
- an assessment of flooding considerations together with environmental, ecological, economic, social and community expectations from within the broader principles of sustainable natural resource and environment management and of integrated or total catchment management;
- a formal risk management analysis to identify, evaluate and treat flood risk;
- assessment of the effects of future development on flood hazard and behaviour on a cumulative basis;
- implementation of adopted measures in an effective and timely way, especially land use planning controls, and the floodplain management plan is incorporated into the relevant statutory planning instruments; and
- floodplain management plans need to be reviewed and updated regularly (for example, every 5-10 years).

Floodplain management study

The floodplain management study aims to identify all relevant issues, quantify them and weigh them appropriately into an overall plan by which the community is better off. These assessments require input from socioeconomic, environmental and land use studies. A land use study for this purpose might include existing land use, likely future land use, location of existing urban infrastructure services and any excess capacity therein.

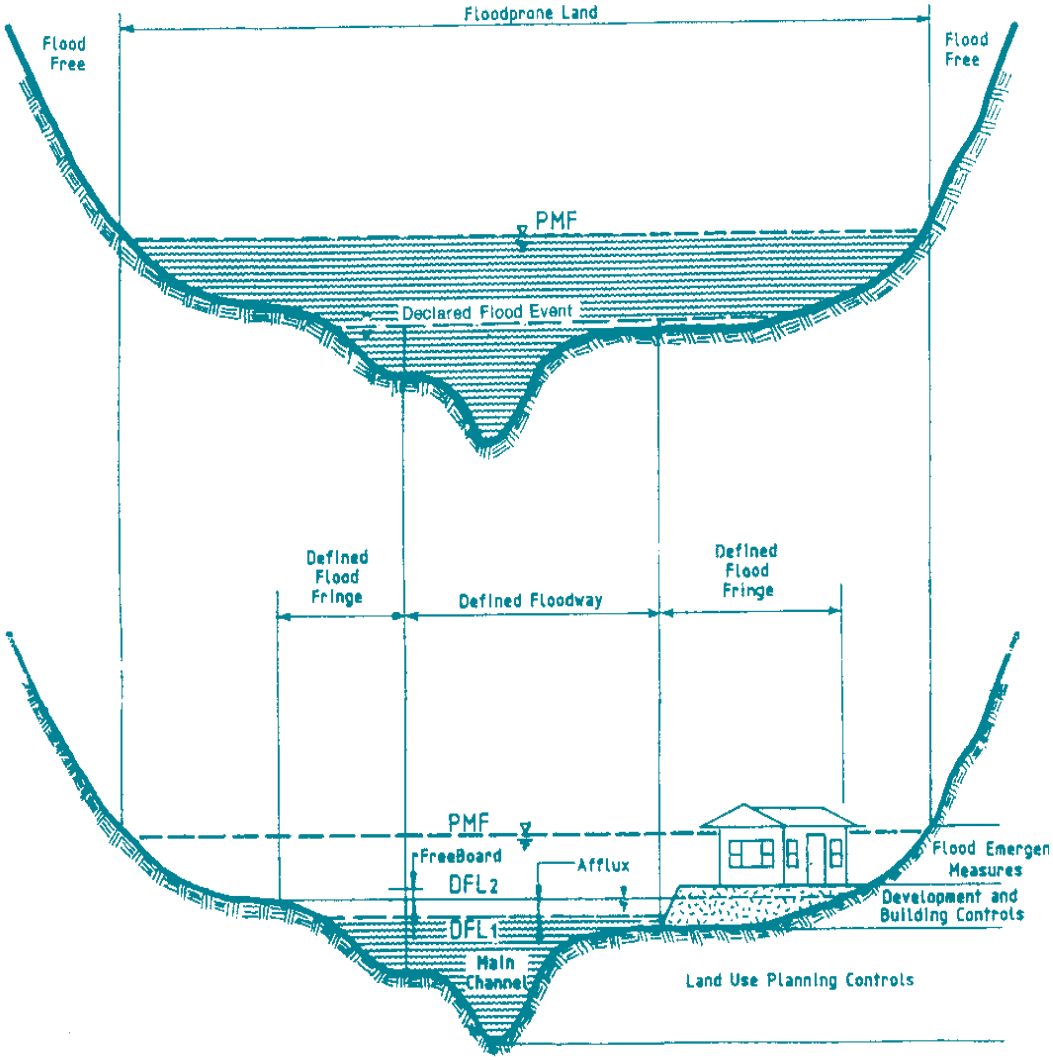
Defined flood events

An integral part of the floodplain management planning is to select a defined flood event (DFE). The adopted defined flood event determines the area of land subject to flood-related development and building controls and to some extent the nature of these controls (see Figures 8 and 9).

The figures illustrate the concept that different types of management measures are most appropriate to each area. So, for example:

- in defined floodway areas - land use planning controls;
- in defined flood fringe areas - development and building controls and flood emergency measures; and
- in flood-prone land outside the defined flood area - flood emergency measures (residual risk management).

Figure 8: Flood zones across the floodplain

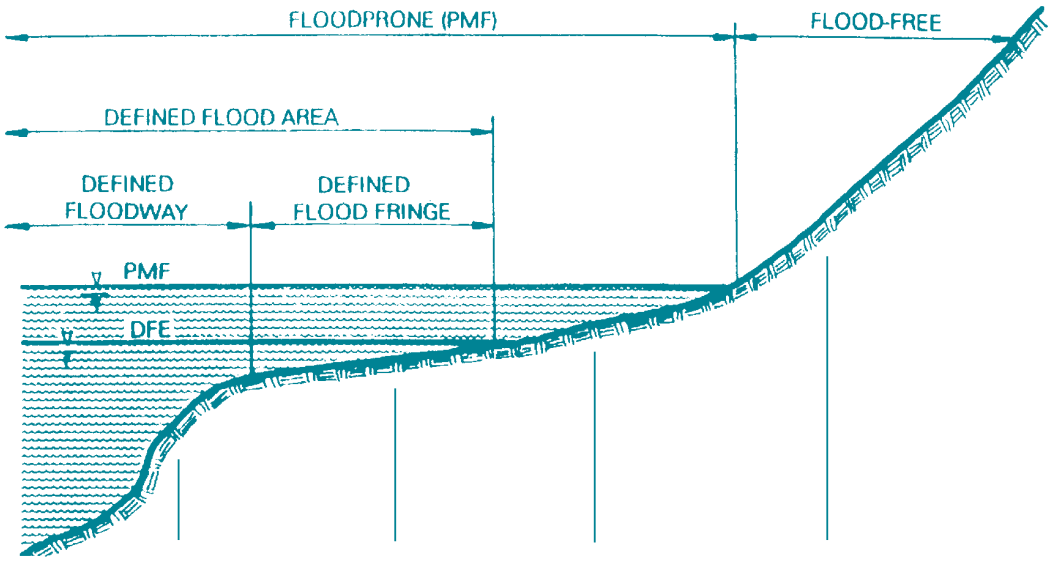


DFL1 :- Level of Declared Flood Event Before Filling of Flood Fringe

DFL2 :- Level of Declared Flood Event After Filling of Flood Fringe

PMF :- Probable Maximum Flood

Figure 9: Appropriate land uses across the floodplain



DEGREE OF HAZARD

Extreme	High	Medium	Low
Rural Recreation Open Space Environment	Rural Recreation Open Space Environment Commercial * Industrial * Clubs * * with special controls	Rural Recreation Open Space Environment Residential * Commercial * Industrial * Clubs * Schools * Public Institutions Caravan Parks Council Police * with special controls	Rural Recreation Open Space Environment Residential Commercial Industrial Clubs Schools Public Institutions Caravan Parks Council Police Telephone Exchange SES Hospitals Homes for Elderly Museums/Libraries

Land use planning controls and hazard

Land use planning controls are the most cost-effective floodplain management measure, particularly with respect to limiting the growth in future flood damage. The statutory planning process provides a suitable and effective vehicle for preparing floodplain management plans and for implementing their land use provisions.

The adopted land use for flood-prone land largely defines the resulting flood hazard. Careful matching of land use to flood hazard maximises the benefits of using the floodplain and minimises the risks and consequences of flooding. For example, the multiple uses of the most hazardous areas of a site, that is, where floodwaters flow fastest and deepest, for open space and recreation is generally appropriate. Residential use is appropriate for areas of low hazard risk, with special consideration for issues like:

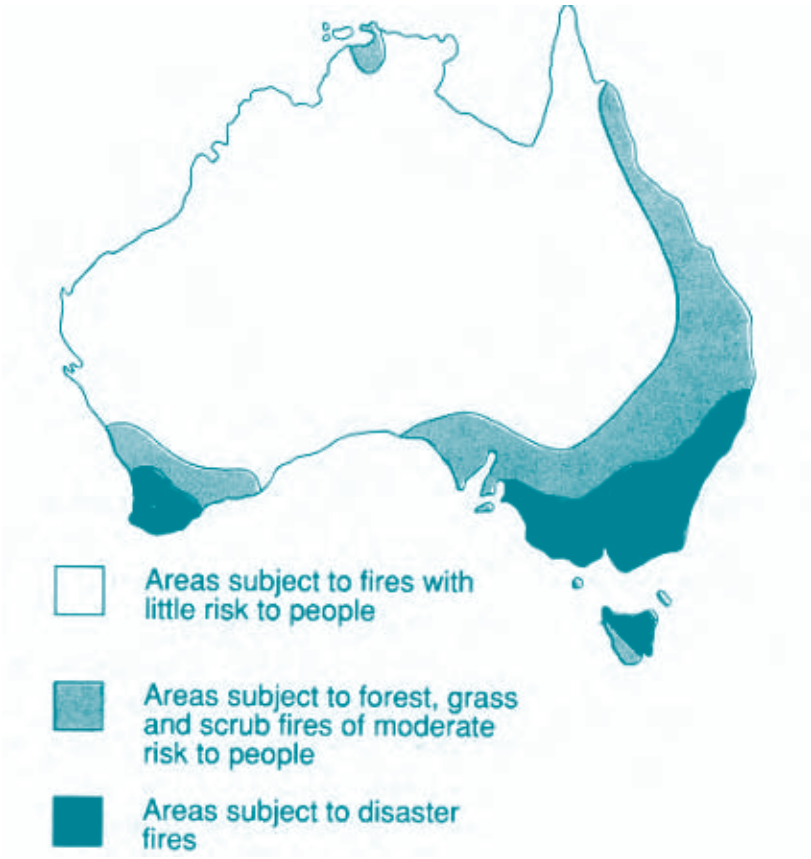
- housing for the aged and those with impaired mobility;
- obstruction to flow by residential development - housing clusters and terraces should be kept as far as possible from the floodway and on higher ground; and
- housing density - simply, the higher the density of population, the greater the potential property damage and social disruption caused by flooding.

BUSHFIRES

Background

Bushfires represent an ever-present risk to life, property and the environment in rural and urban fringe areas in Australia (see Figure 10). It would be ideal to have no development in or near bushfire-prone areas, however while there is increasing demand for rural and urban fringe residential land it remains likely that fire-prone areas will continue to experience development pressure. This in turn may lead to increased risk from bushfire.

Figure 10: Australian fire areas[27]



Bushfire behaviour

A number of factors affect bushfire behaviour. Topography is significant since fires will travel more quickly up a slope than down or across level terrain; topography can also significantly affect wind flow and direction. The type and amount of vegetation determines fuel loads which in part determines fire intensity. Weather is significant, with high temperature, strong wind and low humidity contributing to fire intensity and rate of burn.

The destructive processes are:

- burning debris, which may be blown long distances and start spot fires well in front of the fire line;
- radiant heat, which may fracture glass and ignite susceptible materials; and
- direct flame contact.

[27] Dolan, C 1995, *Hazard-Wise: Classroom Resources for Teachers on Natural Hazards and Disasters*. Emergency Management Australia, p. 15.

All may apply in severe fire conditions.

Approaches to bushfire protection

There are various risk treatment measures available, including:

- active defence measures, such as fuel and vegetation management and water supply provisions;
- maintenance of active defence measures; and
- appropriate land use planning strategies.

Land use planning

Land use planning strategies involve mapping of bushfire-prone areas and development control processes. Such planning may also incorporate building construction requirements and siting and access considerations.

Bushfire-prone area

The Australasian Fire Authorities Council defines a bushfire-prone area thus:

> A bushfire-prone area is an area that can support a bushfire or is likely to be subject to bushfire attack. For the purpose of implementing planning and building controls relating to habitable buildings, a bushfire-prone area is an area subject to attack by embers, radiation, direct flame or any combination thereof, based on a 1 in 50 year bushfire scenario, where the level of attack is sufficient to warrant bushfire related planning and bushfire controls.[28]

A bushfire planning system

The bushfire threat must be considered when planning any development in rural or urban fringe areas, whether or not it is a new development or an addition to an existing development. Developments are the end product of a planning process that involves the following steps.

Land capability analysis

Before any change in land-use zoning occurs, some form of analysis is needed to determine what types of development are appropriate for each area. A number of separate studies may be carried out including a bushfire assessment report. These studies examine the state of the land as it exists and the potential impact of the land on the development. Bushfire assessment reports need to focus on the level of hazard posed to the development by the land or adjacent land, and how that hazard may change as a result of the development.

The land capability analysis will usually contain:

- a land use table which sets out the types of development allowed in each zone — this may include a ban on development;
- a set of written development standards which place conditions on particular types of developments; and
- an accompanying map which shows the area of land included in each zone.

The land capability analysis should be repeated periodically.

[28] Australasian Fire Authorities Council position for *The Protection and Construction of Habitable Buildings in Bushfire Prone Areas* (undated).

Zoning plan

A land capability analysis may allow for preparation of a more detailed zoning plan which can be used to control any or all of:

- the staging of the development;
- the subdivision pattern;
- the road network;
- building envelopes; and/or
- buffer zones and setbacks.

Development approval

The zoning plans should identify all development categories likely to be affected by, or which will increase the risk of, bushfire and require consent for these developments. Because of the complexity of bushfire behaviour, whether this consent is given or not will depend on an assessment of the nature of the development and the adjacent hazard. Also, an assessment of bushfire hazard and protection of life and property are pertinent to the consideration of impacts on the environment, the suitability of the site for the development, and the public interest. A judgement must be made as to whether the proposed development should be approved and, if so, what conditions should apply.

The Building Code of Australia and AS 3959

The Building Code of Australia is a fully performance-based code which obtains its statutory power through various state and territory regulations. The Building Code contains both performance requirements and deemed-to-satisfy provisions relating to construction of buildings in bushfire-prone areas.

Australian Standard AS 3959 *Construction of buildings in bushfire-prone areas* is referenced by the Building Code as the deemed-to-satisfy construction standard for buildings in designated bushfire-prone areas. Application of AS 3959 therefore relies on identification of designated bushfire-prone areas.

Owner responsibilities

In addition to the application of planning controls, the owners of land should also be made responsible for ongoing vegetation management and maintenance of the property and its services. This is to ensure that the effectiveness of relevant bushfire protection measures is maintained. Responsibility is set with the owner through conditions on the development approval, which should be worded so they are enforceable.

Summary

Protection of life (including firefighters and emergency services personnel) and property from bushfire is considered under the planning system through a number of provisions. These include:

- land capability analysis provisions;
- zoning plan provisions;
- approval provisions; and
- control of construction standards

Vegetation management and property maintenance are also important in ensuring that life and property are adequately protected. This, however, is largely the responsibility of individual landholders.

Siting of buildings in bushfire-prone areas

There are a number of siting principles which need to be applied to individual allotments within a development in areas where a bushfire hazard exists. In addition to the development application stage, these siting principles need to be taken into account at construction stage, or when rezoning land.

In applying the points outlined below it is important to understand that:

- where these requirements refer to a particular direction (such as protecting the northern side), it applies only for isolated developments; for larger subdivisions, the importance of these measures is directed toward the side bearing the hazard; and
- although fires may tend to come from a particular direction, local variations are always likely and protection for the southern or eastern side of developments must never be overlooked.

Siting principles

- Avoid ridge tops.
- Avoid steep slopes, particularly upper slopes and narrow ridge crests.
- Avoid locations where adequate buffer zones cannot be provided within the property or subdivision boundary.
- Locate dwellings where vehicular access from two directions can be provided away from identified hazardous areas.
- Avoid building at the top of narrow gullies, which are natural chimneys.
- Surround isolated habitable buildings with a wide driveway of gravel, concrete, pavers, etc.
- Avoid building on slopes with a northerly to westerly aspect as these slopes are more prone to bushfires.
- Build on level ground wherever possible.
- Where buildings must be constructed on sloping land, they should be built on cut-in benches rather than elevated or above fill.
- Avoid raised floors in preference to concrete slabs.
- Locate the habitable buildings near the property entrance for easier access and egress.
- Keep services underground, particularly electricity.
- Locate water storage on-site and near buildings.

Building layout and shape

While specific building standards are covered by the Building Code of Australia and AS 3959, some general principles apply:

- Use simple designs that differ little from a basic rectangular shape; complicated plan forms increase wind turbulence and aid in trapping burning debris against the building.
- Buildings with elevated floors should have the opening between the floor and the ground sealed to prevent entry of burning debris.
- Large glass areas should be avoided, since glass shatters easily in conditions of fire attack.
- Low pitched roofs are less vulnerable to radiant heat, though this should be balanced against the need to avoid debris catchments.

The most vulnerable parts of a building are:

- the ground/wall junction;
- all penetrations of the wall, such as glazed doors, windows and vents;
- all penetrations of the roof, such as skylights, vents and eaves;
- timber decks or verandahs adjacent to glazed openings; and
- unenclosed sub-floor areas.

LANDSLIDES

Background

A landslide (or landslip) is a movement of a mass of rock, debris or earth down a slope. While the causes may be complex, all landslides result from a failure of part of the earth and rock materials that comprise the hillside or slope, with the slide driven by gravity. The failure takes place over a relatively short time frame. The displaced material mass may be large or small and it may move a large distance at a considerable speed.

Landslides are not as well recognised as some other hazards in Australia, but they do occur and have caused economic loss as well as death and injury. Indeed, the twelve months from September 1996 to August 1997 saw five landslides that killed 30 people and injured five others; they included nine deaths when a 14 metre limestone cliff collapsed at Gracetown (Western Australia) and the Thredbo (New South Wales) landslide that destroyed two chalets and killed 18 people.

Classification of landslides

Classification of landslides is important since the expected type of landslide will play a major part in determining the approach to reducing the risk.

Classification can be complicated but basically landslides are classified in two ways, where the first classification describes the material involved and the second describes the type of movement. The material types are rock, earth and debris, where debris is earth containing a significant proportion of coarse material. Movement is described as:

- **fall** — involving some movement through the air and possibly bouncing;
- **topple** — pivot on a base and fall outwards in one or more discrete pieces;
- **slide** — travel along a surface in a rotational or translational manner;
- **spread** — slighter movement over a larger area in a particular direction; and
- **flow** — movement of a liquid or semi-liquid material.

Material that has previously moved may be described as a rock fall or earth slide etc. Further, a complex landslide may combine different materials and movements. Finally, classification may include distribution (widening, channelled etc.), the rate of movement and water content (dry, moist, wet).

Natural slope instability features

Features that indicate existing natural slope instability include:

- **irregular surfaces** — area of hummocks and depressions indicating disturbed material;
- **benches** — anomalous flat areas in uniform sloping areas;
- **scars** — areas where vegetation has been stripped during slope movement;
- **scarps** — linear features showing vertical displacement of the ground surface;
- **cracks** — linear features showing lateral displacement of the ground surface;
- **debris mounds** — deposits of debris on or at the base of slopes;
- **disturbed vegetation** — for example, tilted trees; and
- **seepage** — presence of water or springs, possibly indicated by dense vegetation.

In developed areas, indications that movement may have occurred include cracking, breaking, tilting and/or subsidence of built features.

Hazard identification

The stability of sloping ground is controlled by three main factors:

- the angle of the slope;
- the stability and/or strength of the materials below the surface; and
- the level of water within the slope.

Hazard identification then involves an understanding of the slope processes and their relationship to the geology, hydrology, climate and vegetation of the area. It will then be possible to:

- classify the type/s of potential landslide;
- assess the change to the physical characteristics of the material under different levels of water saturation;
- assess the physical extent of the potential slide, including location, area and volume of material;
- assess the likely initiating events;
- estimate the anticipated travel distance and rate of movement;
- assess the possibility of a rapid process from which escape would be more difficult; and
- generate maps that illustrate the above features.

Frequency and consequence

It is important that the likelihood and/or frequency of landslide occurrence is estimated. This is a difficult process with a high level of uncertainty. A wide range of methods are used including observation and experience, physical investigation of the site, climate studies and examination of historical records.

Consequence analysis will include all the potential elements at risk which include:

- injury and/or loss of life; and
- damage to:
  – property;
  – services, such as water supply, drainage, electricity supply; and
  – roads and communications.

The vulnerability of each element should be included in the analysis.

Risk assessment and evaluation

The analysis of hazard, frequency and consequence enables risk assessment and evaluation to be completed. In property terms, the risk will mostly involve financial considerations, however the estimation of risk to life is more problematic, and in both cases some aspects of the process will be judgemental. The risk evaluation may see the allocation of a hazard rating, which in turn may set the level of acceptable or tolerable risk. An example of hazard ratings is:

- **very high hazard** — either the risk is too great, or extensive investigation, planning and implementation of treatment options is essential to reduce the risk to acceptable levels;
- **high hazard** — detailed investigation, planning and implementation of treatment options is essential to reduce the risk to acceptable levels;
- **moderate hazard** — may be acceptable provided a treatment plan is implemented to maintain or reduce the risk;
- **low hazard** — acceptable, possibly with a treatment plan implemented if deemed necessary; and
- **very low hazard** — acceptable, routine planning procedures apply.

Part of risk evaluation may involve hazard zoning based on hazard ratings.

Treatment plans

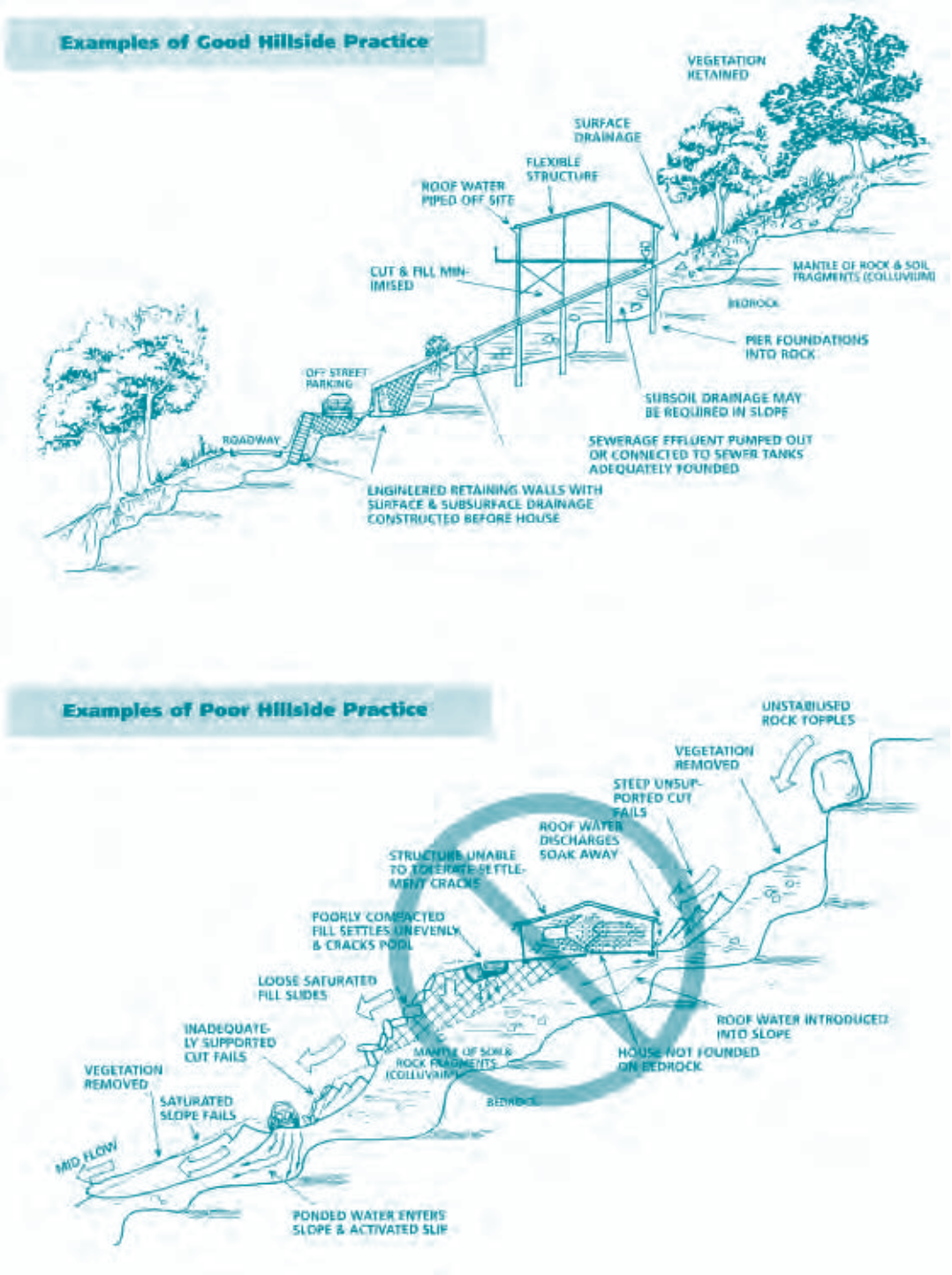
In general, treatment of landslide risk will involve reduction of likelihood or reduction of consequence. Reduction of likelihood involves stabilisation measures to control initiation, including:

- re-profiling the surface;
- groundwater drainage;
- anchors;
- stabilising or protective structures; and
- natural means such as re-vegetation (see Figure 11).

Reduction of consequence involves:

- provision of defensive or hazard amelioration structures; and
- relocation to a more favourable location.

Figure 11: Good and poor hillside practice[29]



[29] Gold Coast City Council (undated brochure). *Guidelines for control of slope instability within the City of Gold Coast.*

EARTHQUAKES

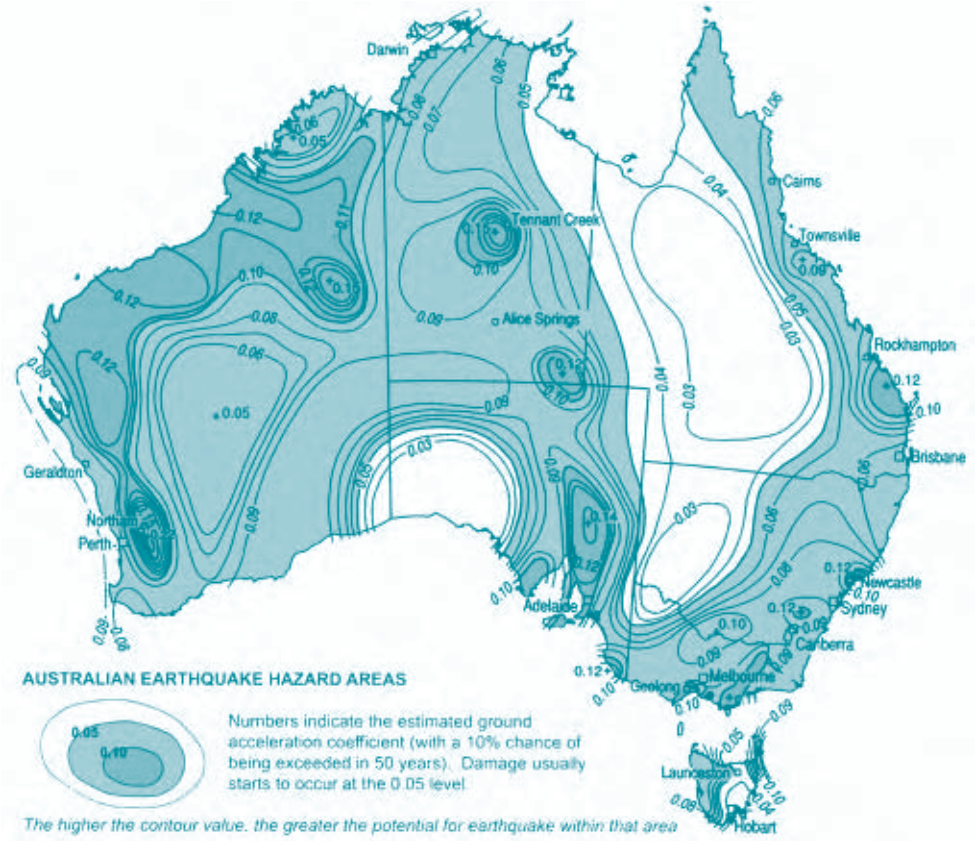
Background

Earthquakes occur when stresses in the earth exceed the strength of the bedrock to resist, with the result that the rock ruptures and displacement occurs along a surface called a fault. The fault may already exist and be known or the rupture may create it. Energy from the fault rupture is transmitted as seismic waves through the ground.

The intensity of an earthquake may be described by the Richter scale, which measures seismic wave amplitude. The scale is logarithmic so an increase in one Richter unit is approximately equal to an energy increase of 33 times. The Richter scale is generally used at the epicentre of the earthquake. Further away the severity of the earthquake effect may be expressed by the Modified Mercalli (MM) Intensity scale, which describes the strength of shaking in terms of building damage, soil disruption or failure, liquefaction and the degree to which it is felt by people.

Australia is well removed from the boundary between the Australian and Pacific tectonic plates. However strong earthquakes have occurred in Australia and they will occur in the future (see Figure 12). They do not need to be particularly intense to cause damage; the Newcastle earthquake was not the strongest recorded in Australia, but it took 13 lives and the total damage was estimated to be $1500 million.

Figure 12: Australian earthquake hazard areas[30]



[30] Emergency Management Australia & Australian Geological Survey Organisation 2001, (brochure), *Earthquake and Tsunami - Awareness for Australians.*

Earthquake hazard

The primary effects of earthquakes are fault rupture and ground shaking. The amount of movement involved in fault rupture depends on the severity of the stress applied to the fault and may range from a movement of some centimetres in a small area to a movement of metres over a very long distance. If the fault is well underground there may be no observed movement at the surface. However, if the fault is shallow or the earthquake severe enough the rupture may result in lateral ground displacement, ground cracking, ground subsidence or the formation of a cliff (scarp).

Though fault rupture is the primary effect of an earthquake, it is relatively limited in extent. The effect that causes most damage is ground shaking that radiates out from the rupture for a considerable distance. The severity of ground shaking at a site is dependent on a number of factors. These include the size of the earthquake, the type and direction of movement at the fault, the distance of the site from the epicentre and the type of soil through which the shaking travels. Ground shaking is a very complex phenomenon. The shock wave has components of different frequency and amplitude, while the soil through which the wave travels acts as a filter to the wave, either attenuating or amplifying components of the wave. Very generally, soft soils tend to amplify the wave whereas solid rock tends to attenuate it. The complexity of ground shaking makes risk analysis difficult.

Other primary effects include the possibility of landslide and, if the earthquake occurs at sea, a tsunami may cause significant damage on shore.

There are also secondary effects of earthquakes. These include:

- primary damage to the fabric of buildings and other structures such as bridges, ranging from minor damage to collapse;
- injury and loss of life;
- damage to critical infrastructure;
- damage to building contents, which may be serious if the structure is part of a community's critical infrastructure (hospitals, communications facilities, emergency services); and
- hazards resulting from damage (fire, gas, chemicals and other hazardous materials).

Vulnerability

Earthquakes threaten communities most through damage to constructed facilities. Earthquake vulnerability is a measure of the damage suffered by a structure subjected to shaking of a particular intensity. The dynamic response of a building to ground shaking is complex. Parameters include:

- the exact character of the ground shaking;
- the extent to which the building will respond to (be excited by) the shaking;
- the strength of materials in the structure;
- the quality of construction;
- the current condition of the structure; and
- the weight of contents in the structure.

Given the complexity of the hazard and the complexity of vulnerability, earthquake risk assessments or modelling is difficult.

Earthquake risk assessment

A generalised regional earthquake risk assessment process follows. It is based on the approach taken by Geoscience Australia in the Cities Project study, *Natural hazards & the risks they pose to South-East Queensland.*

Earthquake hazard model

An earthquake hazard model for the region should address the likelihood of an earthquake occurring in the region and where it is likely to occur. There are a number of sources of data, including AS 1170.4 - 1993 *Minimum design loads on structures - earthquake loads*, which contains earthquake maps, noting that there is a degree of uncertainty in the sources of data. The model should also account for local site effects and their effect on ground shaking. The site effects are largely due to near-surface conditions; an example may be classification into rock, thin sediment over rock and thick sediment over rock.

Property database

A property database should be prepared, with data supplied by local government agencies. The data should cover building construction, age and usage, with sufficient detail to enable assessment of damage likely to be suffered under different earthquake scenarios.

Earthquake scenarios

A number of earthquake scenarios should be run, with differing levels of intensity, in areas deemed most likely to suffer an earthquake. The scenarios should be used to determine loss estimates in terms of injury, loss of life and damage to built structures and the environment.

Risk treatment

Decisions about risk treatment measures will be based on the loss estimates for a particular site in a region. The decision will be based on two criteria: what loss would be tolerable, balanced against what would be the cost to reduce the risk. The decision should also take into account the types of structures concerned: residential buildings, private business, public buildings and, in particular, critical infrastructure (hospitals, transport, power, communications, emergency services etc.). The decision should address whether treatment measures are applied to new structures only or whether existing structures also need treatment and whether treatment should apply only to certain types of structure. Typical measures include hazard zoning and the application of building codes to new and/or existing structures in areas where the risk warrants it.

Summary

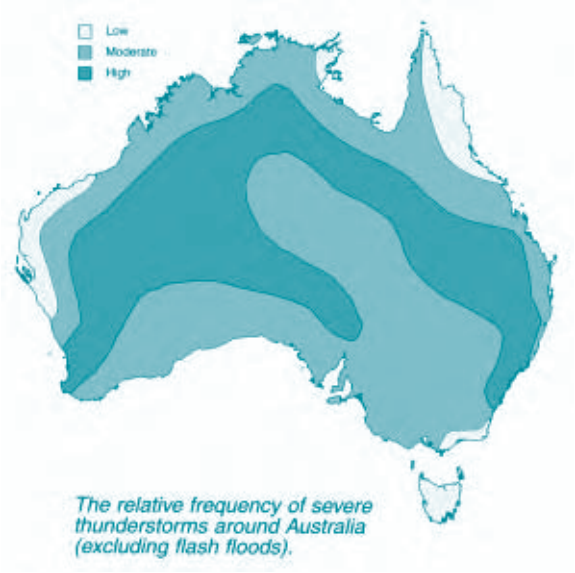
While the overall earthquake risk is relatively low in Australia, strong earthquakes have occurred and they will occur in the future, as evidenced by the event in Newcastle. Consideration of primary and secondary damage from earthquake must occur as part of the land use planning process.

SEVERE STORMS AND CYCLONES

Severe storms are localised events and their impact is often underestimated. However these storms are more common than any other natural hazard and occur anywhere in Australia (see Figure 13). Each year severe storms are responsible for more damage (as measured by insurance costs) than cyclones, earthquakes, floods and bushfires. Storms are also responsible for between five to ten deaths per year as a result of lightning strike, flying or falling debris, flash flooding and boat capsize. Despite common belief, tornadoes do occur in Australia and are equally damaging.

Protection against severe storms takes the form of structural protection, control of possible debris and personal protection measures, allied to warning systems. Land use planning plays a relatively minor role and is effectively limited to zoning controls for areas known to be prone to flash flooding.

Figure 13: Relative frequency of severe thunderstorms[31]



Tropical cyclones are intense low pressure systems which form over warm ocean waters at low latitudes; they occur annually in Western Australia, the Northern Territory and Queensland. Cyclones produce extreme winds which may exceed 200 kilometres per hour. These winds can cause extensive property damage and cause airborne debris to become potentially lethal missiles. The passage of the cyclone centre or 'eye' produces a temporary lull in the wind but this is replaced by extreme winds from another direction. Cyclones also produce flood rains which can cause further damage and death by drowning. The phenomenal seas accompanying cyclones are dangerous both for vessels out at sea and for those moored in harbours; serious erosion of the adjacent foreshore can also occur. Another marine phenomenon which can cause inundation of low lying coastal areas is the storm surge. This 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 occurs at the same time as a high tide the area inundated may be quite extensive.

Protection against cyclones takes the form of structural protection, control of possible debris and personal protection measures, as well as warning systems. Land use planning contributes to risk treatment by the application of zoning controls and building codes to areas assessed as prone to inundation by flood or storm surge.

[31] Emergency Management Australia & Bureau of Meteorology 2000, (brochure), *Severe Storms - Facts, Warnings and Protection.*

COASTAL EROSION

Coastal erosion and recession is a significant issue for land use planning, particularly given the large and rapidly growing coastal population.

Coastal erosion occurs under certain conditions of weather and sea; for example, strong south-east waves on the east coast. It need not be associated with a specific hazard, indeed it need not even be associated with a severe storm. Coastal erosion has two impacts; direct damage to, or destruction of, structures may occur as a result of the impact of waves; indirect impact occurs when the land beneath a structure is undercut by waves. A further problem results from the longer-term effects of such attacks, when the coastline recesses into developed areas, exposing structures that were remote from impact to direct or indirect attack. The risk is separate from pure water level damage that results from flood or storm surge.

Consideration of coastal erosion or recession is also important since it is one of the natural hazards that may increase in frequency and severity due to postulated sea level rise under climate change scenarios.

GLOSSARY

Acceptable Risk: that level of risk that is sufficiently low that society is comfortable with it. Society does not generally consider expenditure in further reducing such risks justifiable.

Annual exceedance probability: the likelihood of occurrence of a flood of a given size or larger, in any one year; usually expressed as a percentage.

Average recurrence interval: a statistical estimate of the average period in years between the occurrence of a flood of given size or larger. The ARI of a flood event **gives no indication** of when a flood of that size will occur next.

Biodiversity: The natural variety of life in all its forms, levels and combinations together with the environmental conditions necessary for survival. Biodiversity includes: regional diversity, ecosystem diversity, species diversity and genetic diversity.

BTE: Bureau of Transport Economics

Code: A document setting out the criteria and standards to be used in making decisions about the use and development of resources and in building design and construction.

CFS: Country Fire Service (Victoria)

Criteria: A means of judging whether or not objectives for use and development of land and/or resources have been met.

Defined flood event: the flood event selected for the management of flood hazard, as determined in floodplain management studies and incorporated in floodplain management plans.

Ecologically sustainable development: Using, conserving and enhancing natural resources so ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.

EMA: Emergency Management Australia

Emergency: An event, actual or imminent, which endangers or threatens to endanger life, property or the environment, and which requires a significant and coordinated response.

Emergency risk management: A systematic process that produces a range of measures that contribute to the wellbeing of communities and the environment.

Environment: Conditions or influences comprising built, physical and social elements, which surround or interact with the community.

Hazard: A source of potential harm or a situation with a potential to cause loss. In emergency risk management, a situation or condition with potential for loss or harm to the community or environment.

Mitigation: Measures taken in advance of a disaster aimed at decreasing or eliminating its impact on society and environment.

Monitor: To check, supervise, observe critically, or record the progress of an activity, action or system on a regular basis in order to identify change.

PBHA: potential bushfire hazard areas.

Preparedness: measures to ensure that, should an emergency occur, communities, resources and services are capable of coping with the effects.

Prevention: measure to eliminate or reduce the incidence or severity of emergencies.

Probable maximum flood: the largest flood that could conceivably occur at a particular location. The PMF defines the extent of flood-prone land.

Recovery: the coordinated process of supporting emergency-affected communities in reconstruction of the physical infrastructure and restoration of emotional, social, economic and physical well-being.

Resource: Anything that is used by people. A renewable resource can renew itself (or be renewed) either because it recycles quite rapidly (water), or because it is alive and can reproduce (organisms and ecosystems). A non-renewable resource is one whose consumption involves depletion.

Response: Actions taken in anticipation of, during and immediately after, an emergency to ensure that its effects are minimised, and that people affected are given immediate relief and support.

Risk: The chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood. In emergency risk management - a concept used to describe the likelihood of harmful consequences arising from the interaction of hazards, communities and the environment.

Risk analysis: A systematic use of available information to determine how often specific events may occur and the magnitude of their likely consequences. In emergency risk management - the systematic use of available information to study risk.

Risk evaluation: The process used to determine risk management priorities by evaluating and comparing the level of risk against predetermined standards, target risk levels or other criteria.

Risk reduction: A selective application of appropriate techniques and management principles to reduce either likelihood of an occurrence or its consequences, or both.

Risk treatment: selection and implementation of appropriate options for dealing with risk.

Stakeholder: Any person, institution, organisation, agency, department, authority, club, association or the like which has any interest in, or association with an area. This does not only mean a financial interest. It includes the public.

Statutory: Having the force of the law.

Storm surge: the difference between the actual water level under influence of a meteorological disturbance (storm tide) and the level which would have been attained in the absence of the meteorological disturbance (astronomical tide).

Vulnerability: The degree of susceptibility and resilience of the community and environment to hazards.

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