Australian Disaster Resilience Handbook Collection

2020

Land Use Planning for Disaster Resilient Communities

Australian Institute for Disaster Resilience

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AUSTRALIAN DISASTER RESILIENCE HANDBOOK COLLECTION

Land Use Planning for Disaster Resilient Communities

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Australian Disaster Resilience Handbook Collection

The Australian Disaster Resilience Handbook Collection provides guidance on national principles and practices for disaster resilience.

The Handbook Collection:

- provides an authoritative, trusted and freely available source of knowledge about disaster resilience principles in Australia
- aligns national disaster resilience strategy and policy with practice, by guiding and supporting jurisdictions, agencies and other organisations and individuals in their implementation and adoption
- highlights and promotes the adoption of good practice in building disaster resilience in Australia
- builds interoperability between jurisdictions, agencies, the private sector, local businesses and community groups by promoting use of a common language and coordinated, nationally agreed principles.

The Handbook Collection is developed and reviewed by national consultative committees representing a range of state and territory agencies, governments, organisations and individuals involved in disaster resilience.
The collection is sponsored by the Australian Government Department of Home Affairs.

Access to the Handbook Collection and further details are available on the Australian Disaster Resilience Knowledge Hub: **www.knowledge.aidr.org.au/handbooks**

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Contents

List of Figures

List of Tables

Executive summary

Australia has a history of high consequence natural hazards such as bushfires, cyclones, floods, storms, and extreme heat, resulting in suffering and loss in a range of direct and indirect ways. Effective land use planning in areas that are subject to, or potentially subject to, natural hazards can significantly reduce the increase in disaster risk and enhance the resilience of existing and future communities.

The *Land Use Planning for Disaster Resilient Communities* handbook focuses on land use planning for new development and its role in supporting disaster resilient communities. Land use planning that considers natural hazard risk is the single most important mitigation measure in minimising the increase in future disaster losses in areas of new development. Planning is a multi-objective process that requires balancing development with a range of community requirements and ongoing updating of appropriate planning tools. By considering natural hazards early and through its processes, land use planning can evaluate and select land use mechanisms to treat disaster risk. In particular, it can direct new development to suitable locations, avoiding or reducing the exposure to natural hazards and the impact of new development on the behaviour of natural hazards. To effectively consider natural hazards and manage their associated risks via land use planning, collaborative approaches across a range of sectors and capabilities are necessary, including land use planners, built environment professionals and developers, natural hazard and emergency managers, and community members and leaders.

The handbook introduces community wellbeing and disaster resilience as the overarching aim of land use planning and disaster risk reduction and outlines nationally agreed principles for land use planning for disaster resilient communities. The aim and principles provide the context for good practice in general as well as across the document. Significant natural hazards and their impacts in Australia are summarised, providing background information about the key concepts such as vulnerability, exposure and risk.

The handbook also presents a procedural framework for land use planning for disaster resilient communities. The framework can be applied across the decision-making process at the different levels of land use planning. Three levels of land use planning are described: legislative and regulatory framing; the plans for managing land use, and development and growth; and the ongoing land use planning and implementation processes. The main instruments and the process to develop and review them are outlined for each of these three levels. Lastly, limitations to land use planning capacity for disaster resilient communities and some ways forward are presented.

This handbook is available on the Australian Disaster Resilience Knowledge Hub:
www.knowledge.aidr.org.au/resources/handbook-land-use-planning

For feedback and updates to this handbook, please contact AIDR: **enquiries@aidr.org.au**

How to use this handbook

Purpose

This handbook outlines nationally agreed principles for good practice in land use planning to build disaster resilient communities. Effective land use planning requires input from a broad range of stakeholders including: urban and regional planners, hazard leaders, developers, communities, businesses, local government, emergency services, state and territory government agencies, and other stakeholder groups that rely on, influence and deliver elements that are essential to community wellbeing and resilience. It also requires ongoing attention to the development and updating of appropriate planning tools and their application over time, taking account of the context in which land use planning is occurring. The handbook focusses on how land use planning for new developments can be undertaken collaboratively to effectively consider natural hazards and manage their associated risks. It is intended to guide and assist a range of stakeholders including:

- natural hazard and emergency managers – to build capability in and understanding of the role of land use planning in natural hazard risk management
- land use planners, built environment professionals and developers – to build awareness of and capability in engaging with natural hazard and emergency managers and to integrate consideration of the risks of natural hazards into the planning process
- community members and leaders – to provide understanding of the reasons for and main mechanisms of risk management in land use planning in their communities and the interdependencies between diverse actors' decisions as these relate to natural hazard risks.

Context

Land Use Planning for Disaster Resilient Communities is part of the Australian Disaster Resilience Handbook collection. It fulfils a critical role in national resilience under the policy framework established by the *National Strategy for Disaster Resilience* (Council of Australian Governments (COAG) 2011).

The handbook reflects increasing national and international focus on the need to reduce disaster risk and build disaster resilience, as considered in the *National Disaster Risk Reduction Framework* (Australian Government Department of Home Affairs 2018) and *Profiling Australia's Vulnerability* (Australian Government Department of Home Affairs 2018).

The handbook was developed from a review of *Manual 7: Planning Safer Communities: Land Use Planning for Natural Hazards* (EMA 2002), which focused on risk reduction at the interface between communities and the natural environment and integrating risk reduction into the land use planning process. The Planning Institute of Australia's (PIA) *National Land Use Planning Guidelines for Disaster Resilient Communities* (2015) along with the range of other AIDR handbooks and supporting documents has also been considered in the development of this handbook.

This new handbook addresses changes to land use planning and the broader issues that have emerged and that are understood more clearly since the publication of the Manual in 2002. These include improved understandings and advances in the areas of:

- the nature of the risks of natural hazards
- improvements in natural hazard information
- changes in technology that facilitate improved information and its sharing
- improved risk assessment techniques, the treatment of risks in communities, and
- scenario modelling.

This handbook also sets out principles for a strategic planning process and describes land use planning in a more integrated way.

Scope

This handbook is limited to consideration of the impacts of natural hazards and the value of land use planning in new developments. It does not include consideration of land use planning in the context of existing developments or disasters which are caused by human, economic or biological causes – even while their importance is recognised.

Natural hazards considered in this handbook include:

- urban fire and bushfire
- flood
- severe storm
- coastal erosion
- cyclone
- tsunami
- extreme heat
- earthquakes.

The handbook does, however, recognise the interconnected and overlapping nature of land use planning for new and existing developments, including the wider systems that communities rely on.

Chapter 1: Introduction to land use planning for disaster resilient communities

This chapter introduces land use planning as a way to promote community resilience to the impacts of natural hazards. It refers to the role of land use planning for building disaster resilient communities and community wellbeing. It presents a set of nationally agreed principles for land use planning for disaster resilient communities. It does not replace more detailed state or local initiatives or activities.

1.1 Why land use planning for community resilience?

This section introduces community wellbeing as a core objective of land use planning and outlines the conceptualisation of disaster resilient communities, emphasising the role of land use planning for supporting them.

1.1.1 Community wellbeing

The safety and protection of human life and wellbeing of communities, and the wider systems that support them in their various forms, is the core objective of land use planning for disaster resilient communities. Communities are a combination of built, natural, economic and human elements, and exist in diverse forms from high-density city centres, to suburban, rural or more "natural" forms. Communities include complex sets of functions that provide for a range of needs and are interconnected with economic, social and environmental systems. Importantly, many of these systems are not under the direct control of land use planning. Across this diversity of settings, natural hazards, including flood, storm, cyclone, bushfire, and extreme heat can pose risks to communities. These risks can vary with both the exposure of the community to the hazard and the vulnerability of the community to the hazard.

Defining communities

This handbook works with the following definition of a community:

'A social group with a commonality of association and generally defined by location, shared experience, or function and with a number of things in common, such as culture, heritage, language, ethnicity, pastimes, occupation, or workplace'

(AIDR Glossary 2019)

1.1.2 Disaster resilient communities

Several organisations have described the characteristics of resilient communities and resilient systems, including: United Nations Office of Disaster Risk Reduction (UNDRR), Australian Institute for Disaster Resilience (AIDR), Intergovernmental Panel on Climate Change (IPCC), and 100 Resilient Cities. This handbook follows the UNDRR (2017) definition of resilience, which associates resilience with communities' capacity to resist and adjust to hazard impacts. Furthermore, it understands disaster resilient communities as defined by the *National Strategy for Disaster Resilience* (COAG 2011), which states that a **'disaster resilient community is one that works together to understand and manage the risks that it confronts'** (p.iv), supporting disaster resilience as a collective responsibility shared by all sectors of society.

Defining resilience

This handbook works with the following definition of resilience:

Resilience is 'the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management'.

(UNDRR 2017)

Land use planning is presented in the *National Strategy for Disaster Resilience* (COAG 2011) as an important element of shaping disaster resilient communities alongside a range of other interacting qualities, including that:

- People understand the risks that may affect them and others in their community. They understand the risks assessed around Australia, particularly those in their local area. They have comprehensive local information about hazards and risks, including who is exposed and who is most vulnerable. They take action to prepare for disasters and are adaptive and flexible to respond appropriately during emergencies.
- People have taken steps to anticipate disasters and to protect themselves, their assets and their livelihoods, including their homes and possessions, cultural heritage and economic capital, therefore minimising physical, economic and social losses. They have committed the necessary resources and are capable of organising themselves before, during and after disasters which helps to restore social, institutional and economic activity.
- People work together with local leaders using their knowledge and resources to prepare for and deal with disasters. They use personal and community strengths, and existing community networks and structures; a resilient community is enabled by strong

social networks that offer support to individuals and families in a time of crisis.

- People work in partnership with emergency services, their local authorities and other relevant organisations before, during and after emergencies. These relationships ensure community resilience activities are informed by local knowledge, can be undertaken safely, and complement the work of emergency service agencies.
- Emergency management plans are resilience-based, to build disaster resilience within communities over time. Communities, governments and other organisations take resilience outcomes into account when considering and developing core services, products and policies. They are adaptive and flexible to respond appropriately to disasters.
- The emergency management volunteer sector is strong.
- Businesses and other service providers undertake wide-reaching business continuity planning that links with their security and emergency management arrangements.
- Land use planning systems and building control arrangements reduce, as far as is practicable, community exposure to unreasonable risks from known hazards and suitable arrangements are implemented to protect life and property.
- Following a disaster, a satisfactory range of functioning is restored quickly. People understand the mechanisms and processes through which recovery assistance may be made available and they appreciate that support is designed to be offered, in the first instance, to the most vulnerable community members.

As a result, the ongoing development and management of communities is not the domain of one agency or group but rather a shared responsibility. Individuals, communities and interest groups, education providers, local government, state agencies, business organisations and others all play significant roles in the ongoing development of communities. Both exposure and vulnerability of communities to the impacts of natural hazards vary across the area of influence of the hazard and across the communities. Resilience to natural hazards is therefore not a static characteristic in a community. Rather, it is unevenly spread across the physical landscape, amongst people, physical structures and the various systems of individual and group support and upon which they rely.

1.1.3 The role of land use planning for promoting disaster resilient communities

The shared responsibility of resilience

Disaster resilience and risk reduction is a shared responsibility, but often not equally shared. While individuals and communities have their roles to play, they do not control many of the levers needed to reduce some disaster risks. Governments and industry in particular must take coordinated action to reduce disaster risks within their control to limit adverse impacts on communities. More than ever, limiting the impact of disasters now and in the future requires a coordinated effort across and within many areas including land use planning, infrastructure, emergency management, social policy, agriculture, education, health, community development, energy and the environment.

(*National Disaster Risk Reduction Framework*, Australian Government Department of Home Affairs 2018)

Land use planning is widely recognised as an important measure for limiting future vulnerabilities and losses in areas of new development and a critical element for building disaster resilient communities. The location and design of buildings, houses, parks and other physical features play multiple roles, providing shelter, transport, places of business, health and education, to name just a few. The physical design and layout of communities and settlements are central to the many functions that sustain the social, economic and environmental support systems upon which we all rely. Land use planning provides the opportunity to manage the growth in risk resulting from new development by limiting or modifying the location of new development and influencing its layout. This can limit both the impacts of new development on natural systems, ecosystem services and hazards and the flow on impacts on the existing community, as well as limiting the impacts that natural hazards can have on new development and its users. The physical location of new development in an area exposed to natural hazards, however infrequent, will generate risks to the community from natural hazards.

When used effectively, land use planning governs the future use of land and influences where development may occur and the types of assets and infrastructure that can be developed. This i ncluding the range of systems that support communities, such as protection of vegetation, agriculture, roads and transport, provision of infrastructure and interactions with other community goals such as retention of heritage, provision of community facilities and economic prosperity. In doing so it can also influence the exposure and vulnerability of communities to the risks of natural hazards over long periods of time.

Placement of communities, infrastructure and assets

Collective planning decisions to place housing, infrastructure and assets in particular locations include considering different factors of benefit to different groups, such as: ensuring equitable access to affordable housing; providing high quality and safe housing and infrastructure; providing enjoyable life experiences (i.e. for a growing population); or providing an economic return (i.e. to the building industry or to real estate developers). These factors cannot always be reconciled with one another, and trade-offs need to be made to prioritise some factors over others. Many of these trade-offs are embedded in processes that incentivise certain decisions about the zoning of areas, in the scoping and planning stages of land-use developments, or during the design, construction, sale and management of infrastructure assets.

(*Profiling Australia's Vulnerability*, Australian Government Department of Home Affairs 2018)

Effective land use planning recognises and works within the context of a range of complex interacting factors and pressures that can influence the resilience of communities. A summary of these factors is presented below:

- Communities are dynamic and changing at different rates – this is all part of the risk landscape.
- Many previous decisions, which enabled development and building in exposed areas are challenging to reverse or remediate without incurring substantial cost and involving decision making for policy makers that may be very difficult and unpalatable to the recipients (for example, the temporary housing planning exemptions in fire affected areas of Victoria after the 2009 bushfires).
- In Australia, some areas are faced with considerable growth pressures. This places stresses on the ecological foundations of natural systems and hazards faced by our communities. Combined with climate change projections, this continues to influence risk landscapes over time.
- New development in communities often has impacts on the physical characteristics and /or processes of natural systems and hazards that can increase risks to the existing community or can transfer risks to adjoining communities. For example, blocking flood conveyance areas can force water flows to behave differently that can have impacts elsewhere in the community or to adjoining communities. It can also create extra demands and need for infrastructure and for support from emergency services.
- Communities function and interact in various ways with other settlements and wider systemic issues. Accordingly, risk is influenced by wider decisions such as road system changes or deficiencies, telecommunications systems, locations of community facilities, protection of natural systems such as vegetation and habitat or concentration of poverty or social inequity.
- Land use planning systems are intended to support a wide range of goals, including limiting the growth of risk through exposure to natural hazards, while supporting the sustainability of ecosystems. This means that trade-offs involving other goals may influence and modify attitudes to risk.
- Levels of understanding, knowledge and risk acceptance within communities vary significantly at any one point in time and over time. This includes technical, political, procedural and moral dimensions and may challenge the quality of decision making. For example, developers that on sell property, governments that set standards and the community that use the development and have to live with the consequences will all have different motivations and therefore appetites for risk, which also changes over time.
- There is a tendency for funding and action to focus on particular hazards or certain aspects of risk management such as response and this may undermine more effective long-term action based on information and hazard modelling or careful forward-oriented land use planning considering natural hazards.
- Wider processes of governance are often difficult to coordinate and may operate in non-complementary ways. While consultation and integration processes take time, they result in higher quality decisions in the long term.
- Many aspects of community resilience are not obviously directly linked to a particular hazard's risk factors. However, strong connectedness, prosperity, care for disadvantaged groups and strong social outcomes through various aspects such as education, service provision, local sporting or volunteer organisations contributes to resilience.

Benefits of focusing on disaster resilience in land use planning

A focus on disaster resilience means planners, hazard leaders, emergency managers and other built environment professionals can contribute to:

- understanding and anticipating risks before they happen and developing more resilient land use and built form tailored to address those risks
- minimising the increase in risks to people and disruptions to social and economic functions when a disaster strikes
- translating learnings from post-disaster recovery to improve settlements and assist communities over time to be more resilient.

(Derived from *National Land Use Planning Guidelines for Disaster Resilient Communities*, PIA 2015)

1.2 Overarching policies for land use planning in disaster resilience

Under the Australian Constitution, state and territory governments are responsible for land use planning and associated development regulation. Nevertheless, an overarching suite of contemporary international and national policies or agreements outline the important and integrated role land use planning plays in building disaster resilient communities. These national policies or international agreements include:

- The *Sendai Framework for Disaster Risk Reduction 2015-2030* (UNDRR 2015), known as the Sendai Framework, aims to achieve the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years. For more information see: **www.unisdr.org/we/coordinate/sendai-framework**
- The *National Disaster Risk Reduction Framework* (Australian Government Department of Home Affairs 2018) outlines a national, multi-sector collaborative approach to proactively reducing current and future disaster risk within a five-year time frame. Decisions related to land use planning are implicit throughout the DRR Framework and specifically highlighted in National Priority 2: Accountable decisions. For more information on the DRR Framework, see: **www.knowledge.aidr.org.au/collections/disaster-risk-reduction/**
- *Profiling Australia's Vulnerability: The interconnected causes and cascading effects of systemic disaster risk* (Australian Government Department of Home Affairs 2018) examines the relationship between our values and our vulnerabilities and aims to understand how Australians can collectively prioritise efforts to reduce loss and harm. Factors that impact on resilience – such as climate change, demographic shifts and reliance on interconnected systems and infrastructure – are addressed throughout the report. It is based on the premise that hazards only lead to disaster if they intersect with an exposed and vulnerable society and when the consequences exceed people's capacity to cope. For more information on Profiling Australia's Vulnerability, see: **www.knowledge.aidr.org.au/collections/disaster-risk-reduction/**
- The *National Strategy for Disaster Resilience* (COAG 2011) provides the basis for governments to shift from the traditional emphasis of response to and recovery from emergencies to one which emphasises the need for a greater focus on prevention, mitigation, preparedness and building capability. The strategy is guided by the principle of shared responsibility and acknowledges that all levels of government and other stakeholders have a role to play in driving systemic change for greater disaster resilience in Australia. For more information on the strategy, see: **www.knowledge.aidr.org.au/resources/national-strategy-for-disaster-resilience/**

1.3 Principles for land use planning for disaster resilient communities

1	**Prioritise life and relief of suffering:** Land use planning is a multi-objective process. A genuine attempt to consider the current and future risk implications of planning decisions prioritises the protection and preservation of human life of existing and new communities over all other considerations. This also includes considering the protection of emergency responders.
2	**Sustainability:** Risk avoidance, limitation of growth in risk, and reduction is a fundamental subset of overall sustainability. This means that land use planning must seek to ensure that cities, towns and regions can sustain and improve their functions over time, including avoiding, limiting and withstanding the impacts of the full range of risk associated with natural hazards. This also recognises the need to respect and maintain the natural systems upon which human systems rely in land use planning processes, in tandem with the recognition that sustainable economic, social and environmental sustainability are linked with improved resilience.
3	**Pursue resilient, sustainable and liveable communities:** Planning decisions are to support improvements to resilient, sustainable and liveable communities, and to minimise the effects of socioeconomic inequalities on vulnerable members of the community.
4	**Support the preservation, maintenance and enhancement of functional natural systems/ ecosystems:** Planning decisions are to support the preservation, maintenance and where possible enhancement of functional natural systems / ecosystems. Human systems rely on and are ultimately subservient to natural systems, even though we may damage and affect them. Decision criteria and mechanisms to support this are in place to ensure the intensification of development is compatible with the natural hazard potential and functionality of natural systems.
5	**Recognise that some land may be unsuitable for certain activities or development:** Planning decisions are to recognise that not all land is suitable for intensification of development and not all development types are viable at a particular location. Decision criteria and mechanisms to support decision-making based on hazard information are to be in place to ensure the intensification of development is compatible with the risk profiles of natural hazards to both existing and future development and its users.
6	**Consider cumulative impacts of changes in development and demographics:** Land use planning processes are to consider the cumulative effects of new development on both the demographics of the community and on the behaviour of natural hazards and their impacts on both the risks of natural hazards to the existing community and the emergency response of the existing community.

7	**Consider how natural hazards vary with climate change for an appropriate planning horizon for development decisions:** Planning decisions need to build in consideration of how natural hazards vary with climate change within the planning horizon related to the development decision. Forward planning for the consideration of climate change impacts on natural hazards is the best approach to mitigate these risks on communities. The distinction between a planning horizon and the horizon of the hazard assessment needs to be considered in the decision-making processes.
8	**Promote multidisciplinary collaboration:** Risk management in communities requires coordinated and integrated action across a range of sectors and capabilities. Land use planning needs to be supported by reliable expert information on natural hazards and where possible relies on processes that draw on a diversity of stakeholders, views and capabilities. Management of natural hazards and protecting ecological processes and sustainability can be mutually beneficial if Principle 9 is utilised.
9	**Consider natural hazards early in and throughout land use planning processes:** All land use planning processes, starting with strategic planning are to consider the management of natural hazard risks to the community. Land use planning is to consider the full range of risks from natural hazards early in the planning processes, particularly by directing new development to suitable locations to avoid or reduce the exposure of new development to natural hazards and the impact of new development on the ecosystems and their behaviour as natural hazards.
10	**Support evidence-based land use planning processes, risk assessment and scenario testing:** Land use planning processes are underpinned by a range of information to support decisions based on risk. Scenario testing and appropriate decision support tools are to be used where possible. These processes are to include deliberate data capture for information considering: • information specific to different natural hazards and how they may vary between events of different scales and across the geographic locations in a range of scenarios. • data analysis linked to an understanding of dynamic change (e.g. social and demographic change, changing risk factors etc.), external factors, identification of a range of risk scenarios, and risk acceptance alternatives.
11	**Use the full range of risk treatment mechanism options prioritising avoiding risks:** Land use planning is to use the full range of mechanisms available to treat disaster risk, emphasising forward and strategic planning. These include: avoidance or reduction of exposure and reduction of vulnerability. These measures can reduce impacts upon development and the impacts of new development upon natural systems, and impacts to the community.
12	**Monitoring and review of land use planning decisions:** Strategic land use planning should include ongoing monitoring and review of the effectiveness of plans in managing the growth of the impacts of natural hazards on the community.

Chapter 2: The need to deal with natural hazards and disaster risk

This chapter addresses natural hazards and disaster risk. It provides an overview of the impacts of natural hazards in Australia. It presents the relationship between natural hazards and disaster risk, emphasising that, among other factors, land use planning seeks to limit the growth in risks. Land use planning takes opportunities to reduce systemic vulnerability and changing exposure patterns to improve disaster resilience. The chapter summarises key natural hazards in Australia, their associated risks and impacts on communities. Lastly, it introduces actions to reduce disaster risk outlined in the *National Disaster Risk Reduction Framework* (Australian Government Department of Home Affairs 2018).

2.1 The impacts of natural hazards in Australia

This section provides an overview of natural hazards in Australia and their impacts.

Natural hazards can have a significant impact on Australian communities and result in suffering and loss in a range of direct and indirect ways. Losses associated with natural hazards include:

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

A report commissioned by the Australian Business Roundtable for Disaster Resilience and Safer Communities (2017) quantified the total economic cost of disasters caused by natural hazards in Australia over the 10 years to 2016 as $18.2 billion per year, equivalent to 1.3 per cent of average Gross Domestic Product (GDP). This cost factors in: tangible physical costs, which include emergency response efforts and damage to property and infrastructure; indirect tangible costs, which include flow on effects to businesses and network disruptions; and Intangible costs, which capture death, injury and a range of long-term interconnected social impacts.

This cost is considered a conservative estimate as there is a range of unquantified impacts. It is forecast to more than double in real terms to $39 billion per year by 2050, which reflects the impact of population growth, concentrated infrastructure density, and increased development in more vulnerable locations in Australia.

The cost of natural hazards in Australia

The total economic cost of disasters associated to natural hazards in Australia over the 10 years to 2016 averaged $18.2 billion per year, equivalent to 1.3% of average Gross Domestic Product (GDP). This cost is forecast to more than double in real terms to $39 billion per year by 2050.

(Australian Business Roundtable for Disaster Resilience and Safer Communities 2017)

2.2 Natural hazards, vulnerability, exposure and risk

This section distinguishes hazards from disasters and presents the relationship between them. It introduces key concepts and their connections: natural hazard, disaster, vulnerability, exposure and disaster risk.

2.2.1 Natural hazards & disasters

Natural hazards are processes or phenomena that may have impacts resulting in loss of life, injury, damage and disruption. Natural hazards are part of Australia's landscape and they include bushfire, floods, cyclones, storms, coastal erosion, heatwaves, earthquakes and tsunamis.

Disasters are serious disruptions of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic or environmental losses and impacts (*National Disaster Risk Reduction Framework* 2018).

The *National Disaster Risk Reduction Framework* (2018) frames the relationship between natural hazards and disasters in the following way 'Natural hazards trigger disasters when they impact what people value'.

When do natural hazards lead to disasters?

It is important to note that natural hazards only lead to 'disaster' if they intersect with an exposed and vulnerable society (interrupting these systems) and when the consequences exceed people's capacity to cope. Such vulnerability is, in part, the result of the conscious and unconscious decisions that have been made and continue to be made about where and how we live our lives, where and how we build our homes and communities, and the placement and effectiveness of the critical infrastructure that supports them.

(*Profiling Australia's Vulnerability*, Australian Government Department of Home Affairs 2018)

2.2.2 Vulnerability and exposure

Vulnerability is defined as 'the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, community, assets or systems to the impacts of hazards (*National Disaster Risk Reduction Framework* 2018). It 'arises from the relationships that we have with the things we value (people, places, objects, critical services, emergency services, etc.) and how these things may be disrupted as a result of an emergency or crisis' (Australian Government Department of Home Affairs 2018). Factors that increase the potential for community to be vulnerable when exposed to natural hazards include: population growth, demographics and socio-economics, isolation by hazards and remoteness from emergency services, language and mobility issues, and vulnerability of key community infrastructure to hazards.

Exposure refers to the people and things in the path of potential hazards. Many cities and settlements in Australia are located in areas of high hazard exposure.

Profiling Australia's Vulnerability (Australian Government Department of Home Affairs 2018) identifies that people and assets are most susceptible to impact when they have been physically placed in hazard-prone areas, and when structures and settlements have not been built to building standards and codes that consider contemporary and anticipated disaster risk reduction. The boxes below provide more details on what makes us vulnerable from the perspective of the placement of communities, infrastructure and assets.

Importantly, reducing systemic vulnerability and changing exposure patterns – among others, through land use planning – build disaster resilience and limit the growth in risk to the community of natural hazards as the community expands.

2.2.3 Disaster risk

Disaster risk is defined by the UNDRR as 'the potential loss of life, injury or destroyed or damaged assets that could occur to a system, society or community'. The *National Disaster Risk Reduction Framework* (Australian Government Department of Home Affairs 2018) refines this definition and recognises that 'disaster risk is a product of hazard (a sudden event or shock), exposure (the people and things in the path of potential hazards), vulnerability (the potential for those people and things to be adversely impacted by a hazard) and capacity (the ability for those people and assets and systems to survive and adapt)'.

Existing vs future risks

It is important to distinguish between existing and future risk. Existing risks are risks to the existing community and built environment that exist due to the legacy of past decisions. Future risks are the risks that will be created due to changes such as the cumulative impacts of new development in areas affected by natural hazards and climatic changes (Principle 6 of this Handbook). This can involve risks to the new development and the expanding community in addition to growing risks to the existing community due to the impacts of new development and its users and climate change on natural hazards and emergency response.

What makes us vulnerable?

From the perspective of the placement of communities, infrastructure and assets, what makes us vulnerable include:

- People and assets in hazardous areas.
- Standards for building assets and infrastructure no longer adequate for location and likely hazard.
- Regulatory authority and controls that are no longer adequate.
- Risks created and transferred to others.
- Economic benefits prioritised higher than safety.
- Limited capacity to understand and communicate what is at risk.

(*Profiling Australia's Vulnerability*, Australian Government Department of Home Affairs 2018)

2.3 Summary of natural hazards and their risk drivers for Australia

This section summarises key natural hazards in Australia, their associated risks drivers and impacts on communities. When appropriate, natural hazards summaries include a description of the likely influences of climate change.

2.3.1 Bushfires

Bushfires are a natural, essential and complex part of the Australian environment and have been for thousands of years. During most summers, Australia will experience a significant bushfire event that can devastate lives, the environment and impact on the suburban fringes of major cities (AIDR Glossary). Climate change is associated with more dangerous bushfire conditions in some regions, particularly in southern and eastern Australia. Several studies show that fire seasons are starting earlier and finishing later.

Immediate risk drivers	Structures and people are impacted by direct flame, radiant heat, embers, fire-driven winds.
Wider risk drivers	• Lack of planning and building regulation and enforcement • Inadequate vegetation management • Lack of community understanding and action • At risk community factors, unemployment, socioeconomic status.
Direct consequences	Loss of life and injury, structures damaged and destroyed.
Wider consequences	Economic impacts and reduced productivity, disruption of communities' functioning and reduced quality of life.

2.3.2 Flooding

Floods are a natural part of the Australian environment. They result from flood producing rainfall events over the catchments of local waterways or rivers. They can be influenced by structures in the floodplain and by the water levels in receiving waters, including sea levels in oceans. They are also influenced by the degree of development in both catchments and floodplains. Floods are episodic and the scale of and time between flood producing rainfall events can vary substantially.

Floods can have both positive and negative impacts on communities. They can bring welcome relief for people and ecosystems suffering from prolonged drought, but also are estimated to be the costliest disaster in Australia (AIDR Glossary). Flood behaviour is influenced by climate change due to changes in flood producing rainfall events and due to the influence of sea levels in the receiving waters of coastal catchments, which can include the ocean and coastal lakes. For more information refer to *Managing the Floodplain* (AIDR 2017) **www.knowledge.aidr.org.au/resources/handbook-managing-the-floodplain**

Immediate risk drivers	Floodwaters can impact on structures and people through direct contact.
Wider risk drivers	• Lack of consideration of flood function of the floodplain in decisions. New development can individually and cumulatively influence flood behaviour and the flood and emergency response risks of the existing community. • Lack of consideration of cumulative changes in the catchment on flood flows and behaviour. New development and its users can influence flood behaviour and the flood and emergency response risks of the existing community. • Lack of consideration of the full range of flooding and emergency management of extreme flood events in land use planning decisions. This can lead to poor decisions on location, increased risk to the growing community and increased demand for emergency service support as communities grow. • Lack of community understanding and timely and appropriate action. • At risk community factors, mobility, accessibility to transport, able to effectively warn, able to respond within effective warning time.
Direct consequences	Loss of life and injury, structures damaged and destroyed.
Wider consequences	Economic impacts and reduced productivity, disruption of communities' functioning and reduced quality of life.

2.3.3 Severe storms

Severe storms can happen anywhere in Australia and generally occur more often than other natural hazard events. These range from localised storms that affect only a small area, to powerful low-pressure systems that can affect an area spanning thousands of square kilometres. Severe storms can produce hail, strong winds, heavy rainfall, flash floods and storm tides (PIA 2015). Climate change is associated with potential large increases for short-duration rainfall extremes, with larger uncertainties for extreme winds, tornadoes, hail and lightning.

Immediate risk drivers	Hail, strong winds, heavy rainfall, flash floods and storm tides can impact on structures and people.
Wider risk drivers	• Severe storms can cause local flash flooding and riverine flooding, and coastal erosion. • Lack of planning and building regulation and enforcement. • Incomplete assessments of the risk posed by severe storms. Due to several gaps in information such as lack of understanding of the thunderstorms behaviour or the influence climate change will have on severe storms. • Lack of community understanding and action. • At risk community factors, unemployment, socioeconomic status.
Direct consequences	Loss of life and injury, structures damaged and destroyed.
Wider consequences	Economic impacts and reduced productivity, disruption of communities' functioning and reduced quality of life.

2.3.4 Coastal erosion

Coastal erosion 'is the loss of coastal lands due to the net removal of sediments or bedrock from the shoreline' (Geoscience Australia 2019). Coastal erosion occurs under certain conditions of weather and sea; for example, strong south-east waves on the east coast. It must not be associated with a specific hazard not even with a severe storm. Coastal erosion can occur very quickly, for instance in a period of days or weeks, or can be occurring over many years, decades or centuries. Coastal erosion is one of the natural hazards that may increase in frequency and severity due to sea level rise due to climate change.

Immediate risk drivers	The action of waves and currents can impact on structures or beneath them.
Wider risk drivers	• Mass wasting processes on slopes and subsidence • Extreme weather events such as coastal storms, surge and flooding as well as tsunami • Lack of planning and building regulation and enforcement • Large and rapidly growing coastal population.
Direct consequences	Coastal erosion has two impacts ways of impacting structures: • the direct impact of waves on structures damaging or destructing them • the indirect undercut of waves beneath structures undercutting them.
Wider consequences	Economic impacts and reduced productivity, disruption of communities' functioning and reduced quality of life.

2.3.5 Cyclones

Tropical cyclones are low-pressure systems that form over warm tropical waters and have gale force winds (sustained winds of 63 km/h or greater and gusts in excess of 90 km/h) near the centre (AIDR Glossary). They can bring strong winds, heavy rain and coastal inundation to many regions on the western, northern and eastern coastlines (PIA 2015). Climate change is likely to affect cyclone activity in a number of ways. Fewer but potentially more intense cyclones are likely to occur in some regions, including tropical cyclones and Australian East Coast Lows.

Immediate risk drivers	Destructive winds and heavy rainfall with flooding and damaging storm tides impact on structures and people through direct contact.
Wider risk drivers	• High concentration of settlements and infrastructure along the Australian coast exposed. • Lack of consideration of cyclone impacts in new development decisions. • Building stock built prior to the establishment of building codes. • Infrequent severe windstorms in non-cyclone-prone areas where buildings are not designed and constructed to withstand the impacts of extreme winds. • Lack of community understanding and action. • At risk community factors, unemployment, socioeconomic status.
Direct consequences	Loss of life and injury, structures damaged and destroyed.
Wider consequences	Economic impacts and reduced productivity, disruption of communities' functioning and reduced quality of life, environmental impacts to natural ecosystems, such as coral damage.

2.3.6 Extreme heat/heatwave

A heatwave is a long-lasting period with extremely high surface temperature (AIDR Glossary). Multi-day heatwave events have increased in frequency and duration across many regions of Australia. Heatwaves are devastating in Australia. More deaths have been caused by heatwave in Australia than any other natural hazard. Heatwaves increase bushfire risk, disrupt electricity and transport services and cause a broad range of social impacts and disruptions. Average temperatures across Australia have increased by about 1°C since 1900 due to human-caused greenhouse gas emissions. This warming trend has led to an increase in the number of extreme heat events that have occurred. Multi-day heatwave events have increased in frequency and duration across many regions of Australia; it is almost certain climate change will continue to worsen and compound the impacts of extreme heat events, with longer heat waves, more frequent extreme heat days, and temperatures above historical records.

Immediate risk drivers	Heatwaves can cause significant health stress on vulnerable people, which may result in death during the heat event or well after the heatwave has passed.
Wider risk drivers	• Lack of planning regulations to avoid 'hotspots' areas and to reduce heat island effects and to improve the access to critical infrastructure. • Lack of building regulations that address thermal comfort in buildings. • Lack of heatwave warning system. • Lack of response plans.
Direct consequences	Loss of life and health conditions aggravated.
Wider consequences	Economic impacts and reduced productivity, disruption of communities' functioning and reduced quality of life.

2.3.7 Tsunami

A tsunami is a water wave generated by a sudden change in the seabed resulting from an earthquake, volcanic eruption or landslide (AIDR Glossary). The tsunami hazard faced by Australia ranges from relatively low along the southern coasts of Australia to moderate along the west coast of Western Australia. This area is more susceptible because of its proximity to large subduction zones along the south coast of Indonesia, which is a region of significant earthquake and volcanic activity (Geoscience Australia 2019). For more information refer to *Tsunamic Emergency Planning in Australia* (AIDR 2018) **www.knowledge.aidr.org.au/resources/tsunami-planning-handbook**

Immediate risk drivers	Huge, flooding body of water of a tsunami can impact on structures and people through direct contact and can continue to rush onto land for an extended period of time.
Wider risk drivers	• Lack of understanding the potential impacts of a tsunami event to communities • Lack of tsunami land use planning and enforcement in land-based communities exposed to on-shore effects of a tsunami • Land-based communities' lack of awareness of their exposure and lack of preparation to respond in case of an event. • Lack of appropriate tsunami detection systems and dissemination of tsunami warnings to the public through multiple channels • Maritime communities of tourists from outside the local area or from overseas exposed to wave actions unfamiliarity with warning arrangements in Australia. • Other at risk community factors that impact on their ability respond within effective warning time.
Direct consequences	Loss of life and injury, structures damaged and destroyed.
Wider consequences	Economic impacts and reduced productivity, disruption of communities' functioning and reduced quality of life.

2.3.8 Earthquake

Earthquakes are the vibrations of the Earth caused by the passage of seismic waves radiating from some source of elastic energy (AIDR Glossary). Since Australia is situated on the Indian-Australian tectonic plate, it does not experience earthquakes as severe as those occurring at tectonic plate boundaries. The main hazard is the resulting ground shaking that can damage or destroy infrastructure and threaten lives (Geoscience Australia 2019, PIA 2015).

Immediate risk drivers	Structures are impacted by ground shaking that can destroy or damage them; in their turn, structures' damage or collapse can threaten human lives.
Wider risk drivers	• Lack of building regulation and enforcement. • Lack of understanding the potential impacts of an earthquake on communities. • Lack of community awareness and preparedness. • Other at risk community factors that impact on their ability respond.
Direct consequences	Loss of life and injury, structures damaged and destroyed.
Wider consequences	Economic impacts and reduced productivity, disruption of communities' functioning and reduced quality of life.

2.3.9 Coincidence of events: multi-hazards and cascading events

In specific context, hazardous events may occur simultaneously, with cascading, cumulative or compounding effects over time (AIDR Glossary). For example, in some cases storm, erosion and flood can occur in simultaneous or cascading manner. It is important to take into account the potential coincidence and interrelated effects of the hazards previously described as well as of other processes and phenomena that might follow them to increase the efficiency and consistency of treatments.

2.4 Actions to reduce disaster risk

This section introduces the actions to reduce disaster risk outlined in the *National Disaster Risk Reduction Framework* (Australian Government Department of Home Affairs 2018).

Disaster risk reduction implies a number of interconnected activities. The *National Disaster Risk Reduction Framework* (Australian Government Department of Home Affairs 2018) (DRR) outlines a national, multi-sector collaborative approach to proactively reducing current and future disaster risk within a 5-year time frame. It sets four priorities for actions: (1) understand disaster risk; (2) accountable decisions; (3) enhanced investment; and (4) governance, ownership and responsibility (see Figure 1).

Decisions related to land use planning are implicit throughout the DRR Framework and land use planning, with support from hazard leaders and emergency managers, can play an important role in each of the priorities for action. Furthermore, land use planning is specifically highlighted in Priority 2: Accountable decisions. For example:

Integrated and robust frameworks are used to assess and reduce disaster risk in all environments, but particularly infrastructure, land use and development planning.

The land use planning and development sector is also identified as an important sector with a role to play in reducing disaster risk.

For further details on using land use planning to manage the risks to specific natural hazards refer to the additional resources available at the AIDR Knowledge Hub: **www.knowledge.aidr.org.au/resources/handbook-land-use-planning**. Individual states and territories may also have relevant guidance that needs consideration.

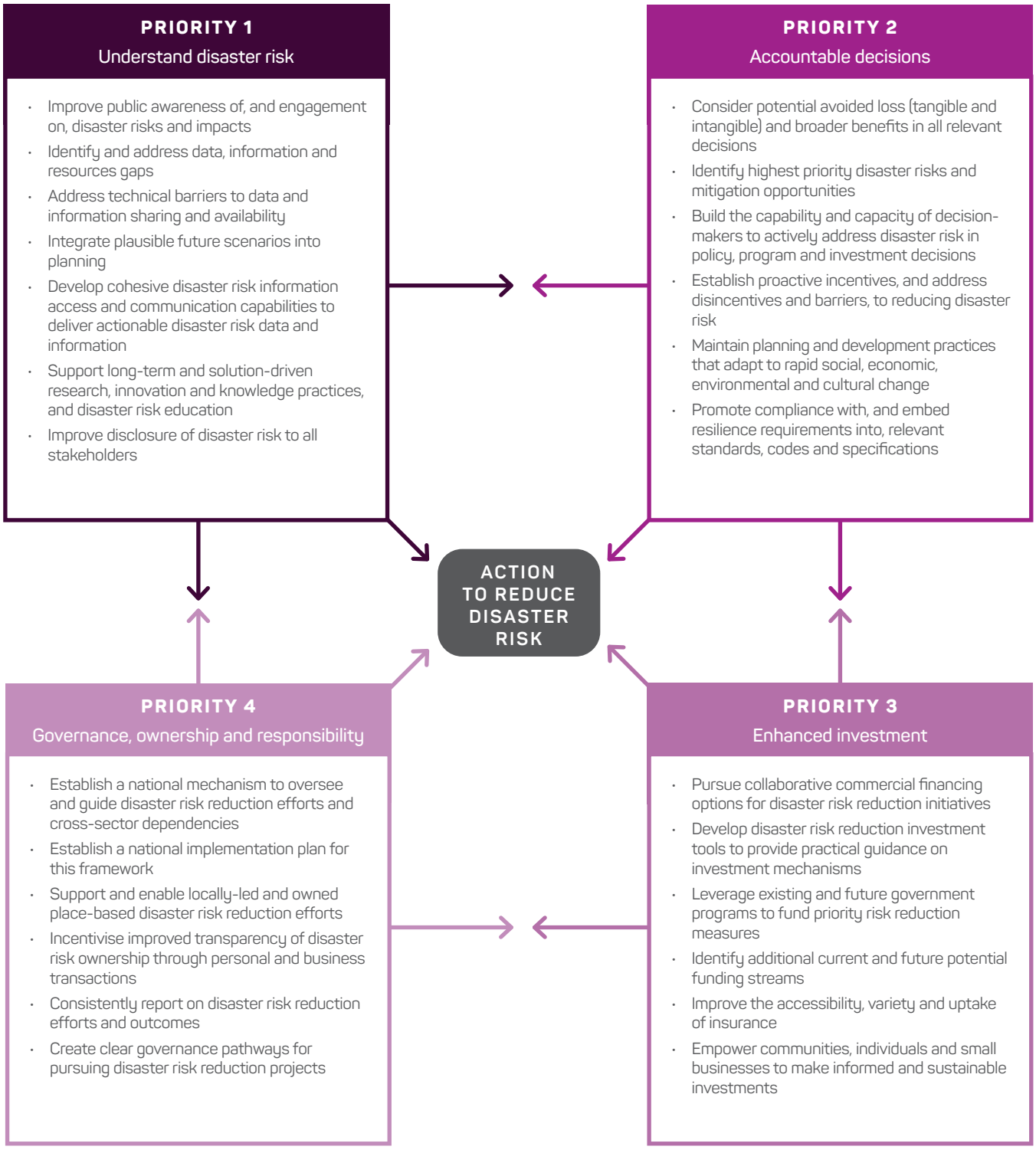

Figure 1: National Disaster Risk Reduction Framework - Priorities and Strategies at a Glance

Chapter 3: The land use planning framework for disaster resilient communities

This chapter presents a procedural framework for land use planning that facilitates disaster resilient communities. First, it shows the similarities and parallels of land use planning and risk management procedures. Then, it introduces the procedural framework and describes each of its components.

3.1 Parallels between land use planning and risk management procedures

Risk management and land use planning have procedural similarities, as summarised in Table 1. Table 1 is based on the processes established by ISO 31000 (2018), the *National Emergency Risk Assessment Guidelines* (AIDR 2020), and the *National Land Use Planning Guidelines for Disaster Resilient Communities* (PIA 2015). Ideally, both risk management and land use planning processes facilitate systems of guidance and control based on evidence and ongoing assessment. They should promote continuous improvement of the system by monitoring its effects and modifying it when necessary, learning and incorporating feedback as conditions change and knowledge improves.

The procedural similarities of risk management and land use planning allow them to work together and complement each other if appropriate sequencing occurs and forums for decision-making are created. Furthermore, they facilitate the integration of risk management considerations throughout the land use planning processes by taking a risk-based approach to planning. However, the practicality of this integration depends on the availability of existing information or the timeframe for developing an effective understanding of the natural hazard so that this can be considered in risk treatment, among other technical, political and procedural influences. To promote complementary work and actions, collaboration between risk management and land use planning agencies needs to be encouraged and hazard leaders and emergency managers need to be engaged early in the land use planning process (Principle 8 of this Handbook). In addition, to ensure natural hazard information produced through hazard management processes and frameworks is suitable for land use planning purposes, land use planning should seek to be involved in these.

3.2 Procedural framework of land use planning for disaster resilient communities

This section introduces the handbook's procedural framework of land use planning for disaster resilient communities, as illustrated in Figure 2.

The framework is based on the processes of risk management and land use planning. It establishes an evidence-based, continuous process of land use planning improvement to support the development of disaster resilient communities. This framework sets a procedural ideal that can be applied across the decision-making process at the different levels of land use planning, as illustrated in chapters 4, 5 and 6. Nevertheless, it must be taken into account that land use planning processes occur within a set of existing systems and pre-established structures and procedures that influence its capabilities and limitations. It must also be acknowledged that the risk management and land use planning processes are influenced by technical, political, procedural and moral dimensions that may challenge the quality of their outcomes and that land use planning decision-making for disaster resilient communities relies on political decisions (for further commentary on this refer to Chapter 7, section 'Competing technical, political, procedural and moral influences').

The framework considers five components that are described in a generic way, acknowledging that they may appear in different combinations and varying sequence in different planning contexts.

Table 1: Parallels between land use planning and risk management procedures

Risk management procedure	Land use planning procedure
Establishing the context	Visioning, overarching desired futures
Risk assessment	Analysis of the circumstances and problems/opportunities
Selection of risk treatment options	Identification of planning alternatives, and evaluation and selection of them
Risk treatment implementation	Planning implementation
Ongoing communication and consultation	Communication and consultation
Ongoing monitoring and review	Monitoring effects and adjusting

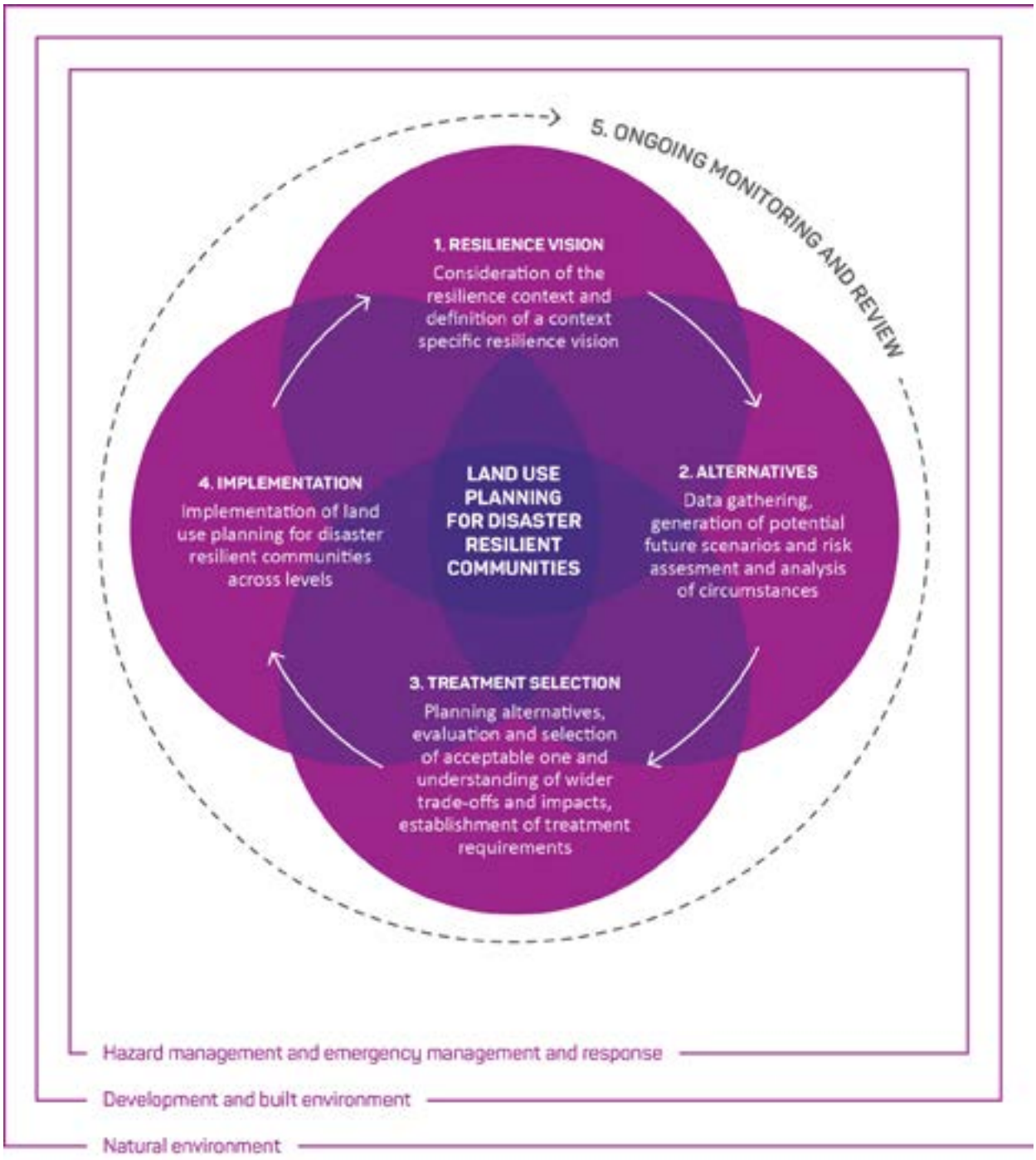

Figure 2: Land use planning for disaster resilient communities framework

Note: this figure assumes that land use planning processes seek good quality information and inputs from relevant hazard agencies and other stakeholders, acknowledging the range of other processes and goals.

3.2.1 The context: Natural and institutional environment, roles and responsibilities

The land use planning framework occurs within the context of different roles and responsibilities of planning agencies, natural hazard leaders, emergency managers and their integration with other stakeholders, including other government agencies and the community in the processes of land use planning for disaster resilient communities.

Under the Australian Constitution, state and territory governments are responsible for land use planning and associated development regulation. State and local government agencies are allocated several key roles in the processes of land use planning. Local governments take on the bulk of administrative roles, while state and some regional authorities play overarching roles oriented to the establishment of wider frameworks and processes. Ministerial roles often allow for some extraordinary planning powers, although these are still required to be within the limits of relevant legislation. Institutional frameworks should define clear roles and responsibilities concerned with the disaster resilience of communities. Education programs and training sessions are important to build the planners and others' capacities for disaster-related decision-making.

Land use planning for disaster resilient communities requires natural hazard information, coordination and integration with a range of sectors and capabilities. Planning agencies in Australia include several integrating processes that seek to achieve coordinated action between individuals, stakeholders and government agencies (see Figure 3). Integration may be achieved by collaboration, referral with other government agencies, working with hazard leaders and emergency managers as part of natural hazard management frameworks, or community consultation in various forms and at different stages of planning. Other regulatory systems such as building may occur in sequence or with urban planning or in parallel. It is important for planning agencies to promote and enhance these opportunities for integration, to draw from the diversity of stakeholders, views and capabilities that influence and manage disaster risk and community resilience. This approach follows the principle of shared responsibility and acknowledges that all levels of government and other stakeholders have a role to play in driving systemic change for greater disaster resilience in Australia (COAG 2011 and Australian Government Department of Home Affairs 2018). Furthermore, land use planning decisions must consider community engagement, acknowledging that each community is different, as is the context and mechanisms for engaging them. Community engagement is crucial both to the success of land use planning and to the community's overall capacity to deal with disaster events when they occur. For further guidance on national principles and practices for community engagement, communication and inclusion for disaster resilience in Australia, refer to *Community Engagement for Disaster Resilience* (in press AIDR 2020).

Hazard leaders can assist in interpreting hazard information, confirming the natural hazard information being used is the best available and to provide advice where natural hazard information is not available or does not exist. Where information does not exist hazard leaders may inform the scoping of risk assessments for the hazard and its impacts both on and as a result of the development.

It is also important to acknowledge that land use functions are interconnected with environmental systems. Communities and settlements occur within environmental support systems upon which we all rely. Land use planning decisions must consider their potential impact on the environment.

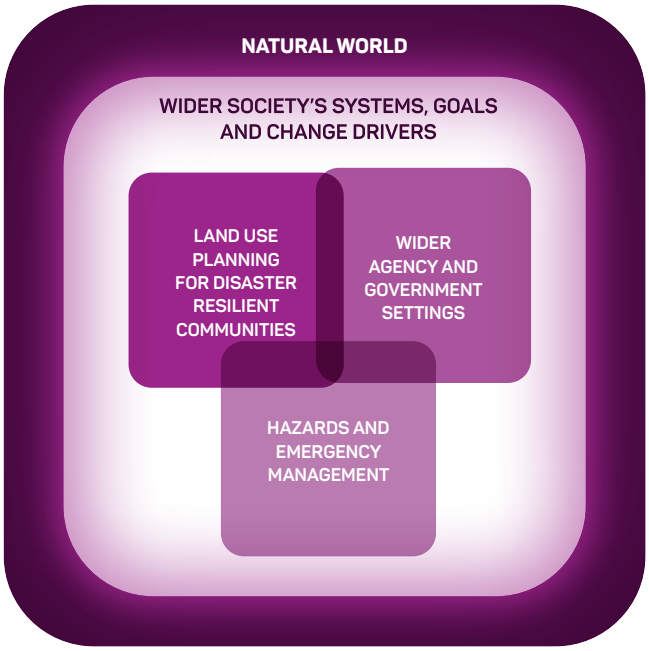

Figure 3: Processes and influences

3.2.2 1 – Resilience vision: definition of a context-specific resilience vision

The first component of the framework refers to the consideration of the resilience context and to the definition of a context-specific resilience vision at the relevant geographic scale.

An overarching vision for land use planning should be the promotion and enhancement of disaster resilient communities, alongside the range of other goals sought, such as economic prosperity, social equity and environmental sustainability. The vision should be aligned with all of the principles for land use planning for disaster resilient communities defined in this handbook, considering in particular Principles 2, 3 and 4.

It is important to identify a context-specific disaster resilience vision for individual communities. In envisioning a new future for settlements, the natural hazards and disaster risks communities face (their exposure) should be considered and how settlements might need to develop and adapt to address the risks, as well as the impacts new development might have on natural hazard behaviour and the existing community, including response to natural disasters. The visioning must take into account that Australian communities are characterised by diversity. Each incorporates populations with a range of experiences, capabilities and motivations that might affect their vulnerability levels. These communities, of diverse individuals and groups, interact with each other and the natural systems upon which they rely in many ways. Each community is connected in multiple ways with other communities across Australia and globally. The process of setting the internal and external context for natural hazard risk assessment can be useful for planners to help set the resilience context for consideration when developing the vision (derived from PIA 2015).

2030 Vision for Disaster Risk Reduction in Australia

In Australia, we are enabled and supported to actively reduce disaster risk and limit the impacts of disasters on communities and economies. All sectors of society understand and respond to social, environmental, technological and demographic changes which have the potential to prevent, create or exacerbate disaster risks. All sectors of society:

- make disaster risk-informed decisions,
- are accountable for reducing risks within their control, and
- invest in reducing disaster risk in order to limit the cost of disasters when they occur.

(*National Disaster Risk Reduction Framework*, Australian Government Department of Home Affairs 2018)

3.2.3 2 – Alternatives' analysis: hazard identification, scenario consideration and analysis of issues and trends to understand potential disaster risks

The second component of the framework refers to the identification and analysis of issues and trends, including risk assessment, within the circumstances of a place.

Land use planning for disaster resilient communities must be based on appropriate data gathering and risk analysis. Understanding disaster risk is the first priority for both the *Sendai Framework for Action* (UNDRR 2015) and the *National Disaster Risk Reduction Framework* (Australian Government Department of Home Affairs 2018). Understanding current and future disaster risks is also critical for land use planning as the basis for well-informed decision making. Linking to natural hazard information and incorporating risk assessments early into the planning process provides the opportunity to have resilience considerations 'front of mind' (PIA 2015), as emphasised in Principle 9 of this Handbook.

The understanding of natural hazards can be undertaken at a range of levels from indicative, to first pass, to detailed. These different degrees of hazard information would need to be considered differently in land use planning decisions, due to their limitation and the effect these limitations may have on decision making. For example, indicative estimates of the behaviour of natural hazards may provide advice on an indicative area where consideration of the hazard may be of interest; however, these estimates do not provide sufficient detail to put in place detailed controls which implies that there is a need for local studies to better understand hazards. Furthermore, natural hazards assessments can be done considering different time horizons depending on the type of decisions they are expected to inform.

A key output of the hazard assessment is the information provided in relevant reports and mapping. In many ways, natural hazard studies and associated information and mapping may be a first step on the resilience journey for a community. Mapping provides the opportunity to develop an understanding of the varying spatial exposure of different areas to the natural hazard and can also identify specific characteristics of natural hazards as they affect the area. These characteristics can identify significant constraints on development in the area due to the hazard. But not all maps are 'created equal' – given the complex characteristics of some hazards, mapping can either be detailed and precise or coarse and uncertain depending on how the hazard has been modelled/mapped and the involvement of the community in defining the characteristics of hazard. Using information, mapping or modelling outside the limits of its utility can lead to poor decisions. Furthermore, it is important to know that modelling, information and mapping should be fit for the purpose for which it is intended.

In some instances, the land use planning system might generate its own data and knowledge, but it is common that this knowledge has been developed by other organisations. If this is the case, informed specification of processes such as modelling, hazard assessment and reporting with collaboration from emergency managers and hazard leaders will facilitate this information to be fit for purpose and able to be most effectively used to inform decision making in land use planning.

Alternative development scenarios which provide an understanding of the potential impacts due to future development based on credible scenarios must be considered and analysed to understand the potential disaster risks they may create. Ideally the full range of risks are understood as are the associated impacts on development, infrastructure and people so that they can inform decision making, as stated in Principle 10 of this Handbook. It is also important to consider the potential coincidence of interrelated effects of natural hazards and of other processes and phenomena that might follow them when developing the alternative scenarios. For example, it is common that heatwaves, which put additional pressure on electricity demand coincide with bushfire events, smoke impacts on urban areas and power outages, putting pressure on emergency and medical services and the wider community.

3.2.4 3 – Treatment selection: evaluation and selection of land use planning risk treatment options

The third component of the framework refers to the evaluation and selection of land use planning treatment options in consideration of natural hazard information and in collaboration with hazard leaders and emergency managers.

Land use planning systems contain many tools and processes that relate to the location, layout, design and functions of settlements. They are particularly valuable in setting out future plans for growth or conservation, although they can still influence ongoing change in existing communities.

Land use planning decisions should aim to consciously determine levels of acceptable risks in the context of other goals such as development and change management, considering the potential coincidence of interrelated effects of natural hazards and of other processes and phenomena that might follow them to increase the efficiency and consistency of treatments. A number of risk treatment options are available as part of the risk management process. The alternatives for treatment identified should be tested to determine their acceptability and effectiveness at addressing the issues at hand. These issues can include but not be limited to:

- impacts of new development on the hazard and the flow on effects to the existing community
- impacts of the hazard on new development and its users
- impacts of the new development and its users on the emergency response of the existing community.

Based on the analysis and evaluation of the possible treatment scenarios and alternatives, the safest locations and regulations for guiding new development must be selected, as stated in Principle 10 of this Handbook

It is important to consider that planning is a multi-objective process. This implies that risk treatment options will be analysed and evaluated from the perspective of risk reduction as well as other community objectives, in alignment with Principle 11 of this Handbook. Having this in mind, a genuine attempt to consider the current and future risk implications of planning decisions prioritises the protection and preservation of human life over all other considerations, as stated in Principle 1 of this handbook.

Risk treatment options available as part of the risk management process are generally categorised as follows:

- **Risk avoidance:** Measures taken to avoid risks from natural hazards. These measures could include avoiding development in hazardous areas, relocating people or assets away from hazardous areas, or developing buffer zones to the hazard.
- **Risk reduction/mitigation:** Measures undertaken to reduce the risks from natural hazards, such as strengthening buildings against ground shaking from earthquakes. Development controls for new development can be seen as a way of reducing the growth of risks from natural hazards due to new development. In addition, while often limited, there may be opportunities to reduce risk over time as redevelopment occurs through, for example, the implementation of new development standards that consider the impacts of the hazard or the relocation of development to less hazardous locations.
- **Risk transfer:** Measures taken to transfer the risk from a natural hazard from one party to another, such as property insurance.
- **Risk acceptance:** The acceptance of risk from a natural hazard; any realised losses will be borne by those parties exposed to the hazard. This is not specifically a treatment option as no action is taken, but it is an option for addressing risk.

Risk tolerance and 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.
(*National Land Use Planning Guidelines for Disaster Resilient Communities*, PIA 2015)

Different people or organisations bear the risk of loss and damage in different ways, at different times.
(*Profiling Australia's Vulnerability*, Australian Government Department of Home Affairs 2018)

3.2.5 4 – Implementation: instruments for disaster resilient community land use planning

The fourth component of the framework is the implementation of the risk treatment options previously selected in the development of land use planning instruments informed by natural hazards through earlier steps.

In general, planning can only influence decisions about new development using powers and decision-making tools in approved planning schemes and documents. Accordingly, appropriate regulations need to be in place prior to decisions being made about land use developments. Planning powers are usually exercised via written policy and regulations in association with supporting plans and maps. Following from the above, land use planning powers can be general or specific to certain types of activities and can be specific to particular locations via mapping, including:

- **Overarching legislative and regulatory frameworks.** Control and guide new development through interconnected policies, laws, regulations and other instruments such as codes and standards.
- **Spatial land use and development plans.** Influence location, type and quality of development permitted in certain areas through various kinds of urban and territorial plans.
- **Case by case application.** Apply the disaster resilience vision and risk treatments in the developments and buildings mainly through the planning permit application process and through infrastructure projects.

Further details on the implementation instruments and processes at these three levels of land use planning is provided in Chapters 4, 5 and 6 of this handbook.

3.2.6 5 – Ongoing monitoring and review

The fifth component of the framework refers to the ongoing monitoring and reviewing of the land use planning instruments and processes in place, as stated in Principle 12 of this Handbook.

Land use planning operates through a series of continuous and iterative processes. Through its processes, land use planning is also a mechanism that can integrate understandings of and seek to account for, ongoing change, challenges and opportunities, including growth in knowledge of natural hazards and their impacts. Examples might include developing understandings of Australia's diverse population, its growth and change and the different ways that this is occurring spatially across Australia's cities, towns and regions. Other examples might be understanding changes to the natural environment and weather patterns, intensification of growth and particular activities in certain areas, or understanding the implications of future growth patterns on natural hazard risk profiles.

The iterative characteristic of land use planning should be used to promote ongoing monitoring and review of the current and future risks and vulnerabilities of communities and settlements, especially considering that risk is not static and nor is knowledge of the risk. It is necessary to continually monitor the status of the risk being managed and the interaction of risk, community and environment; and to review the land use planning instruments and processes in place. Continual monitoring of land use planning enables to dynamically adapt to changes in risk as well as changes in stakeholder needs (PIA 2015).

Chapter 4: Establishing and maintaining the regulatory system

This chapter identifies the importance of reviewing and ensuring the ongoing appropriateness of the core elements underlying communities' disaster resilience at the legislative and regulatory framing level of land use planning. It is fundamental that this overarching level of land use planning establishes risk assessment processes for all planning decisions and that it clearly articulates the levels of disaster risk tolerance of the system. This chapter outlines the main instruments to consider in the implementation of disaster resilient communities via land use planning at this overarching level. It then refers to the processes associated with the development and review of these instruments in a generic manner and illustrating them with two applied examples.

4.1 Framing land use planning instruments for disaster resilient communities

This section outlines instruments to consider in the implementation of disaster resilient communities at the overarching legislative and regulatory level of land use planning.

All states and territories have a suite of framing instruments applicable to land use planning that set out responsibilities and powers, mainly oriented to the production and implementation of policy and plans, providing a strong legal basis for land use planning capacities and limits. The instruments at this overarching planning level control and guide new development through interconnected policies, laws, regulations and other instruments such as codes and standards.

Legislative and regulatory frameworks play an important role in land use planning for disaster resilient communities. They are essential to enable, guide and coordinate risk reduction actions – such as discouraging new development from hazard prone areas or areas where development might impact on the behavior of hazards and therefore on their interactions with existing settlements – and establishing site, design and construction mitigation standards that are then to be applied at lower levels of land use planning. It is fundamental that risk assessment processes are established for all planning decisions and that the levels of disaster risk tolerance are clearly articulated in the legislative and regulatory framing level of land use planning.

While the regulatory framework is an important part of planning for achieving disaster resilient communities, they are not the sole determinant or control factor, and many of the instruments deal with disaster resilience as part of broader considerations. Furthermore, land use planning operates within a wider context that influences its capabilities and limitations – many other actors and drivers of change influence the planning system over time such as population growth, economic forces, politics and social expectations, to name a few.

The Table 2 summarises the main instruments at the legislative and regulatory planning level and their potential role in disaster resilience.

4.2 Processes to develop and review the 'framing' regulatory system

This section presents the processes associated with the development and review of the overarching legislative and regulatory instruments in a generic manner and it illustrates them with two applied examples.

Legislative and regulatory instruments are produced and reviewed based on the powers allocated to state government agencies by the state regulatory framework and legally based on each state's parliament enactments. Generally, state government planning agencies prepare and review plans on an ongoing basis. They are usually approved by the state governments by the decision of a planning minister or in some cases a board or commission. Major policy changes may require parliamentary review prior to ministerial approval (March 2015).

The processes to develop and review the regulatory system instruments follow a similar approach to the one presented in the procedural framework for land use planning for disaster resilient communities (Chapter 3). In general terms, the instruments at the legislative and regulatory level of land use planning are continuously improved through evidence-based processes that allow learning and incorporating feedback as conditions change and risk management knowledge improves.

The ongoing review and improvement of the legislative and regulatory framework is critical to producing a system that appropriately – and proactively – enables, coordinates and guides disaster resilience across the different levels of planning. It ensures the ongoing appropriateness and validity of the core elements underlying land use planning for disaster resilience, such as when and how risks are assessed, what level of risk tolerance frames the system and guide decision-making, and what are the acceptable risk treatment options. However, the extent of the consideration of hazard related matters and the integration of other relevant stakeholders and agencies in these processes differs depending on the instrument and the hazard. Furthermore, these processes are influenced by technical, political, procedural and moral dimensions that may challenge the quality of their outcomes.

Table 2: Summary of the main instruments at the legislative and regulatory planning level and their potential role in disaster resilience [Based on UNDRR 2019 and PIA 2015]

Instrument	What they entail	Role in disaster resilience
Legislation	Each state and territory in Australia has a planning act setting out the general powers, responsibilities and rights of various parties of land use planning, including setting processes for plan development and implementation. They require local governments to administer land use planning. Additionally, there is other legislation that may have an influence on planning matters (for example, environmental or building legislations) (March 2015).	Enable and provide context for land use planning for disaster resilient communities by containing goals for community safety or resilient development. Specify that disaster resilience is to be included in all land use planning levels. Specify the need to consider natural hazards in land use planning decisions. Establish links to risk assessment processes and advice from natural hazard leaders and emergency managers for all planning decisions. Specify that risk assessments must consider existing and future risks, and may include scenario testing of future settlement patterns. Consider other disaster management legislations that have impact on planning matters.
Policy	All states and territories have developed policies that impact on land use planning and disaster management. These may include fire, flood, landslide and water quality management policies; coastal, environmental, agricultural and wetlands protection policies, and management of urban expansion policies.	Ensure that the policy is aligned with the direction of other overarching national policies or international agreements, establishing clear links and hierarchies between them. Clearly articulate how disaster resilience and risk information is considered in land use planning, to guide decision-making processes and selection of future growth patterns. Articulate guidance on the level of risk tolerance that will frame the system and guide decision-making.
Regulation	In each state and territory, planning Acts are associated with planning regulations that set how the legislations' requirements are to be met.	Link planning decisions to advice from natural hazard leaders and emergency managers. Specify the need to consider natural hazards in land use planning decisions, including in strategic planning decisions, and their implementation. Require assessment of strategic alternatives when appropriate. Support with guidance on the level of risk tolerance that will frame the system and guide decision-making. Provide an objective of disaster risk reduction and resilience processes or mechanisms as appropriate, according to the level of risk tolerance that frames the system.
Standards and Codes	Standards and codes can be technical or functional and cover the physical characteristics, materials and components for new developments. They specify what is considered satisfactory in a given context. Usually, regulations refer to standards.	Relevant standards and codes provisions to natural hazard information and risk assessments. Restrict certain uses, building types, and occupancy density in hazard prone areas where risk is considered to be beyond acceptable. Restrict certain uses, building types, and occupancy density in hazard prone areas to that compatible with the natural hazard and its constraints. In areas where development is considered acceptable, specify disaster risk reduction treatments that meet the objectives of the policy or regulation and correspond with the system's level of risk tolerance.

The following boxes provide two examples that illustrate the processes associated with the development and review of the instruments of the regulatory framework.

Establishing the Bushfire Management Overlay in the Victoria Planning Provisions

The processes associated with the development and review of the bushfire overlays in the Victoria Planning Provisions (VPP) illustrate how state regulatory framing instruments can be reviewed and improved over time, and how these processes allow learning and incorporating feedback.

In 1997, the Wildfire Management Overlay (WMO) was introduced within the planning restructuring and the introduction of the Victoria Planning Provisions (VPP), which provide state wide provisions that serve as templates for planning schemes.

After Black Saturday bushfire events in 2009 and the inquiry by the Victoria Bushfire Royal Commission that followed them, issues with the WMO and its implementation were identified. The WMO was consequently replaced by the Bushfire Management Overlay (BMO). The changes introduced by the BMO were informed by the 19 (out of 67) recommendations about planning and building controls provided by the Royal Commission. The BMO reformed the way statutory planning approached bushfire risk management setting more strict conditions and giving greater decision powers in the planning permit process to the relevant fire authority, that was established as 'determining' referral authority.

Since the introduction of the BMO, bushfire provisions have been reviewed several times. An amendment introduced in 2014 considerably adjusted the provisions, correcting and relaxing the 2011 reforms. It introduced two pathways for compliance based on approved or alternative measures and reduced the decision powers of the relevant fire authority, that was the changed to 'recommending' referral authority.

(Gonzalez-Mathiesen, March, Leonard, Holland and Blanchi 2019)

AS3959 process of revision

The processes associated with the development and review of the AS3959 – Construction of buildings in bushfire-prone areas (Standards Australia 2018) illustrate how national technical standards can be reviewed over time based on collaborative endeavours at the national scale.

AS3959 is a national standard that outlines the methodology to establish the Bushfire Attack Level (BAL) used for determining site specific construction requirements for building in bushfire prone areas. Usually land use planning regulations refer to this standard.

The first version of the standard was introduced in 1991. Since then, the second edition was published in 1999, the third edition in 2009 and the fourth edition in 2018. Intermediate versions that include minor amendment were also issued in between editions.

This standard is prepared by a committee called FP-020 which consist of representatives from different stakeholders involved in the construction of buildings in areas exposed to bushfires. It includes representatives from public and professional associations such as the Australasian Fire and Emergency Service Authorities Council (AFAC), and the Australian Institute of Architects; and industry body representatives such as the Fire Protection Association Australia, and the Forest and Wood Products Australia.

The process to develop the standard is generally based on consensus, following the steps: proposal, kick-off, drafting, public comment, ballot and publication. During the drafting stage working groups provide the technical content to write the standard. The stage of public comment provides the opportunity for the broader community to review and comment on the draft. The ballot stage refers to the process of reaching a decision, generally within a consensus model to approve the standard through the Committee members' vote.

(Standards Australia 2019)

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

Chapter 5: Plans for managing land use, development and growth

This chapter identifies the importance of considering disaster resilience when establishing directions for change and development via spatial plans. Geographically specific land use planning instruments for managing change must consider current and future risks and establish measures to treat risk to new development and its users and to limit any impacts of new development on natural hazards and associated risks to the existing community to an acceptable level in terms of its consequences to the community. This can also allow for the improvement of knowledge of natural hazards overtime, including consideration of natural hazard information where this is yet to be included. Concurrently there is a need to balance other development and change requirements and priorities with disaster risk reduction considerations such as the provision of sufficient housing or heritage controls. The chapter outlines the main instruments to consider in the implementation of disaster resilient communities when applying planning regulations to the land through place-specific land use and development plans, emphasising that strategic plans are critical to direct new development to suitable locations and limit development in areas where risks are considered unacceptable. It then refers to the processes associated with the development and review of these instruments in a generic manner and illustrating them with two applied examples.

5.1 Land use plans for disaster resilient communities

This section outlines land use planning instruments (types of plans) to consider in the implementation of disaster resilient communities when applying planning controls to land through geographically appropriate and place-specific land use and development plans.

Urban and rural plans reflect the overarching intentions of policies and regulations applied to the land in a local context. These plans establish broad directions for development, preservation or control, influencing the location, type and quality of new development that can occur in a certain location. Local planning schemes are the main mechanism of development control that include tools such as policy, zoning, overlays and provisions based on performance criteria.

Geographically specific land use planning instruments for managing change play an important role in land use planning for disaster resilient communities, balancing other development requirements and priorities with disaster risk reduction considerations. These spatial plans must be based on the assessment of existing and future risks, identifying hazard exposure and risk to specific locations via mapping.

They are essential to direct development to suitable locations and avoid or reduce locational risk factors or impacts of development on natural hazards leading to increases of risk to the existing community. In particular, strategic plans – such as regional plans and future growth or expansion areas – are critical to the process of directing new development to suitable locations and can be the most effective mechanism for avoiding or reducing the exposure and the impact of new development on the behaviour or natural hazards if these issues are considered in their development. It must be recognised that some land may be unsuitable for certain activities or development and that development must be considered in consideration of the constraints of natural hazards (Principle 5 of this handbook).

If strategic plans do not consider hazards or do so in an inadequate manner, by guiding growth and development they are setting a path that builds risks that then are difficult to change (for further commentary on this refer to Chapter 7). Furthermore, when development is considered appropriate, spatial plans that limit the type and extent of development that can occur in a given area – such as zones, overlays and controls – must establish measures to treat risk to an acceptable level in terms of its consequences to the community. Appropriate use of regulatory mechanisms to their intended purpose is an integral part of this consideration.

Land use planning also needs to consider that the acceptable risk levels are different for certain uses and critical infrastructure (for example, hospitals or nursing homes) and authorise their location accordingly. Furthermore, they enforce mitigation measures to specific spatial locations when the risk is considered acceptable. They can also assist in facilitating and improving response actions through suitable settlement layouts that consider civilian evacuation, the protection of emergency responders and the efficacy of their response .

They must allow for the improvement of knowledge of natural hazards to improve over time (including consideration of natural hazards where these are yet to be spatially mapped or where the hazard information improves). There also needs to be allowance in plans for controls in areas where a hazard is expected but is yet to be assessed and mapped that may require the applicant to undertake a study to define the hazard so that this hazard can be considered within the requirement of land use and development plans.

The Table 3 summarises the main spatial instruments and their potential role in disaster resilience.

Table 3: Summary of the main spatial instruments and their potential role in disaster resilience [Based on UNDRR 2019 and PIA 2015]

Instrument	What they entail	Role in disaster resilience
Regional plans	Regional plans in Australia provide broad strategic directions for land use and development patterns across the states territories and in key regional centres. Usually, they contribute to coordinate and guide service and infrastructure provision.	Contribute to understanding hazard and risks at a territorial scale, considering rural-urban relationships and impacts. Promote regional coordination of infrastructure networks and set priorities based on a regional infrastructure vision. Identify and protect areas of special importance to the region. Promote the need to consider natural hazards, whether mapped or not.
Strategic growth or expansion areas	Future growth or expansion areas (the names differ across Australia) are strategic plans that guide the way that land for expansion on the edge of large settlements is generally managed.	Provide adequate space for expected future growth in areas that are suitable for development considering natural hazards, by testing alternative scenarios and selecting those where development is compatible with natural hazards and where impacts of development on natural hazards and the existing community can be effectively managed. Support outcomes that manage residual acceptable risk to new development when identifying areas suitable for expansion.
Local policies & strategies	Local policies and strategies provide detailed policy direction at the municipal level. They contribute to implementing state policy in a way that is relevant to the local context.	Ensure that the policy is aligned with the direction of overarching policies. Clearly articulate how natural hazards and associated disaster resilience is to be considered to guide decision-making processes.
Structure plans	Structure plans define the preferred direction of future growth at a local strategic level. They usually provide more details and articulate how growth will be managed. They can derive short, medium and long-term objectives.	Allow merging of scenario testing and risk analyses with a detailed planning exercise. Identify sector-specific actions to reduce risk and facilitate adaptation to natural hazards. Incrementally drive resilient outcomes and desired urban forms that respond to the hazard exposure and consider impacts of development on natural hazards and the existing community. Contribute to managing areas with more serious hazard exposure, such as urban-rural interface or coastal areas.

Instrument	What they entail	Role in disaster resilience
Zones, overlays and controls	Zones, overlays and their associated controls or reference to resource documents set limits on the type and extent of development that can occur in a given area. Appropriate land uses are identified first, addressing built form requirements thereafter.	Implement resilience provisions for hazard-prone areas. Articulate risk tolerances through parameters for acceptable development. Limit development or certain uses in areas identified as inappropriate to accommodate new development due the natural hazards or impacts of development on natural hazards. Address acceptable/residual risk through build form considerations. Limit density or types of development that are inconsistent with the risk profile and intent of the zone. Ensure rebuilding improves risk profiles and avoids the reproduction of avoidable risks by rezoning of land to avoid reconstruction in hazard prone areas after an event.
Hazard/risk mapping	Hazard mapping spatially represents where the hazard may occur in relation to the natural landscape and built environment. Risk mapping considers the likely consequences of an event on the community. They usually operate in concert with (but are different from) 'overlay mapping'.	Spatially represent the hazard/risk articulating risk tolerances to inform the direction of new development and the specification of requirements for acceptable development. Declare the underlying assumptions and assessment criteria.

5.2 Processes to develop and review spatial plans

This section presents the processes associated with the development and review of spatial plans in a generic manner, illustrating them with four applied examples.

Local plans are developed or reviewed based on the enabling powers allocated to local councils by the regulatory framework at the state level. Generally, local planning agencies prepare and review plans on an ongoing basis using state prepared 'templates' that comply with mandatory state policy. Plans usually require consultation processes to the community and relevant government agencies. In almost all instances, elected local councils undertake the initial approval and state governments give the final approval, based on the content and quality of the plans. Community engagement and participation is crucial for the success of the processes to develop and review spatial plans.

The processes to develop and review spatial plans follow a similar approach to the one presented in the procedural framework for land use planning for disaster resilient communities (Chapter 3). The geographically specific land use planning instruments for managing change are continuously improved through evidence-based processes that allow learning and incorporating feedback as conditions change and risk management knowledge improves. These processes are critical to avoid or reduce the exposure and the impact of new development on the behaviour of natural hazards and existing community by directing new development to suitable locations.

Well-informed decision making for developing or amending geographically specific land use planning instruments for managing change must be based on appropriate data gathering and hazards assessment, generation of development scenario and analysis of their potential risks, considering potential coincidental and interrelated effects of natural hazards and of other processes and phenomena that might follow them. Furthermore, the processes must be set to evaluate and select the development alternative that corresponds with what is considered acceptable risk levels and evaluate and select the residual risk treatment scenarios and alternatives. It is important to point out that certain levels of risk may be tolerated, provided that the risks are known and managed (AIDR 2015).

Where possible, it is important to use appropriate decision support tools that allow considering a range of options, especially in the decision-making processes of strategic plans. Scenario testing mechanisms, the risk matrix and the ALARP principle illustrated in the Table 4 and Figure 4 are particularly relevant to planners and other built environment professionals as they provide the means to categorise risks according to their severity, and to assign risk treatment options accordingly (PIA 2015). This allows determining the safest locations and regulations for guiding new development and to establish measures to treat risk to an acceptable level in the context of other goals such as development and change management. The consideration of disaster resilience during the process of developing and renewing spatial plans can greatly contribute to disaster prevention and yield significant returns on investment because it can avoid or significantly reduce the creation of new risks in the first place. However, the extent of the consideration of hazard related matters and the level of integration of other relevant stakeholders and agencies in these processes differs depending on the instrument and the hazard. Furthermore, these processes are influenced by technical, political, procedural and moral dimensions that may challenge the quality of their outcomes. For more information on risk assessment refer to the National Emergency Risk Assessment Guidelines (AIDR 2020).

Table 4: Risk matrix presented by the National Emergency Risk Assessment Guidelines (AIDR 2020)

	CONSEQUENCE LEVEL				
LIKELIHOOD	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
ALMOST CERTAIN	Medium	Medium	High	Extreme	Extreme
LIKELY	Low	Medium	High	Extreme	Extreme
UNLIKELY	Low	Low	Medium	High	Extreme
RARE	Very low	Low	Medium	High	High
VERY RARE	Very low	Very low	Low	Medium	High
EXTREMELY RARE	Very low	Very low	Low	Medium	High

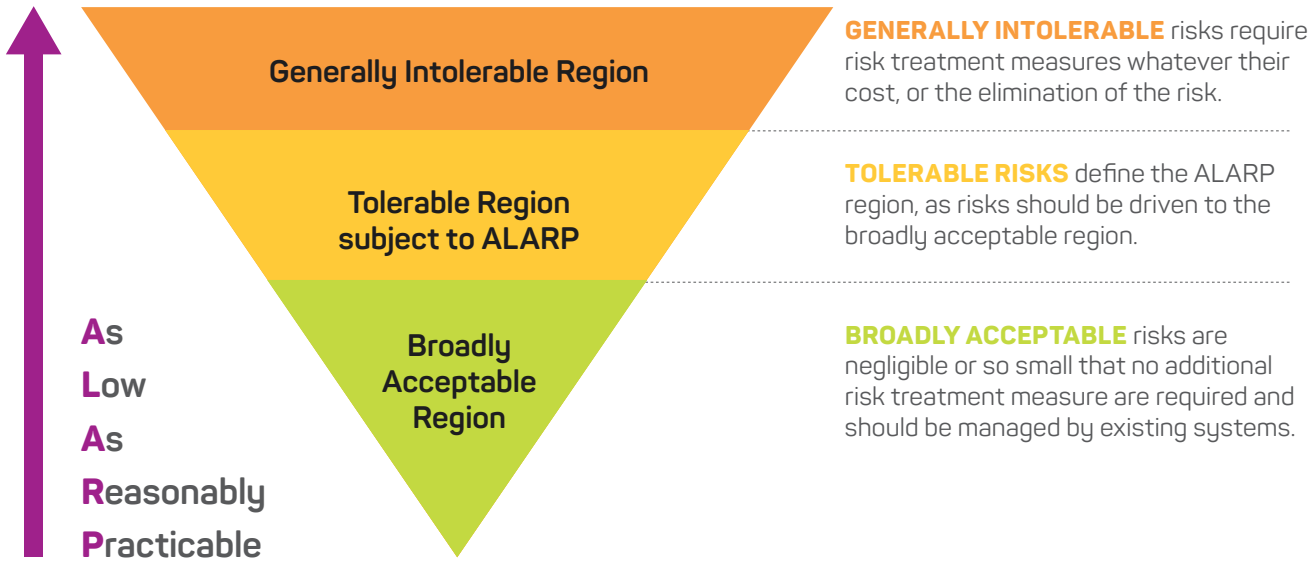

Figure 4: ALARP principle of risk tolerance levels (PIA 2015)

The following boxes provide one example where strategic planning prevented development earlier in the planning process due to disaster risk as well as three examples of some of the processes and assessment tools associated with the development and review of spatial plans.

Example 1: Strategic planning preventing development due to bushfire risk in Ingleside, NSW

In 2016 a draft *Land Use and Infrastructure Strategy* was released for community consultation by the NSW Department of Planning, Industry and Environment in conjunction with the Northern Beaches Council. The proposal considered the release of land for residential and business development that allowed for the development of more than 3,000 new dwellings. Following consultation, the safety of the plan was further investigated, and a Bushfire Risk Assessment produced. The assessment raised concerns about bushfire safety for Ingleside. It concluded that the proposed plan would introduce unacceptable risk to the community by constraining the existing evacuating routes and expose future residents to unacceptable bushfire risks. Based on this information, the Department of Planning, Industry and Environment together with Northern Beaches Council and Rural Fire Service NSW decided to withdraw the proposed draft Land Use and Infrastructure Strategy for the Ingleside area.

Following the decision to withdraw the proposed draft, further work was undertaken looking at ways to improve bushfire resilience for current residents, including carrying out a detailed bushfire evacuation model.

(Department of Planning, Industry and Environment 2018).

Example 2: Flood information to support land use planning

Guideline 7.5 Flood information to support land use planning (AIDR 2017) provides a basis for the development of flood information to support land use planning decisions.

The guideline outlines the process of developing constraint mapping for land use planning purposes. This information provides the basis for understanding existing flood behaviour in view of how flooding is currently managed, as well as for an understanding of how flood behaviour may be altered based on future catchment conditions.

The guideline then identifies typical high-level floodplain management objectives. The floodplain management objectives and the flood-related constraints must be considered by land use planning processes, which in turn support the use and development of land that is compatible with them. It must be acknowledged that constraints go beyond just the hazard. The guideline provides examples of typical treatment options to address these objectives when facing different flood planning constraints.

The guideline follows to provide information on the relative vulnerability to flooding. This considers both the potential use of developments in community response to floods and the relative vulnerability of land uses and their users to flooding.

Lastly, the guideline discusses how this information should be reported in studies meant to advice land use planning decision making.

Guideline 7.5 is available at: **www.knowledge.aidr.org.au/media/3519/adr-guideline-7-5.pdf**

Example 3: Cost-benefit analysis assessment

One of the tools that can be used in evaluation the alternative development scenarios for community resilience to disasters is a cost-benefit analysis assessment. This technique allows comparing the costs and benefits of a development plan or project over a period in monetary terms, contributing to identify less vulnerable valuable areas for long term planning and public spending. This assessment tool answers questions such as how costly would it be to reduce risk to certain level when developing an area. It can consider potential direct and indirect damages as well as tangible and intangible losses – social, environmental and economic. Cost-benefit analysis of infrastructure investments is an excellent tool for regional decision makers to use to assess implementation strategies of long-term resilience (PIA 2015). Some of the limitations of this assessment technique are associated to the difficulties of valuing non-market goods (for instance wildlife) and that it does not quantifies the distribution of the costs, benefits and overall impacts. Cost-benefit analysis assessments should be used in conjunction with other methods.

The paper *Integrating intangible values in economic analyses of flood mitigation: a case study of the Brown Hill and Keswick creeks catchment in Adelaide* (Florec, Chalak and Hailu 2017) undertakes an economic analysis of flood mitigation options for a high flood-risk catchment in Adelaide that illustrates and provides further details on this technique. Available at: **www.knowledge.aidr.org.au/resources/ajem-oct-2017-integrating-intangible-values-in-economic-analyses-of-flood-mitigation-a-case-study-of-the-brown-hill-and-keswick-creeks-catchment-in-adelaide/**

Example 4: Scenario testing

Scenario testing can contribute to strategic planning for disaster resilient communities. Scenario testing simulates and tests alternative potential scenarios using diverse parameters. These can be integrated within risk assessment processes and inform land use planning decision making, particularly at the strategic direction of new development.

The paper *Urban Planning Capabilities for Bushfire: Treatment Categories and Scenario Testing* (March, Riddell, Nogueira de Moraes, Stanley, van Delden, Beilin, Dovers and Maier, in press) sets out a framework for urban planning's decision support and future scenario testing to reduce risks relating to bushfire.

The paper *Exploratory scenario analysis for disaster risk reduction: Considering alternative pathways in disaster risk assessment* (Riddell, van Delden, Maier and Zecchin 2019) provides a methodology to capture the dynamics of the components of disaster risk within exploratory scenarios designed to test the effectiveness of policy responses to reduce disaster losses that illustrates and provides further details on this technique.

Chapter 6: Ongoing land use planning and implementation processes

This chapter identifies the importance of considering disaster resilience in the ongoing application of land use planning disaster risk reduction (DRR) plans and regulations in specific sites and places. Ideally the higher levels of planning trigger disaster resilience considerations, including the assessment and treatment of risk, and integrate the processes with the relevant agencies. This facilitates site-specific decision-making associated with the application and enforcement of disaster risk prevention land use policies, regulations and development controls to a site. The chapter outlines the main ways of implementation associated with the planning permit application processes and trough infrastructure projects. It then refers to the processes associated with planning permit and development approvals.

6.1 Day to day application of land use planning for disaster resilient communities

This section outlines the ways of the case by case application of land use planning for disaster resilient communities through planning permits and development approvals.

Land use planning gradually directs settlement change through the processes of planning permits and development approvals of individual projects that range in scale, purpose, and ownership. All new development and infrastructure projects should be based on strategic plans and must comply with the land use planning policies and plans. The site by site physical implementation of land use planning implies that change is gradual and continuous and that it depends on other stakeholders' motivations and needs to develop and use land. While land use planning does not exert absolute control over the actual use and development of land, it can play a significant role in decisions about where new development occurs, the design, characteristics and layout of development, and the activities that occur in particular places. The sum of small decisions associated with individual planning permits and development approvals has profound long-term impacts on the change and growth of settlements that take shape in a gradual and ongoing manner.

Considering that planning and urban development is largely driven by projects, mainstreaming disaster resilience considerations into planning permits and development approvals is critical. This is especially the case if projects are undertaken by the private sector, as they might have insufficient knowledge about the hazard, and they might prioritise short-term, individual gains above other long-term, collective development goals. Mainstreaming DRR considerations into planning permits and development approvals can build disaster resilience, for instance, by undertaking a detailed risk assessment for the project at the appropriate scales, ensuring the compliance with the regulatory framework and corresponding spatial plans; designing projects that are prepared to withstand a hazard and implementing mitigation strategies; and considering back-up measures (such as self-evacuation alternatives). Land reclamation and buy-back schemes are another way to address existing risks on a site-by-site basis. Sometimes, these schemes can be the ideal solution to treat existing risks that are considered unacceptable. However, they can be contested and expensive.

Table 5 summarises the main ways land use planning for disaster resilient communities is operationalised on a site by site basis and their potential role in disaster resilience.

6.2 Processes of case by case planning permit and development approvals

This section presents the planning permit and development approval processes as the main ways land use planning for disaster resilient communities is applied on a site by site basis, illustrating them with two applied examples.

Planning permit applications are assessed by local planning officers for compliance with the planning scheme components relevant to the proposal. During the assessment process, planners might be required to send the proposal to referral authorities designated in the planning scheme; referral authorities might refuse a proposal or condition their approval to certain requirements. Usually, if the proposal is considered minor the final decision is automatically made based on local planning officers' recommendations (that consider referrals' input), or if considered important councillors might have the final decision based on officers' recommendations. A permit can be approved, typically including conditions associated with the use or forms of development, or it can be refused. The applicant has the right of appeal or review (March 2015). The process of assessing single permit applications is the main way to apply and enforce land use policies, regulations and development controls to a site. Regardless of how minor applications might be, and the sum of planning permit decisions has profound long-term impacts on settlements' development paths.

The processes for assessing and approving urban development and infrastructure projects vary depending on the scale and type of project. Projects are usually assessed and administered by different state governments bodies. In some cases, larger projects can be prioritised and funded at the national level, but the administration usually still depends on state governments. Local governments can also undertake development or renewal projects of a minor scale. Decisions about individual urban development or infrastructure projects can have large impacts on the change and growth of settlements even if they are not strictly planning decision.

Table 5: Summary of the main ways land use planning for disaster resilient communities is operationalised on a site by site basis, and their potential role in disaster resilience

Instrument	What they entail	Role in disaster resilience
Planning permit application process	Planning permit application process implies applying policies, regulations and development controls set by the planning scheme to a site. All uses or developments are categorised in planning schemes as: no permit required, permit required, and prohibited. Based on this categorization, a project might require a planning permit. The planning permit application process acts as a mechanism to shape and control proposals that are broadly acceptable with defining details depending on the case, and to decide marginal cases (Rowley 2017).	Undertake risk assessment at the appropriate levels to promote context-specific decision-making based on pre-determined processes. Ensure compliance with the regulatory framework and corresponding spatial plans. Trigger a permit and DRR provisions based on spatial information about the hazard/risk (usually through 'overlays'). Require a detailed risk assessment at the appropriate scales. Ensure projects are designed to withstand a hazard and implementing mitigation strategies. Consider back-up measures (such as civilians' evacuation alternatives). Integrate the relevant government agencies in the decision-making process (usually as referrals).
Urban development and infrastructure projects	Urban development and infrastructure projects can provide new or upgraded support to communities. They include roads, parks, community centres, and education, sport and health facilities. Urban development and infrastructure projects are usually required when land is developed for urban purposes.	Undertake previously established tests to avoid the impact of natural hazards on infrastructure. Ensure compliance with the regulatory framework and corresponding spatial plans. Incorporate disaster resilience requirements and measures early in the conceptualization of the project. Consider redundancy and back-up measures. Integrate the relevant government agencies in the decision-making process.
Land reclamation and buy-back schemes	Land reclamation and buy-back schemes are compulsory or voluntary purchase schemes undertaken by the local or state government where warranted.	Alter settlement patterns and built form more directly to treat existing or future risks, based on processes previously established. Expand resettlement options for displaced people.

The processes to approve individual planning permits or developments to some extent follow a similar approach to the one presented in the procedural framework for land use planning for disaster resilient communities (Chapter 4). Their assessment is evidence-based and must ensure compliance with the regulatory framework and corresponding spatial plans.

Decision-making processes associated to the site by site application of land use planning can have profound impacts on risk prevention through the application and enforcement of land use policies, regulations and development controls to a site for disaster resilient communities. These decision-making processes should consider context-specific risks assessments on the basis of processes pre-determined at higher levels of land use planning. An important challenge is that decisions associated with individual sites and projects need to be consistently made from the perspective of disaster resilience. The consistency and coordination of individual approval decisions are highly dependent on the clarity and guidance articulated by the regulatory frameworks and spatial plans. Extraordinary processes such as the ones associated with major infrastructure projects often do not follow standard development processes, which implies that disaster resilience might not be fully considered. Furthermore, these processes are influenced by technical, political, procedural and moral dimensions that may compete and interfere with the application of disaster resilience policies and plans.

The following boxes provide two examples. The first one illustrates the planning permit and development approval processes as the main ways land use planning

for disaster resilient communities is applied on a site by site basis; the second one exemplifies land reclamation and buy-back schemes to more directly to treat risks by altering settlement patterns.

Well-informed decision making for developing or amending geographically specific land use planning instruments for managing change must be based on appropriate data gathering and hazards assessment, generation of development scenario and analysis of their potential risks, considering potential coincidental and interrelated effects of natural hazards and of other processes and phenomena that might follow them. Furthermore, the processes must be set to evaluate and select the development alternative that corresponds with what is considered acceptable risk levels and evaluate and select the residual risk treatment scenarios and alternatives. It is important to point out that certain levels of risk may be tolerated, provided that the risks are known and managed (AIDR 2020).

Where possible, it is important to use appropriate decision support tools that allow considering a range of options, especially in the decision-making processes of strategic plans. Scenario testing mechanisms, the risk matrix and the ALARP principle illustrated in the Table 4 and Figure 4 are particularly relevant to planners and other built environment professionals as they provide the means to categorise risks according to their severity, and to assign risk treatment options accordingly (PIA 2015). This allows determining the safest locations and regulations for guiding new development and to establish measures to treat risk to an acceptable level in the context of other goals such as development and change management. The consideration of disaster resilience during the process of developing and renewing spatial plans can greatly contribute to disaster prevention and yield significant returns on investment because it can avoid or significantly reduce the creation of new risks in the first place. However, the extent of the consideration of hazard related matters and the level of integration of other relevant stakeholders and agencies in these processes differs depending on the instrument and the hazard. Furthermore, these processes are influenced by technical, political, procedural and moral dimensions that may challenge the quality of their outcomes. For more information on risk assessment refer to the National Emergency Risk Assessment Guidelines (AIDR 2020).

Example 1: Planning permit applications subject to the Bushfire Management Overlay in Victoria

In Victoria, the planning permit application process can be triggered by the Bushfire Management Overlay (BMO). The BMO is an overlay included in the Victorian planning schemes that maps bushfire hazard. Clause 44.06 of the schemes specifies when a permit is required under the BMO. Clause 53.02 specifies the application requirements for areas subject to the BMO. If a permit is triggered by the BMO, applications must include a bushfire hazard site assessment, a bushfire landscape assessment, and a bushfire management statement. Furthermore, the relevant fire agency (usually the CFA) is specified as a recommending referral authority for a dwelling or a subdivision and as a determining referral authority for other applications subject to the BMO. Recommending referrals provide advice and guidance to the responsible planning authority. Based on all the information, the responsible authority decides whether to grant or refuse the permit.

The planning permit application process under the BMO considers key aspects of the implementation of bushfire resilience measures to specific sites. It triggers further considerations specifics to bushfire hazard. It promotes assessing bushfire hazard at different scales and frames the collaboration between planners and fire managers in the permit decision-making process. Furthermore, it allows mitigating bushfire risk via sitting and building design and construction and, to a lesser degree, avoiding individual developments that are constrained to provide the mitigation measures required and are located in high bushfire risk environments.

Example 2: Land reclamation and buy-back schemes in East Gippsland, Victoria

In East Gippsland, Victoria's 90 Mile Beach, thousands of lots were sold to individuals in the 1950s prior to planning controls being established. The land is located in a low-lying coastal dune system. Approximately 12,000 lots were sold, promoted as "Victoria's Gold Coast". Unfortunately, large areas of this land are flood prone along a 25km stretch of coast. In addition, the land is on unstable dune systems that are unable to be provided with utilities and reticulated services. The relatively small size of many of the lots, combined with the sandy soils and coastal proximity mean that septic waste systems are non-viable. Further, the removal of vegetation has often led to erosion and ground destabilisation.

As it became apparent that the land was unsuitable for development and planning systems were established over time, restrictions over clearing, earthworks and building were progressively introduced, often triggering considerable community opposition. Various statutory instruments have been introduced in attempts to redress the risks associated with development and use of the land. Flood and inundation overlays prevent development on low-lying lots. A Restructure Overlay was introduced that established a minimum lot size before development can occur on unstable land, in combination with a Vegetation Protection Overlay that restricts clearing. This means that a number of lots (typically between four and nine) need to be amalgamated via the planning system prior to seeking approval for a single house on one large lot. In combination, Council purchased some land as it became available on the market, or through a voluntary buy-back scheme. Later, some remaining land was compulsorily acquired through statutory mechanisms, although it was politically unpopular. Now, some 65 years later, the impacts of this unregulated land subdivision and sale are in the final stages of being resolved.

Chapter 7: Further issues and directions

This chapter elaborates on the limitations of land use planning for promoting disaster resilient communities, emphasising that resilience and DRR require comprehensive and interdisciplinary approaches. It lists some of the key issues that limit land use planning capacity and provides some directions forward based on them.

7.1 Competing technical, political, procedural and moral influences

Land use planning requires balancing a range of community and development priorities that might sometimes compete and even conflict with disaster risk reduction. It is fundamental that state governments clearly articulate the levels of disaster risk tolerance in the regulatory frameworks to guide the resolution of these conflicts.

Land use planning objectives might also intersect with the work and priorities of other stakeholders and government agencies. 'Planners and other built environment professionals must work in close collaboration with other natural hazard and emergency management practitioners in order to make that a reality, across multiple processes and with often competing objectives, priorities, funding constraints and other influences' (based on PIA 2015).

Land use planning also occurs in the context of political and wider democratic processes, which can influence decisions that are otherwise technical and regulatory in nature. Sometimes, land use planning for disaster resilient communities might need to apply provisions to treat risk that have implications in the existing rights of use and development of land or in the costs of development. These measures can be politically sensitive or perceived as unacceptable by the community. It is important to recognise these views during the land use planning decision making processes and balance them with the technical aspects underpinning the decision-making to avoid both compromising the quality of the outcomes or including provisions that will be contested.

7.2 Community engagement and balancing community expectations

Community engagement in any part of the natural hazard and associated emergency management and in the resilience planning process is crucial both to the success of land use planning and to support community awareness and understanding of hazards, and what the government and community can do to manage or respond to hazards. However, there are many and varied challenges to community engagement. Engaging with the community on a topic that may impact the development of their land and is emotive and potentially frightening as the risks of natural hazard presents significant challenges for planners, emergency managers and natural hazard practitioners. These challenges are unique to the local context across matters such as settlement and natural hazard history, community socio-economic profile and the actual characteristics of the hazards to which the community may be subject.

The community's views related to the risk of natural hazard can be heavily influenced by the most recent event experienced locally. Generally speaking, a community that has not experienced a natural hazard event in recent history is usually less receptive to discussing these issues than a community that has just experienced a major event, which may be receptive to discussions and taking measures to reduce the risk and recover, or a community that experiences events with more frequency, which can be more receptive of taking measures to reduce the risk. Furthermore, community concern over risk management and resilience building is likely to be greatest where there is inadequate hazard and risk information, where community expectations of the risk to which they are subject is lower than the actual risk (current and future), and where significant change to development rights is proposed through the planning changes developed to respond to the identified risk.

A major challenge in community engagement is balancing community expectations. Residents may resist the need for risk awareness and proposed management measures because they go too far in seeking to manage risks which might not have recently been experienced firsthand in the area, whereas other residents may resist the proposals because they do not go far enough (PIA 2015). Refer to the *Community Engagement for Disaster Resilience* handbook (In Press AIDR 2020) for further guidance.

7.3 Risk perceptions and the levels of risk acceptance

It is important that the level of risk tolerance is clearly articulated by the state and territory governments through the land use planning regulatory framework. Risks cannot be completely removed or anticipated, yet land use planning can promote settlements and development according to the level of risk tolerance defined by the system. The risk tolerance level should be associated with the level of risk that communities regard as acceptable or unacceptable. The definition of what is considered acceptable or unacceptable risk is fundamental to guide the decision-making processes of planning. Nevertheless, it is important to keep in mind that risk perceptions are different from different communities and that perceptions also vary depending on the visibility of the risk. Regulatory frameworks should calibrate this when articulating the systems' risk tolerance. For instance, a major bushfire disaster usually

alters communities' perception of bushfire risk and the levels of risk they consider acceptable. After such an event, the risk awareness increases, and it is likely that there is less risk tolerance. However, as time goes by the risk awareness is likely to decline if there is no other bushfire disaster that 'refreshes' the people's memory. Furthermore, some risks are less visible than others which also affects communities' perceptions of risks and the levels of risk they consider acceptable. For instance, heatwaves are less visible, and they are often not perceived as disaster risk, even though in Australia they have caused more deaths than any other natural hazard.

7.4 Capacity of agencies

A range of capability, capacity, financial and time-bound issues of planners, emergency managers and natural hazard managers and their agencies can preclude them from collaborating in planning for disaster resilient communities. Land use planning measures have been used for many decades to reduce exposure and vulnerability, yet 'not all built environment professionals have a detailed understanding or awareness of the challenges or how to address them' (PIA 2015). It is also often the case that planning, emergency management and natural hazard management agencies have limited financial and technical resources. Financial constraints and work overloads are impediments for incorporating natural disaster risk management into land use planning and for appropriate and timely collaboration, especially at the local level. It is important to build capacities through education to adequately equip planners, hazard leaders and emergency managers for decision making about disaster resilience. Furthermore, understandings about the roles, responsibilities and disciplinary emphasis are needed across the agencies involved in disaster resilience. For good and timely collaboration, the financial and technical resources available at the different agencies and levels must also be realistically estimated and dedicated to incorporate disaster resilience into planning. Policy integration intentions need to be matched with training and resourcing to encourage more effective collaboration between agencies.

7.5 Efficacy of emergency responders

Land use planning can promote developments that facilitate the response of civilians and emergency services. However, unsuitable settlement layouts can constrain and limit the response actions, and the efficacy of emergency responders. Layouts may hinder the efficacy of emergency responders by not considering responders' protection; their capacity to efficiently access and egress; or that civilian evacuation might occur simultaneously to responders' actions; among others (Gonzalez-Mathiesen and March 2014).

7.6 Strategic growth decisions that 'create' risk

Broad strategic decisions associated with future growth and land release often do not consider hazards and risks early in the process, limiting land use planning capacity to prevent disaster risk to remedial measures. The pressure to provide land for future growth and development can be high, and planning strategies and policies often provide indications of where growth is to occur. The direction of growth and development to suitable locations at this broad level is essential to avoid or reduce locational risk factors. However, there is a significant issue with the timing of the availability of information on natural hazards, and risk identification and treatment in urban planning associated to these instruments. Often these broad plans that guide growth decisions do not consider risk assessments, or they do later in their processes. Thus, it is common that new risks are created via land release or extraordinary processes prior to risk assessments occurring. This implies that land use planning regulations are only able to establish remedial measures, limiting the systems' capacity to promote disaster resilient communities.

7.7 Risk generation and transfer in a typical development process

Land development processes may generate and transfer risk. Land use planning requires balancing development with a range of community priorities. Community and development priorities might sometimes compete or even conflict with disaster risk reduction. Furthermore, land use planning objectives might also intersect with other government agencies' work and priorities. This implies that the typical land development processes are complex and entangled. It must be recognised that the reality of how these processes modify risk and have implications beyond the process. Decision makers are often unaware or unaffected by the implications of their decision. Decisions are often driven by private or political influences, and they can be made without adequate consideration of natural hazards and their risks and limited or late collaboration with emergency management and natural hazard leaders. However, the potential risks from natural hazards must always be considered early in all land use planning and development processes. Once risks are built-in to development it is difficult to reduce these without significant disruption and expenditure.

7.8 Rapid recovery processes that recreate risk

After a disaster, there is a planning opportunity to reconstruct in a way that communities are safer and stronger. However, this is usually difficult to achieve and requires commitment, dedication and leadership. Many challenges can be confronted during post-disaster planning activities, for instance associated with the timing of reconstruction, the conditions and standards required to assets to be reconstructed and the cost implication of them, the decision of whether heavily impacted areas should be reconstructed, and the emotional impact of reconstruction processes on communities, to name a few (PIA 2015). Unfortunately, it is often the case that the opportunity to 'build back better' after a disaster is missed and risks are recreated. Having in place land use plans that support rebuilding to more disaster resilient standards after an event can help to navigate some of these issues, increasing the chances to reconstruct communities that are safer and stronger.

Land use planning for building back better after a disaster

Typically, post-disaster recovery measures are implemented at state and local government level which seek to reduce red tape and allow the efficient process of rebuilding to occur. Planning provisions which interfere with this process are likely to be met with significant community aggravation. It is important that short, medium and long-term reconsideration plans are adopted. In the first instance this process should allow for immediate resumption of 'normal' community activity. Where the re-building of assets is required, these may take on medium or long term timeframes, but can be expedited by pre-planning for post-disaster activities that anticipate and address the need.

(*National Land Use Planning Guidelines for Disaster Resilient Communities*, PIA 2015)

7.9 Socioeconomic spatial disparities

Poverty and socioeconomic inequality are key determinants of individuals and communities' exposure to risks and the ability to cope. Vulnerability is disparate across a city or state. Usually, the poorest are disproportionately at risk due to their location, access to resources and socioeconomic spatial inequalities (UNDRR 2019). It is often the case that people living in the outer suburbs and peri-urban areas of Australian cities are more socioeconomically disadvantaged. Furthermore, these areas often lack infrastructure, such as parks, community centres, and education, sport and health facilities; have limited access to public transport; and fewer jobs are available. Land use planning can also influence the systems that support communities and interacts with other community goals such as the provision of community facilities and economic prosperity. However, land use planning does not exert absolute control of land. Rather, it interacts with a range of other actors as part of multiple systems. In many ways, socioeconomic spatial inequality and its impacts on risk management depend on careful integration of land use planning with a range of other actors and systems.

7.10 Climate change uncertainty

Climate change is generating new risks and aggravating existing ones by increasing the severity and frequency of natural hazard events. Publications produced by Bureau of Meteorology (BOM), CSIRO, NIWA and universities conclude based on scientific evidence now available that human-caused climate change has already influenced various weather and ocean hazards in Australia. Scientific research through the 20th century has established that human-caused greenhouse gas emissions are the primary cause of climate change. These observations continue into the 21st century with indicators of long-term trends such as global warming and rising sea levels. Increasing atmospheric greenhouse gas concentrations into the future will continue amplifying many weather and ocean hazards.

Cities both contribute and are affected by climate change. Land use planning has a role in climate change mitigation and adaptation as an underlying risk factor. In the processes of data gathering and analysis of land use planning, future climate change models should be considered and transparently communicated acknowledging the uncertainties associated with them. This is aligned with Principle 7 of this Handbook.

There is uncertainty on factors that influence natural hazards in future climate changes predictions. Uncertainties are influenced by the range of representative climate pathways (RCPs) used to reflect the uncertainty on the world's response to climate change and the differences between, and limitations and skills of climate models in modelling these RCPs and factors that influence different natural hazards. Up to date knowledge and consideration of relevant research can inform the understanding of how climate change may influence natural hazards over time.

Fit for purpose consideration of these changes in the understanding and modelling of natural hazards can provide insight of the sensitivity to change at an appropriate scale. Risk based approaches can support consideration of the impacts of climate change on natural hazards in decision making.

7.11 Existing settlements and settlements' ongoing management

Land use planning's capacity to deal with the risks associated with existing settlements is limited. In general, planning can only influence decisions about new development using existing powers and decision-making tools in approved planning schemes and documents, and appropriate regulations need to be in place prior to decisions being made about land use developments. Accordingly, land use planning provisions are not typically retrospective, meaning that requirements to modify existing legally permitted land use and development cannot be imposed. However, most existing settlements were built before DRR land use planning regulations were in place. In some cases, subdivisions and structures were located, designed and constructed with little or no consideration of their hazard exposure or based on old standards and considerations of natural hazards at the time. Despite this not being the typical focus of land use planning, it is important that planning agencies work collaboratively with other relevant agencies and seek to be involved in existing hazard management processes to examine options to manage the risks of natural hazard to existing settlements and implement retrofitting action to reduce the exposure or vulnerabilities of these areas.

Existing risk can be managed through specifying requirements or recommendations for redevelopment such as contemporary building materials, setbacks or floor level requirements depending on the natural hazard and planning constraints. It must be recognised that new land use planning interventions in existing areas can be contested and difficult to put in place and that some settlements at risk might be physically limited in their capacity to treat disaster risk. However, whilst redevelopment can take many years, and where the community is receptive to development controls, using these methods in conjunction with community engagement and emergency management land use planning may be effective in reducing the risk exposure and increasing the disaster resilience of the community over time.

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