

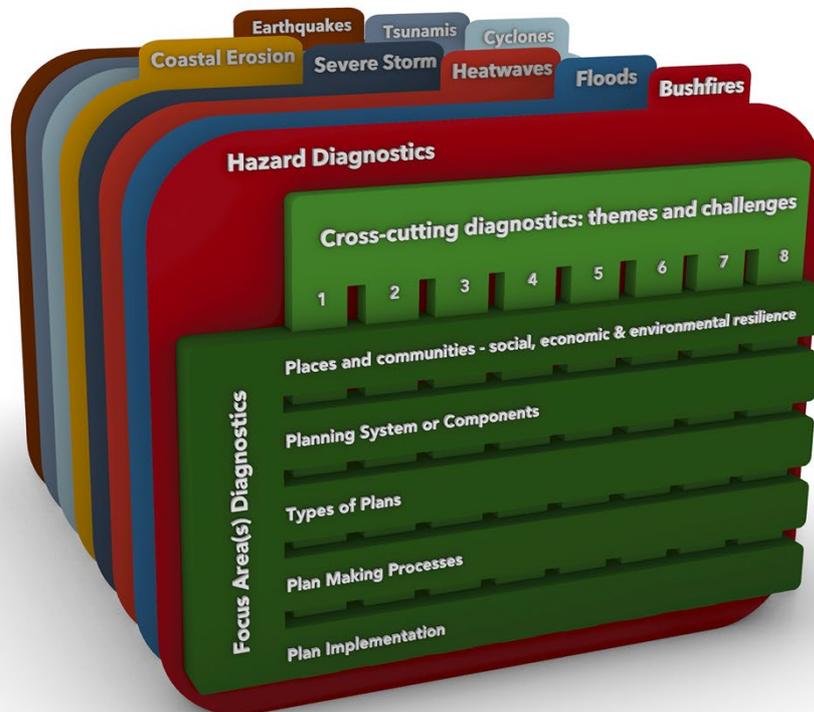


URBAN PLANNING AND NATURAL HAZARD RISK REDUCTION

Critical frameworks for best practice

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Cover: Types of diagnostic tools to assess urban planning and DRR integration by hazard

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EXECUTIVE SUMMARY

Urban planning offers a range of potential benefits to reduce or even avoid many of the risks associated with natural hazards. However, it is not always fully utilised as a core mechanism to manage natural hazard risks, particularly those relating to human settlements.

This document sets out a critical framework to guide improved integration of land use planning and wider natural hazard risk reduction actions. It is intended to support emergency managers and urban and regional planning practitioners in the complex task of integrating land use planning and disaster risk reduction in different Australian jurisdictions. The critical framework has been designed to speak to current terminology, processes and arrangements already used by these audiences.

The diagnostic tools are scalable and adaptable to various circumstances and needs. Hence, the diagnoses can be applied to particular hazards, certain geographical places, parts of or the entire planning system, or specific challenges associated with disaster risk reductions.

Three interconnected elements comprise the diagnostic tools, based on developing and applying knowledge regarding:

1. **Natural Hazards**, the sources of harm or situations with a potential to cause loss with their core transmission systems in the natural world.¹
2. **Cross-Cutting Themes**, core disaster risk reduction principles that apply to all urban planning, settlement and natural hazard circumstances.
3. **Diagnostic Focus Areas**, risk reduction principles that relate to key categories of urban planning, communities and the range of other systems they interact with.

The diagnostic tool includes a sequenced approach to examine complex situations and to develop logical and evidence-based directions for improved urban planning. This also allows improved connections with wider Disaster Risk Reduction practices.

- 1 – Establish Context, scope and key focus
- 2 – Analyse focus area(s) in terms of relevant hazards
- 3 – Analyse focus area(s) in terms of cross-cutting themes and challenges
- 4 – Analyse focus area(s) in terms of specific diagnostic focus areas
- 5 – Review and adjust or modify as appropriate

¹ It is assumed here that expertise and data will mainly come from a variety of credible sources as a basis for effective action. Accordingly, detailed descriptions of each hazard are not included here. Rather, reference to more exhaustive materials available elsewhere is provided.



END-USER STATEMENT

Ed Pikusa, *Manager Policy and Reporting, Fire and Flood Management Unit
Regional Programs Branch, Department for Environment SA*

Land use planning continues to be one of the best tools for long term reduction of disaster risk, particularly for geographic hazards including bushfire, riverine and coastal flooding, and storms.

The recent Black Summer of fires over 2019-20, also reflected in significant bushfires overseas, illustrate the risks of closely associating hazards, people and assets.

This project has worked closely with end users to try and reconcile the complexity and variety of hazards, and land use planning systems across Australia.

This diagnostic tool seeks to assess an inherently complex system, and provide guidance on the planning system features needed to meet disaster reduction or other strategic objectives.

It is highly encouraging that this project shifted direction early in its development in response to end user feedback, to work on this type of diagnostic tool.

It is also encouraging that progress has been made for a predominantly Victorian team to complete this stage of the project in the time of COVID-19.

In the last months of the current CRC, it would be desirable for end users to try and apply the method to their local situation to try and maximise its utility.

I commend the project team for their ability to complete this project in challenging times, and hope through continued end user support that this framework is able to be effectively used nationally.



INTRODUCTION

This document outlines a critical framework to guide improved integration of land use planning and wider natural hazard risk reduction actions. These frameworks have been developed to complement other key Australian documents such as the 2020 AIDR *Handbook on Land Use Planning for Disaster Resilient Communities*. They translate key principles of integration to allow interrogation of existing and proposed planning tools, systems and risk treatments.

From an international perspective, the critical framework outlined below seeks to provide clear directions for implementation of the 2015 *SENDAI Framework for Disaster Risk Reduction* and support the translation of UNDRR's 2020 *Land Use Planning Implementation Guide* to Australian land use planning contexts. At the Australian national level, this critical framework supports implementation of the 2011 *National Strategy for Disaster Resilience* and the 2018 *National Disaster Risk Reduction Framework*, while also responding to the 2019 report *Profiling Australia's Vulnerability*. The framework also takes into account the 2015 *UN Paris Agreement*, the 2015 *National Climate Resilience and Adaptation Strategy* and the 2019 set of volumes on *Guidance for Strategic Decisions on Climate and Disaster Risk*, acknowledging climate change as influencing emerging disaster risk by affecting the frequency and intensity of natural hazards.

The critical lens provided by this document is intended to support emergency managers and urban and regional planning practitioners in the complex task of integrating land use planning and disaster risk reduction in different Australian jurisdictions. The critical framework has been designed to speak to current terminology, processes and arrangements already used by these audiences. While each Australian jurisdiction undertakes land use planning and emergency management according to local circumstance, these processes can be interrogated using the critical framework presented here.

This framework has been structured as **diagnostic tools** supporting core urban planning, disaster risk and emergency management concepts outlined in the Planning Institute of Australia's 2015 *National Guidance on Land Use Planning for Disaster Resilient Communities*, the 2020 AIDR *Handbook on Land Use Planning for Disaster Resilient Communities*, the 2020 *National Emergency Risk Assessment Guidelines – NERAG* and the 2019 *Australian Emergency Management Arrangements*.

HOW TO USE THE DIAGNOSTIC TOOLS

The diagnostic tools presented here are designed to examine existing and proposed land use planning systems, places, plans and implementation processes from multiple viewpoints – primarily oriented to ongoing community resilience to natural hazards. These multiple viewpoints are necessary due to the scale and complexity of contemporary urban planning and the places, communities and other systems that planning systems interact with. These diagnostic tools can be used to fine-tune existing processes, to inform comprehensive system reform or as a reference used to interrogate scenarios deriving from different pathways of planning decisions such as those affecting urban expansion, the overall design of greenfield precincts, the schedules of a particular overlay or the conditions associated with a planning permit.

The tools can be used in conjunction with the 2020 AIDR Handbook on Land Use Planning for Disaster Resilient Communities and have been designed to enable tailored disaster risk reduction analyses of existing and future systems, plans, places and development. They are intended to work as an adaptable starting point from which systems and procedural design, plan-making and implementation can be interrogated and improved. The tools can also be used in parallel with quantifiable measurement of performance, such as that set out in *AS ISO 37123:2020 / ISO3713:2019 Sustainable Cities and Communities – Indicators for Resilient Cities*.

THREE INTERCONNECTED TYPES OF DIAGNOSTIC TOOLS

Figure 1 illustrates the proposed three types of diagnostic tools and how they interconnect.

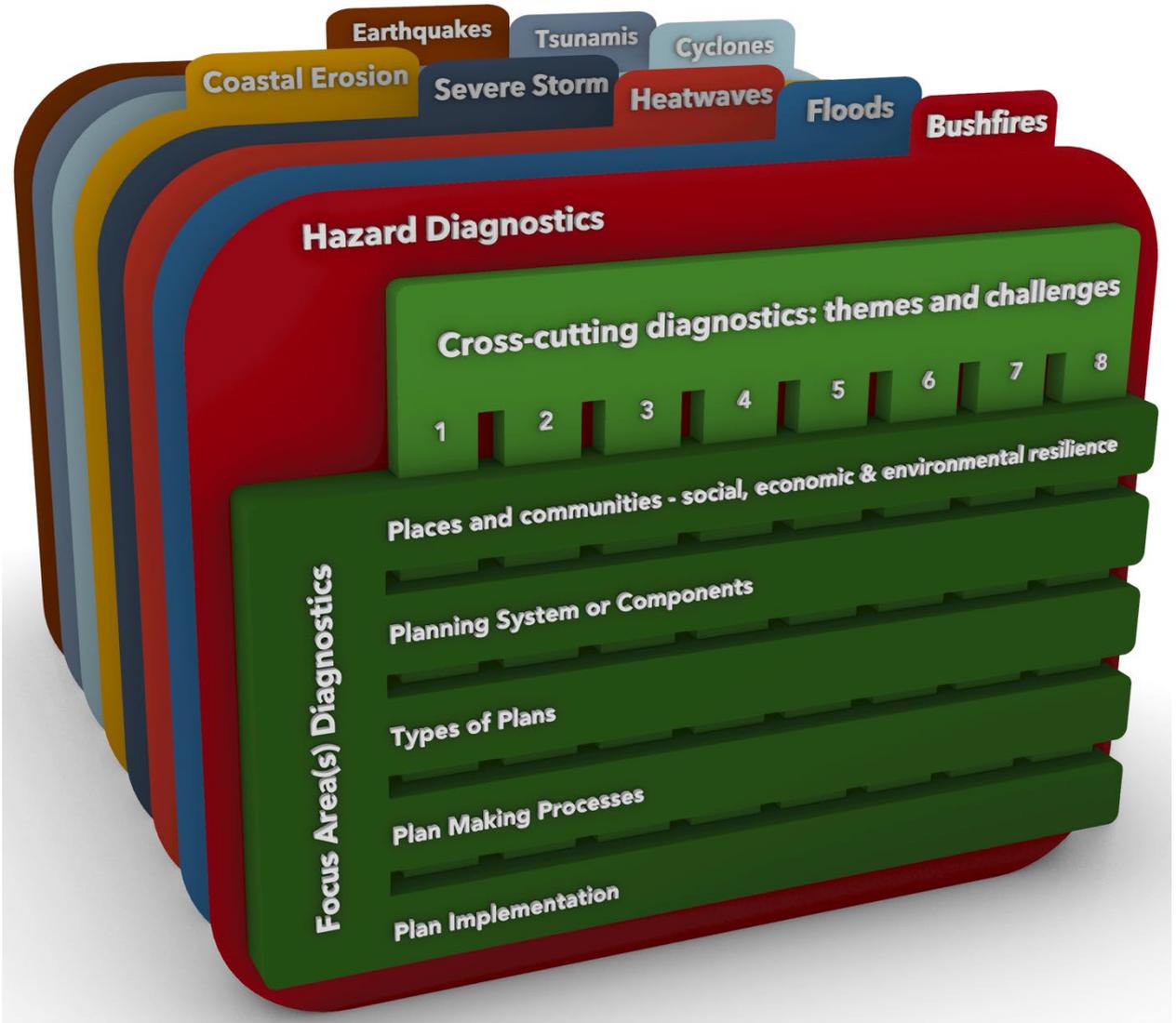


FIGURE 1: TYPES OF DIAGNOSTIC TOOLS TO ASSESS URBAN PLANNING AND DRR INTEGRATION BY HAZARD

The following three categories of diagnostic tool are explained in the body of the report.

1. **Natural Hazards** are the sources of harm or situations with a potential to cause loss with their core transmission systems in the natural world.²
2. **Cross-Cutting Themes** are core disaster risk reduction principles that apply to all urban planning, settlement and natural hazard circumstances.
3. **Diagnostic Focus Areas** are risk reduction principles that relate to key categories of urban planning, communities and the range of other systems they interact with.

² It is assumed here that expertise and data will mainly come from a variety of credible sources as a basis for effective action. Accordingly, detailed descriptions of each hazard are not included here. Rather, reference to more exhaustive materials available elsewhere is provided.

DIAGNOSTIC STEPS

Figure 2 illustrates key steps for using the diagnostic tools to assess current and future systems, plans, places and development. While these steps are not intended to be prescriptive, they encourage comprehensiveness to ensure wider aspects of integration can be appreciated.

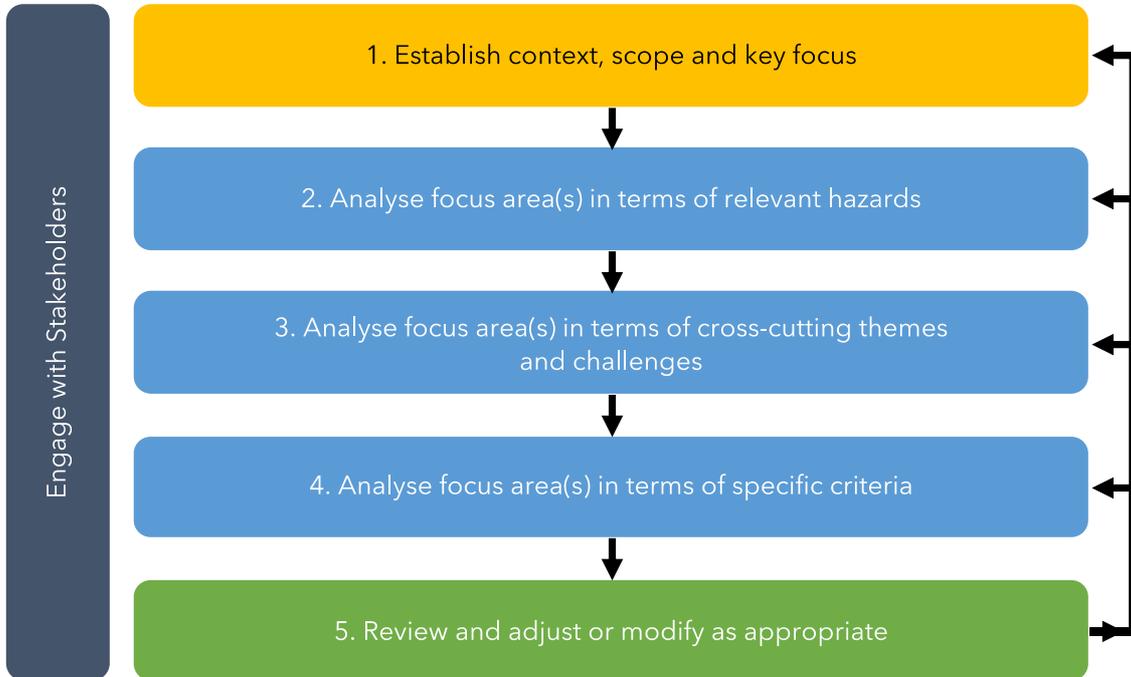


FIGURE 2 – SUMMARY OF DIAGNOSTIC STEPS.

1 – Establish Context, scope and key focus

Includes the selection of components of the planning system or geographic area.

2 – Analyse focus area(s) in terms of relevant hazards

Identify relevant hazards to the focus area(s) and seek to describe and analyse them.

3 – Analyse focus area(s) in terms of cross-cutting themes and challenges

Analyse according to the eight cross-cutting themes.

4 – Analyse focus area(s) in terms of specific diagnostic focus area criteria

Apply diagnostic tools specific to the hazard and planning focus

5 – Review and adjust or modify as appropriate

Review findings and effectiveness of study and adjust as needed. Ensure ongoing learning, knowledge production and use occurs.

NATURAL HAZARD DIAGNOSTICS

Disaster Risk Reduction requires the integration of multiple factors, including detailed knowledge of natural hazards relevant to a geographical location and the ways that risks can result from the interaction of these hazards with humans, the natural and “built” world, and our environmental, social and economic systems. Before assessing disaster risk, it is critical to develop a foundational understanding of hazards and their characteristic in given locations and circumstances.

KNOWLEDGE OF NATURAL HAZARDS

When seeking to integrate land use planning and disaster risk reduction, making sense of relevant natural hazards through a set of specific enquiry criteria can be a critical starting point. Here we propose an assessment of land use planning as to whether it includes, enables or requires the following as appropriate:

1. Knowledge of the natural hazards that are likely in the jurisdiction, based on up-to-date data
2. Spatial distribution, intensity, frequency, duration and other relevant hazard aspects
3. Understanding of the mechanisms of spatial and functional interaction between the hazard and human and natural systems including likelihood, expected consequences and other relevant aspects needed as a basis to determine risks in related systems
4. The potential impacts of human and other factors such as climate change upon the hazard. Also consider indirect consequences.
5. Ability to access and use relevant data in conjunction with relevant agencies and other relevant parties during planning processes.

Summarised illustrative application of the proposed enquiry criteria to severe storms³:

Severe storms can occur anywhere in Australia and generally manifest more often than other natural hazard events. They can 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 include hail, strong winds, heavy rainfall, flash floods and storm tides that can impact on structures and people.

Wider risk drivers

- Climate Change
- 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.

³ See AIDR Land Use Planning for Disaster Resilient Communities.

CROSS-CUTTING DIAGNOSTIC THEMES: DRR & URBAN PLANNING INTEGRATION

Successful Disaster Risk Reduction (DRR) is based on the integration of multiple factors that shape risk profiles across locations and systems. While urban planning is the key focus of this document, an approach to assess its integration with disaster risk reduction needs to encompass other related factors. The questions set out below allow the critical examination of planning processes and settings in line with **eight cross-cutting diagnostic themes** or principles for integration⁴.

CROSS-CUTTING DIAGNOSTIC THEMES

Q1 – Are potential risk treatments integrated and fully used across Prevention, Preparedness, Response and Recovery?

There are five core categories of action that, together, represent the full use of possible risk treatments, depending on the particular nature of risk in given locations.

1. Avoidance of Exposure / Separation from Hazard
2. Reduction of Hazard
3. Reduction of Vulnerability to Hazard
4. Preparedness for, and Facilitation of Appropriate Response
5. Preparedness for, and Facilitation of Appropriate Recovery

These are represented diagrammatically in Figure 3, using bushfire hazard as an example:

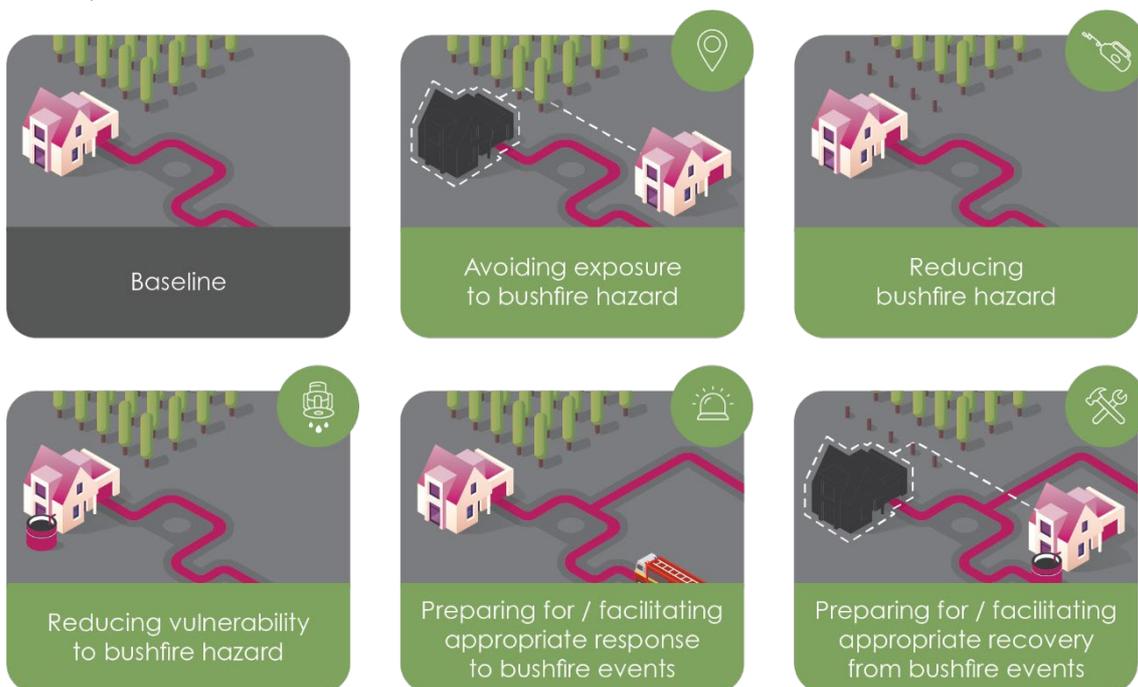


FIGURE 3 – CATEGORIES OF URBAN PLANNING RISK TREATMENTS: BUSHFIRE HAZARD EXAMPLE

⁴ See March et al. (2018, p. 19) and March, Nogueira de Moraes, Riddell, et al. (2020, p. 10).



The terms Prevention, Preparedness, Response and Recovery (PPRR) are used to represent the broad interlinked phases of emergencies and disasters^{5, 6}. Theoretically, the five categories of risk treatment can be undertaken during each phase of PPRR⁷, although this is dependent on specific circumstances. For example, to implement avoidance of exposure and reduction of a hazard usually requires actions to be taken prior to any emergency or disaster event, often over long time horizons. Table 1 shows the typical emphasis placed on risk treatments across PPRR. It is suggested that effective risk reduction would much more fully utilise these treatments across PPRR in ways that are complementary. Emphasis on prevention and preparedness will yield the greatest benefits.

Treatment Approach	Typical Application Phases			
	Prevention	Preparedness	Response	Recovery
Avoidance of Exposure / Separation from Hazard				
Reduction of Hazard				
Reduction of Vulnerability to Hazard				
Preparedness for, and Facilitation of Appropriate Response				
Preparedness for, and Facilitation of Appropriate Recovery				

Legend	Minimal	Little	Some	Extensive
Level of Treatment				

TABLE 1. PPRR BY TYPICAL TREATMENT CATEGORIES

Illustrative Example - San Francisco Non-Potable Water Ordinance

The City and County of San Francisco 2012 adopted the Ordinance "Onsite Water Reuse for Commercial, Multi-family, and Mixed Use Development" in 2012. Widely known as the Non-Potable Water Ordinance, it modified Article 12C to the San Francisco Health Code. It allows and in many cases requires, collection, treatment, and use of alternate water sources for non-potable uses in individual buildings, as well as at the district scale.

Being able to collect alternative water sources such as greywater, rainwater, stormwater allows for a range of integration benefits that achieve shared objectives across a number of agencies and stakeholder groups. Benefits include preparedness and prevention of flooding severity and demands on response agencies via reduced volume and velocity of storm flows, reduced damage to infrastructure and buildings, reduction of potable water use, integration with plant watering and greening programs, and contributions to drought proofing and heatwave risk reduction programs. The Non-Potable Ordinance represents integration of goals and actions across multiple agencies and discipline areas including: engineering, architecture, health, landscape architecture, city planning, water utilities and response.

Ongoing work is occurring at state and national level to develop more widely applied guidance and policy frameworks for local jurisdictions to overcome barriers to onsite water retention and reuse. At national level, establishment of the National Blue Ribbon Commission seeks to develop model state government policy and resources to that demonstrates best practice onsite non-potable water systems that also assist utility organization achieve environmental and efficiency goals set out in the One Water charter.

⁵ See AIDR (2019).

⁶ In Victoria, these are summarised as Prevention, Response and Recovery (PRR), with Planning, Preparedness and Coordination considered three elements of the underlying structure that subsidises PRR - see EMV (2018, pp. 1-2).

⁷ See Appendix 2 for examples of possible intersections in the case of bushfire hazard DRR.

Q2 - Are the full spectrum of legacy, projected and emergent risks spatially considered on the basis of up to date hazard mapping and integrated spatial assessment?

Effective Disaster Risk Reduction requires urban planning provisions and decisions to be based on considered risk assessments. Accordingly, any subsequent actions and decisions can be made in informed ways. The starting point for assessment of risks is up to date hazard mapping. After hazards are understood, an assessment of risk can then be made based on the likely exposure of vulnerable elements to the identified hazards for a given location. Risk is assessed by determining the likelihood of a given negative outcome in terms of its expected consequences.

Integrated urban planning needs to act and have influence across legacy, projected and emergent risks. The determination of acceptable levels of risk and subsequent establishment of policy and regulation to achieve this as a minimum must underly all urban planning. Legacy risks are pre-existing and a result of historical decisions, such as previously built housing located near coastal areas that are being eroded over time. Projected risks are those that are likely to exist in the future if a proposed action or collection of actions were to occur, such as ongoing development or a planned subdivision in an area that is within a floodplain. Emergent risks are those that are changing over time due to changed conditions, such as climate change.

Illustrative Example - San Francisco Hazards and Climate Resilience Plan

The climate change impacts of increasing temperatures, rising sea levels and changing precipitation patterns on hazards (namely heatwaves, drought, wild/urban fires, coastal and stormwater flooding, soil liquefaction) are considered quantitatively in the San Francisco Hazards and Climate Resilience Plan (2020, p.54-65).

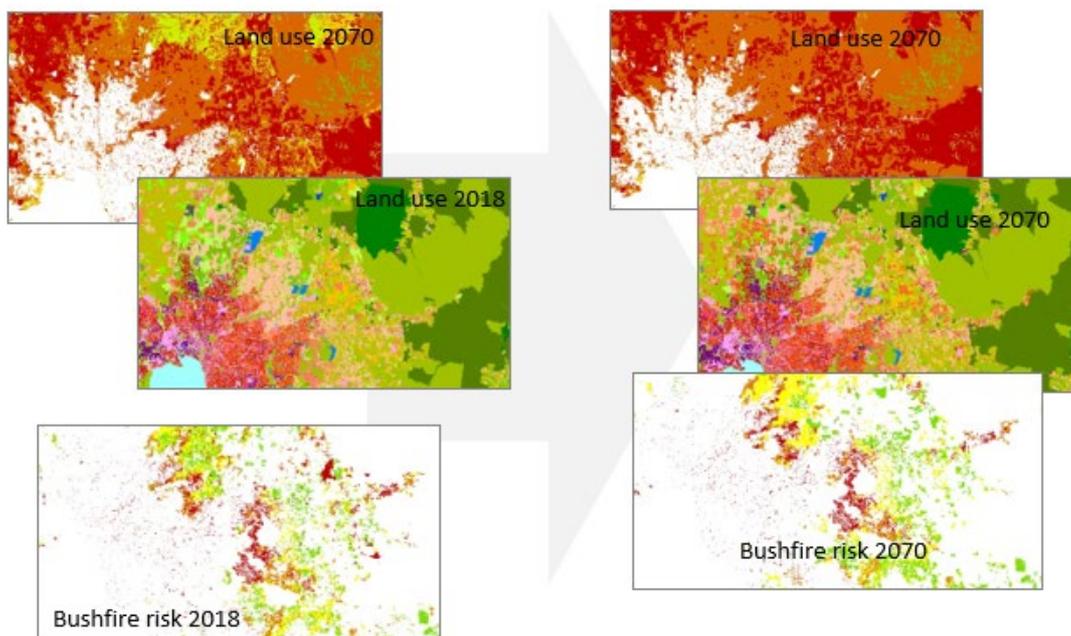
Planning issues for subsequent community exposure and vulnerability to natural hazards identified in the San Francisco Plan include (p. 201–7): Waterfront Communities, New Developments, Existing Aging Building Stock, Housing (affordability, crowding and displacement), Public Awareness and Communication and Disruptions to both Critical Transportation Networks and Utilities. The above issues capture legacy (Waterfront Communities, Aging Building Stock), projected (New Developments) and emergent (Climate Change) risks.

Illustrative Example – Unharmred Scenario Testing and Decision Support

Risk profiles are not static. Climate change and socio-economic developments impact on the key characteristics of risk: hazard, exposure and vulnerability and thus impact on the frequency and severity of the hazard, who and what is affected and the susceptibility of these values to the characteristics of the hazard. Although there is a general understanding that our future will be different than the present, the quantification of those changes and related future risk profiles is often lacking in policy development, often because of the uncertainties related to them and the difficulties in making these quantifications. Simulation models can help to better understand the current and future risk profiles and explore the impact of future uncertainties on them. Moreover, these tools can help to assess the impact of risk reduction strategies now and in future and thus help to make planning more future proof.

An example of such a tool is UNHARMED, a decision support system for natural hazard risk reduction. By simulating current and future hazard frequencies and magnitudes; demographic, urban and natural environments; and the vulnerabilities of these assets to hazards, it calculates dynamic risk profiles at a high level of spatial detail. This information allows planners and policy makers to target risk reduction options to areas most at risk, tailor the needs to the social, economic, and environmental assets at those locations, and better embed risk reduction strategies into strategic spatial planning.

Such tools allow assessment of the likely implications of different mitigation options (structural, changes to building codes, spatial planning, land management, awareness & education) are on the reduction of risk across the various hazards, as well as on other relevant aspects of the natural and built environment. The dynamic nature of these approaches also allows for the cost benefit calculation for those costs and values that can be monetized.



Q3 - Are goals, objectives and other relevant guiding principles and terminology integrated across relevant systems?

Urban planning and emergency management processes and actions are guided by a range of higher order goals and objectives, while using terminologies with carefully defined meanings. These cut across policies, statutes, regulations, doctrine and other decision-making processes in a range of ways that influence outcomes. These will integrate horizontally and vertically across systems. Clearly defined and agreed terminology provides for clarity and common language across agencies and modes of action.

Disaster Risk Reduction goals can only be achieved if the goals, objectives and terminologies that influence and inform decision making mechanisms integrate across all tiers of governance, agencies and processes. In that respect, sub-optimal outcomes are likely to result if urban planning objectives seeking ongoing land development are more highly “weighted” than risk management objectives and lower tier assessment guidelines. Further, if urban planning goals and objectives do not integrate with those of emergency services, the achievement of response objectives may be significantly compromised.

One example of the importance of terminology concordance, is the use of the term hazard, which is defined in the National Emergency Risk Assessment Guidelines ⁸ as: “a source of potential harm or a situation with a potential to cause loss”. Flood waters during an actual or modelled peak event are an example of a hazard. Risk occurs only when vulnerable people or assets are exposed to this hazard, for example by housing being located in this area. Currently, some urban planning regulations use the terms hazard and risk interchangeably, which confuses the processes of identifying and mapping hazards, and then assessing risks as part of decision making.

Illustrative Example – Auckland, Embedding Risk-Based Hazard Management in Planning Frameworks

Auckland’s 2019 Natural Hazard Risk Management Action Plan (NHRMAP) sets out a range to risk-based actions, based on an initial description of the hazards themselves, comprehensive risk assessment, and the allocation of tasks and responsibilities across a range of agencies and stakeholders. A key component of actioning the NHRMAP is the integration and embedding of risk-based natural hazard management into Auckland’s Planning Framework.

Developing a common language of risk and terminologies across these documents is identified as a requirement (p. 73). The interdependencies in natural hazard risk management between planning, development and resource allocation are recognized.

The extensive report also includes in each of its the 42 distinct actions links to other action plans, frameworks, objectives, some which relate to broader national strategies, representing horizontal and vertical integration.

Illustrative Example – Novel risk assessment and quantification approaches in the Netherlands

The Flood Risk in the Netherlands Project applied the risk approach to the entire country, analyzing the probability of levee breaches and the possible consequences of a flood. The high water load, strength and height of flood defences and the potential impact of flooding have been considered for the first time in simultaneously, providing a spatial distribution of flood risks in the Netherlands.

The Netherlands considers the impact of single or multiple sea wall breaches and expresses these alternatively as economic risks, individual risks and societal risks. For example, individual risk and an annual probability that an notional person at a particular place in the protected area will die as a result of flooding in the area can be calculated.

⁸ See AIDR (2020, p. 109).

Q4 – Are relevant legislative, regulatory, policy and planning provisions integrated across systems?

The activities, powers and responsibilities of urban planning, emergency management and related agencies are enabled by legislation, policies and regulations. While considerable activity and integration occurs outside of mandated arenas, provision for key points of intersection in decision-making, information and data sharing, responsibility and establishment is central to integration. This will occur vertically and horizontally across relevant systems.

Illustrative Example - New Zealand's Climate Emergency – An Opportunity for Risk Management Integration

New Zealand's nationally declared state of climate emergency has created an opportunity for councils to integrate legislative, regulatory, policy and planning frameworks across systems, under the wider framing provided by national legislation and policy.

Significant inconsistencies between natural hazard risk management and planning frameworks have been identified in Auckland, New Zealand. A range of issues which have been identified and need to be rectified to allow integration. These include: irregular definitions of relevant hazard and risk concepts; the need for standardization of required planning timeframes and climate change scenarios within legislation, and; omission of relevant risk reduction objectives within planning documentation.

This process of identifying inconsistencies and omissions provides opportunities for understanding the range of documents, policies, agencies, stakeholders and actions seeking to deal with natural hazards risks, along with wider challenges, such as climate change. Further, it provides pathways for the allocation of actionable tasks, timeframes and identification of new opportunities.

Q5 – Are relevant local, cultural, social, economic and ecological matters acknowledged and taken into account?

Urban Planning and Emergency Services operate in settings that require careful acknowledgement of the diverse range of objectives, values, understandings and goals that exist in human settlements and natural systems. Accordingly, achievement of DRR goals need to be aligned with other relevant goals and systems in given locations. Many examples exist. Culturally embedded practices of land management may need to be aligned with fuel reduction, tourism and modern agricultural processes. Retention and preservation of heritage places may need to be aligned with modern standards of risk management and the economic realities of building maintenance. Socio-economic aspects may significantly impact upon the vulnerability of certain communities and their propensity to engage with emergency services.

Illustrative Example - Vancouver: Recognising the value indigenous people bring to city-wide resilience

The Musqueam, Squamish and Tsleil-Waututh Nations are the traditional landowners of the city now known as Vancouver. The city's 2019 Resilient Vancouver strategy recognises the importance that these indigenous groups bring to building resilience within modern day Vancouver. Particular stressors which afflict indigenous peoples are recognised as reducing city-wide resilience. Day-to-day challenges that disproportionately affect indigenous peoples include homelessness, gender inequity and racism.

Uniquely, the reduction in culturally appropriate food retailers and indigenous food sources are highlighted as further challenges to resilience. At a strategic level, the City of Vancouver aims to integrate the Resilience Plan and the Reconciliation Framework in strengthening the resilience of both First Nations people and others living in the city. At an operational level, the Resilient Vancouver Plan highlights ongoing initiatives to give indigenous names to civic facilities (The néca?mat ct Strathcona Library (p.55) and Objective 1.1.A(p.54)) to build awareness for indigenous heritage and reconciliation. Objective 2.1.A (p. 66) further seeks to incorporate indigenous knowledge and culture into climate and disaster resilience risk actions. The strategy says:

"we have much to gain and learn by recognizing and elevating the knowledge of Indigenous Peoples, who have been here for millennia and have long embodied resilience and reciprocity through law and culture"—Resilient Vancouver (p. 16).

néčá?mat ct Strathcona encompasses the idea of 'we are one' in the hənícəminíəm' (Musqueam) language. This name recognizes and honours the Coast Salish peoples and their traditional unceded territories, while also reflecting the neighbourhood's historic city name, Strathcona. Local First Nations were consulted on the branch name in relation to suggested First Nations names and the use of specific Coast Salish languages.

Pronouncing néčá?mat ct

- The first syllable "néč" is pronounced in a way that is very similar to the English word nuts.
 - The unstressed "á?" is identical to the underlined vowel in but.
 - The "á" in the last syllable is the same as the underlined vowel in father.
- "mat" also rhymes with the name Mott as in Mott's Clamato juice.
The two letters at the end sound like tst

Q6 – Are relevant processes integrated across relevant systems – vertically and horizontally?

Urban planning, emergency and other DRR-related activities include a range of routinised or semi-routinised processes, usually run by key agencies, through which outcomes are sought. These include the ongoing development of plans and policies, regulations, doctrine and encompass the range of actions within the broad categories of Prevention, Preparedness, Response and Recovery. The complexity of processes and their tendency to be "owned" by particular groups means that they may be carried out in ways that do not integrate at key informational or decision points, undermining the achievement of wider goals. For example, the ongoing identification of land for urban expansion often occurs well in advance of other processes such as hazard mapping or risk assessments of new development proposal. This may result in new development occurring in areas where it is difficult to treat risks. Similarly, fast-tracking processes to approve major projects that achieve important economic goals but circumvent risk assessment procedures could lead to sites and their infrastructure being at risk of natural hazard exposure. At a site-specific scale, the failure to refer an application for new dwellings near heavy vegetation to a fire agency might lead to structures being built to a standard inadequate to withstand bushfires. Overall, systematised processes must integrate at key points to ensure relevant information informs decision making.

Illustrative Example - San Francisco: Stakeholder engagement and integration, vertically and horizontally

San Francisco's engagement process is outlined in the Resilience Strategy, and requires consultation of neighboring jurisdictions, national plans, public and businesses. Inclusion of Departments of Planning, Public Health, Environment and Emergency Management on the Steering Committee and Technical working group represents horizontal integration of stakeholders in the planning process.

Additionally, the engagement of neighbouring counties and jurisdictions in the stakeholder process further integrates actions. Vertical integration occurs upwards through the engagement of federal officials and use of California State level documentation of hazard and mitigation planning. Downward vertical integration is undertaken via the inclusion of neighborhood interest groups, councils, and community-based organizations in resilience planning.

Of particular importance is the specific engagement of vulnerable sub-groups within the consultation process, including minority racial and social justice groups, children, youth and families, disability and functional needs adults and elderly adults. Representation of these groups within resilience planning captures the needs of the most at-risk communities.

Q7 – Are all relevant stakeholders represented in key processes and activities?

Stakeholders can be understood as a “...person, group of people or organisation that can affect, be affected by or perceive themselves to be affected by a decision or activity”⁹. The potential impacts of natural hazards across communities and the need for complex, long-term and integrated approaches mean that a diverse range of stakeholders are likely to be impacted by disaster events. Furthermore, many aspects contributing to reduced risks and improved resilience exist across diverse stakeholder groups. A key aspect of DRR integration is the considered identification and active inclusion of stakeholders across the range of processes, decisions and activities contributing to risk reduction. Inputs from stakeholders may be diverse and include the identification of important cultural or location-specific information, technical inputs, sharing of expertise and data, generation of ideas, and development of relationships and trust that can contribute to improved resilience.

Illustrative Example – Stakeholder Involvement within the Adaptive Greater London Authority Strategy

A fundamental aspect of stakeholder involvement and representation is establishing strong systems that ensure involvement and input of relevant persons and stakeholders, in parallel with a need for adaption to changing circumstances, new challenges and societal change.

The Greater London Authority (GLA) seeks to acknowledge and deal with the challenge that, while London's emergency planning and response structures engage a variety of agencies and are robust, the medium-term planning and prevention resilience structures may not always have these qualities. Plans, legislative and regulatory structures and relationships between multiple agencies can become outdated or unsuited to new and emergent challenges.

Accordingly, the GLA's London City Resilience Strategy (2020, p.65-7) targets this weakness at Actions C1 and C2, which develop a more adaptive planning strategy for planning and prevention against hazards in the medium term. This project seeks to “enable the rapid and ongoing circulation of policy ideas and information, involving policy teams and stakeholders in a dynamic learning process” (London City Resilience Strategy 2020 p.66). Through creating agile governance structures the GLA aims to better represent stakeholders, institutions and local peoples in more adaptive and responsive ways.

⁹ See AIDR (2019, p. 118).



Q8 – Are the range of financial and investment mechanisms integrated with other processes, activities and goals?

Human settlements change dynamically according to a range of financial and economic influences outside the reach of urban planning and DRR systems. Additionally, many actions are taken seeking DRR outcomes via financial or granting systems that are relatively independent of one or both of urban planning and emergency management agencies. For example, urban growth can be strongly influenced by government housing policy at federal, state and local level. Buy-back schemes, disaster relief funding, development of infrastructure, and special project or capital works grants aimed towards DRR goals can be funded by various agencies for a range of purposes. The coordination and integration of these financial influences upon settlements and the ways risk is managed over time is necessary to achieve desirable long-term outcomes.

Illustrative Example - San Francisco Funding and Financing Capabilities for Disaster Resilience

Harnessing and integrating the various monetary influences and actions relating to natural hazard risk reduction poses many challenges. Appendix F to the San Francisco Hazards and Climate Resilience Plan (2019) identifies 22 financial mechanisms which facilitate the broad development of resilience, seeking to draw these together to ensure concerted action in the short, medium and long term.

A total of 22 financial capabilities are detailed in the plan. These extend across financial mechanisms including: a ten year capital plan; capital appreciation bonds; catastrophe bonds; departmental general revenue bonds; improvement and property tax levies; geological hazard abatement district financing; and, resilience bonds.

An example is the ability of the City and County of San Francisco to “levy an assessment against businesses or property to fund services or improvements that benefit the assessed value of businesses or property within a given overlay area” (Appendix F, p.3). Other examples include the catastrophe bonds and resilience bonds which provide insurance and financing for adaptation, resilience and recovery projects. In the case of catastrophe bonds: “Financing comes from rebates to sponsor government action where rebates are used to reduce exposure and risk. Thereby, investor risk is reduced and premiums go down for the sponsoring entity” (Table F1, p.4).

UNDERSTANDING AND ACCOUNTING FOR CHALLENGES

Coupled with the cross-cutting diagnostic themes is the need to recognise that land use planning's critical role in creating and addressing disaster risk is confronted with a set of challenges. These are complex and multi-faceted, evidenced in the ways environments are reshaped and land is used and developed by different groups. As shown in Figure 4 below, the risk profiles in a given place are the result of multiple drivers over time.

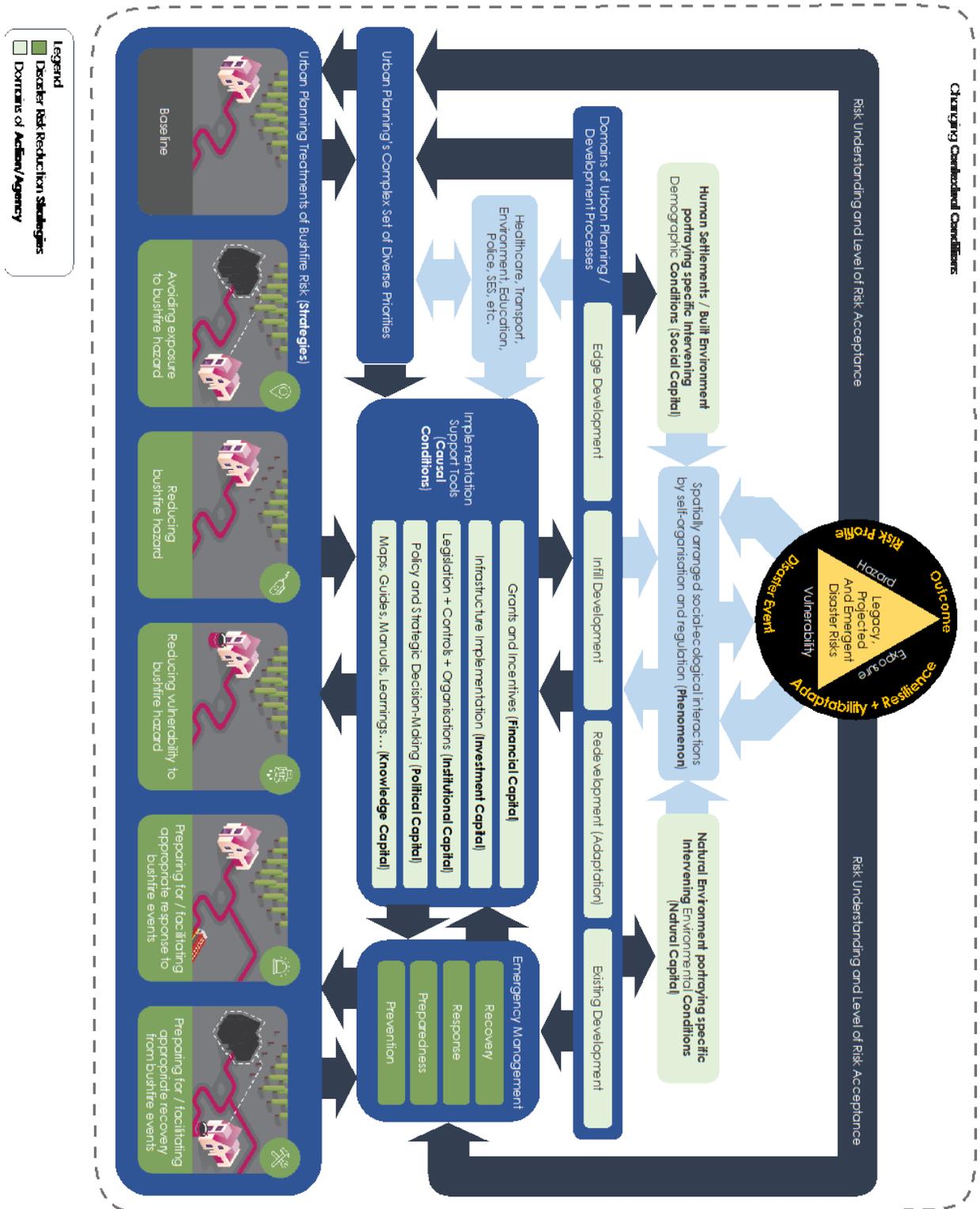


FIGURE 4. COMPLEX INFLUENCES ON ADAPTATION FOR NATURAL HAZARD DISASTER RISK AND RESILIENCE VIA URBAN PLANNING

Accordingly, it is suggested here that key challenges facing settlements' resilience to natural hazards are understood and accounted for, as appropriate. The list below seeks to outline some of these key challenges, but by no means is it an exhaustive account¹⁰:

- **Disaster risk is dynamic** – place-based and time-specific. As landscapes are developed and managed in certain ways, disaster risk levels keep changing. They also change based on contextual factors such as climate change, which adds further complexity to the equation. This requires mechanisms to reduce disaster risk not only in new developments but also in existing ones as the *riskscape* changes.
- **Disaster risk is an output of built environment development and change processes and their outcomes**, requiring hazard mapping and disaster risk to be ongoing processes.
- **Short-term and long-term risk treatment outcomes may differ and need to be synergistically considered and “balanced”**. This is challenging when decision-making is spread horizontally and vertically across different aspects of government, within different neighbouring municipalities or states, and between agencies with partially overlapping domains, thus requiring a coordinated approach.
- **Different temporal and spatial scales** apply to hazard events, site and settlement development and climate change, requiring risk assessment and treatment to be forward-looking and considerate of legacy and emerging risks.
- **Feedback processes interlink risk assessment and treatment**. This requires careful consideration of multiple scenarios in which treatments designed to respond to a certain risk assessment will result in new levels of risk once these treatments are implemented.
- **Various stakeholders are involved** in risk assessment, understanding risk and its implications, defining what risk is acceptable, and designing and implementing risk treatments. Disaster risk reduction is a complex undertake that requires multi-level, multi-stakeholder and spatialised perspectives.
- **Risk is spatially created** and can be **spatially re-distributed** or **transferred** through co-location, but also through financial mechanisms such as insurance and property transfers.
- **Site-based risk can often translate as risk affecting a whole settlement** - higher degrees of hazard risk accepted by an individual or a group may have a significant impact on collective risk at the settlement level.
- **Municipal-based risk can also translate as regional disaster risk** when neighbouring municipalities may accept different levels of risk and may apply (if they do) treatments of risk that may seem locally appropriate but regionally problematic.
- **Compounded effects of interacting hazards** can increase disaster risk.

¹⁰ For further reading, refer to Chapter 7 – Further Issues and Directions in March and Gonzalez-Mathiesen (2020) which also includes a number of salient issues.



- **Disaster risk reduction is part of a complex set of diverse urban planning priorities**, requiring its integration to strategies targeting social equity, mobility, economic development and environmental conservation, to name a few – strategic growth that creates disaster risk through urban encroachment in forested areas is an example.
- **Levels of individual vulnerability within communities, different species and elements of the built environment are highly variable**, requiring urban planning to seek equitable outcomes when balancing physical, social and environmental goals of disaster risk reduction.
- **Rapid reactive recovery processes can re-create or increase risks** in settlements hit by hazard events. Enhancing preparedness for *Building Back Better* and/or retreating through buying-back of land in high-risk areas is a fundamental strategy for bouncing forward, requiring a delicate balance between the consideration of individual and collective rights, values and interests.
- **Certain urban planning treatments of risk are more suitable for specific stages of land development**. Different stages of decision-making processes in land use and development planning require different levels of risk assessment and are more suitable for specific types of risk treatment. Avoidance of exposure, for example, is more easily implemented in decision-making affecting urban growth boundary expansion as part of metropolitan strategic planning than it is as part of a municipal retreat strategy to reduce bushfire disaster risk through buying back land.

FOCUSED DIAGNOSTICS

Focused diagnostics deal with specific areas of risk reduction relevant to urban planning, communities and the range of other systems they interact with. It is recommended that the cross-cutting themes guide enquiry relating to hazards, in addition to the focussed diagnostic criteria below. While these diagnostics are based on ideals and best practice that may not always be attainable, they provide powerful directions for improvement and change.

PLACES AND COMMUNITIES

Communities are central to urban and regional planning processes. Those involved with planning and emergency management are required to consider community resilience to disasters. The characteristics of any place are fundamental to its resilience to natural hazards. Urban planning plays key roles in understanding and guiding the characteristics of diverse *communities and places*, understood to be a combination of *physical, social and economic* aspects, within wider *environmental* settings. The section below deal with these as two inter-related areas: physical and non-physical community resilience.

Social, Economic and Environmental Community Resilience

1. Understanding of Disaster Risk and Access to Actionable Knowledge

The community is **knowledgeable** of and **understands** local **risks associated with natural hazards**^{11,12}. Its connection to place and knowledge of local conditions allows the community to foresee and act on escalating natural hazard threats before a hazard event takes place. In addition to holding and sharing **local** knowledge, the community is able to tap into **global** and **scientific knowledge** and access early-warning systems that can inform the formulation and activation of prevention, response and recovery plans. **Indigenous knowledge** and practices are respected and acknowledged as an important element of understanding disaster risk¹³ and they are embedded in prevention, response and recovery plans, helping to implement nature-based solutions to reduce disaster risk¹⁴. There is a shared understanding of community disaster resilience that can serve as a springboard for individual and collective action for disaster risk reduction. The community is **knowledgeable** of local assets that are critical to their survival, adaptation and thriving, and hence to their preparedness to prevent, respond to and recover from crises and disasters. It is also **aware** of these assets' levels of vulnerability to the effect of different isolated and compounded hazards. It has the **capacity** and effectively takes reasonable steps to protect these assets before, during and after hazard events¹⁵.

¹¹ “Underpinning a disaster resilient community is knowledge and understanding of local disaster risks” (Attorney-General’s Department, 2012, p. 11).

¹² See Sendai Framework for Disaster Risk Reduction Priority 1 (UNISDR, 2015).

¹³ Ibid.

¹⁴ See IUCN (2020).

¹⁵ See EMV (2016, p. 21).

2. Resilience-Oriented and Risk-Informed Systems and Processes

The community is also **knowledgeable of the essential systems and processes** on which it depends. It is capable of, and effectively **takes reasonable steps to avoid their exposure to hazards** and to help them recover when impacted. To reduce the risk of disruption during and after hazard events, the community plans and implements a **reasonable level of redundancy** (back-up systems, spare capacity, alternative mechanisms etc) **in essential systems and processes**, so it is unlikely they will be all impacted by the same single or compounded hazard event¹⁶. To aid in this process, the community is aware of the ecosystem services it depends on and makes use of the potential of **nature-based¹⁷ and engineered solutions** as appropriate to local conditions. When it comes to their **local economy**, the community seeks **diversity, dynamism and complementarity**, thus allowing for **synergies** that can foster economies of scale that would otherwise be exclusive to traditional specialization, hence reducing the risk of economic collapse should a particular economic sector or industry be heavily hit by a hazard event¹⁸.

3. Social Capital, Resourcefulness and Self-Organisation

The community's **level of risk acceptance** is **collectively agreed upon** and helps drive individual and collective action to reduce collective risk, but also individual risks that could translate into community risks that are above what is deemed collectively acceptable¹⁹. Disaster risk reduction is widely understood as a **shared responsibility** that is acted upon. There is **strong engagement** between individual members of the community, and collective disaster risk reduction **action**, appropriate to individual and collective circumstances²⁰. Underpinning that is an **inclusive leadership culture** that is integral to the community. It translates as an incentive to individual and collective initiatives targeting disaster risk reduction that can be readily supported by individual community members and the community as a whole. Individuals and the community are “**empowered** to exercise choice and take **responsibility** for disaster risk reduction”²¹ in a **democratic and inclusive setting** that allows multiple perspectives to be considered. This empowerment is embedded in the community's local **identity** and **attachment to place**. It is driven by supporting levels of **social cohesion**²² and translates as a high level of **self-organisation**. The community is resourceful and capable, actively encouraging and supporting the **building and sharing of individual and collective reserves of essential resources both locally and regionally**, which are critical to its survival and thriving when preventing, preparing for, responding to and recovering from hazard events. There is, therefore, redundancy in stocks of critical resources that can be easily tapped into as needed and in an equitable manner²³. In addition to redundancy in physical and financial resources, there is also a desirable level of overlapping in the pool of local skills. Where feasible and appropriate, local volunteering

¹⁶ See National Resilience Taskforce (2018).

¹⁷ See IUCN (2020).

¹⁸ See EMV (2017, p. 26).

¹⁹ See March, Nogueira de Moraes, and Stanley (2020, p. 107).

²⁰ See AIDR (2013).

²¹ See National Strategy for Disaster Resilience Priority Five, (Attorney-General's Department, 2012, p. 23).

²² See Leonardo Nogueira de Moraes (2018).

²³ See Leonardo Nogueira de Moraes (2014).

structures allow external stakeholders and visitors to meaningfully connect with local residents and second-home owners, by bringing their skills and resources to enhance prevention, preparedness, response and recovery efforts.

4. Well-Managed Connectivity

The community is internally and externally **well-connected**, through formal and informal networks and channels that translate as well-managed and effective communication for reducing disaster risk and building disaster resilience. By being well-connected, the community is **knowledgeable** of the vulnerability of its different groups to specific hazards and their compound effects. It is also **aware** of the geographical distribution of vulnerability across its territory in contrast to hazard mapping. It takes reasonable steps to **address** these **vulnerabilities** and seeks to **reduce vulnerable groups' exposure** to hazards, and act to **reduce** the **intensity** and **frequency** of **hazards** to which they may be subject²⁴. The community can cultivate **positive connections with external stakeholders** which can be promptly activated when preventing, preparing for, responding to and recovering from disasters²⁵. Well-managed connection to place allows the community to hold a deep environmental understanding of risk and its duty of care. Well-planned spatial connectivity translates as a settlement that avoids unnecessary exposure to hazards, allow vulnerable groups to be protected and promptly supported and facilitates the deployment of resources as part of prevention, preparedness, response and recovery.

5. Resilience-Oriented and Risk-Informed Land Use Planning

When **planning and assessing future development**, individuals and the community seek to address **multiple scenarios**, and their individual and collective **decisions are oriented to resilience-building and informed by disaster risk**. Decision outcomes respect collective and individual levels of risk acceptance and address individual and collective levels of vulnerability and exposure to hazards. To do that, these **communities are diverse, well-connected** and supported by **polycentric governance systems that allow the integration of overlapping domains of action**. They have established **learning mechanisms** that allow them to critically **reflect** on past events and current settlement conditions and make sense of existing and emerging threats by paying heed to context, **slow-unfolding challenges** and **path dependencies**²⁶. Proposed infrastructure is assessed in terms of its capacity to allow **flexible** use, to add to a desirable level of **redundancy** in case of hazard events, and to contribute to overall infrastructure **robustness**. Spatial, physical, digital and social connectivity considerations are embedded in planning processes to allow their contribution to resilience-building.

6. Inclusive and Community-Based Emergency Management Planning

Individuals and the community have been engaged and supported to effectively develop individual and community **prevention, preparedness, response and recovery plans** that can be swiftly actioned. These plans are

²⁴ See National Resilience Taskforce (2018).

²⁵ See National Strategy for Disaster Resilience Companion Booklet's Priority 4 (Attorney-General's Department, 2012, p. 18).

²⁶ See Simonsen et al. (2014).

comprehensive yet simple to implement. They cover actions aimed at reducing the intensity and frequency of hazards in specific locations, and the reduction of exposure and vulnerability to these, before, during and after hazard events. **Cultural diversity** is celebrated and acknowledged in these plans, resulting in effective strategies that are **inclusive** and that make best use of the **diversity of knowledge, practices and skills** available in the community. The community's capacity to be prepared to avoid exposure is especially critical during the response to a hazard event, which requires timely action to ensure evacuation and access to shelters are effectively implemented if needed²⁷.

Built Environment Resilience

From a land use planning perspective, there are five types of risk treatments (listed below) that can be employed to reduce the risk of natural-hazard-related disasters. These treatments can be divided into those directly affecting risk (focused on hazard, exposure and vulnerability) and those affecting our adaptive capacity to implement these treatments during and after a hazard event (preparedness to respond and to recover).

Specific Enquiry Criteria: Land Use planning includes, enables or requires the following as appropriate:

1. Physical and functional outcomes in communities achieve the following risk treatment objectives as relevant to the particular hazard:
 - Avoidance of Exposure / Separation from Hazard
 - Reduction of Hazard
 - Reduction of Vulnerability to Hazard
 - Preparedness for, and Facilitation of Appropriate Response
 - Preparedness for, and Facilitation of Appropriate Recovery

Generally, these will be achieved in the following ways, as appropriate to the specific hazard, in summarised form below. It is recommended that detailed investigation is undertaken.

Bushfire	
Structures and people are impacted by direct flame, radiant heat, embers, fire-driven winds.	
Design Principle	Achieved by
Avoidance of Exposure or Separation from Hazard	Structures, infrastructure and people are located at a sufficient distance from flammable vegetation.
Reduction or Modification of Hazard	Vegetation is removed or modified to an appropriate level and managed appropriately over time.
Reduction of Vulnerability to Hazard	Structures are built to a standard sufficient to withstand expected impacts of bushfires.
Preparedness for, and Facilitation of Appropriate Response	Design of buildings and settlements, in conjunction with human systems, allows for fires to be combatted or evacuated from, as appropriate.
Preparedness for, and Facilitation of Appropriate Recovery	Initial design allows efficient and timely recovery, and/or the recovery process reduces risk by redesigning rebuilding according to these five principles to achieve high standards of risk reduction.

Flood

²⁷ See L. Nogueira de Moraes and March (2020).



Floodwaters can impact on structures and people through direct contact of waters, submersion, force upon people and structures and damage or disruption to systems and infrastructure.

Design Principle	Achieved by
Avoidance of Exposure or Separation from Hazard	Structures are not built in flood prone area or are located only in areas where depths and velocities are not excessively risky considering the occupants, activity carried out and design of structures.
Reduction or Modification of Hazard	Construction of levees, diversions, retention basin, dams, facilitation of greater soil permeability or slowing of flows e.g. via vegetation management.
Reduction of Vulnerability to Hazard	Structures are designed to withstand flood and protect lives. Activities and persons allowed in particular locations are appropriate to the type of flooding likely.
Preparedness for, and Facilitation of Appropriate Response	Built form is appropriate for the type and location of community, numbers of persons, road capacity, warnings times and time taken to evacuate.
Preparedness for, and Facilitation of Appropriate Recovery	Design allows efficient and timely recovery of buildings (i.e. they are not easily damaged by water and can be easily re-occupied), and/or the recovery process reduces risk by redesigning rebuilding and its location according to these five principles.

Heatwave

A heatwave is a long-lasting period with extremely high surface temperature that causes higher than normal rates of morbidity and mortality in the population. It may also impact on systems and infrastructure.

Design Principle	Achieved by
Avoidance of Exposure or Separation from Hazard	Built environment is designed and managed to reduce heating effects and provides "cool Spaces" in combination with building design and other services to ensure vulnerable people are not exposed to prolonged levels of heat.
Reduction or Modification of Hazard	Precinct, urban design plans, individual building design and landscaping reduces heat island effects, provides shading, facilitates cooling breezes and their maximisation.
Reduction of Vulnerability to Hazard	Building design, building systems (e. g. mechanical cooling), occupants, responders and health professionals reduce heat impacts on vulnerable persons. Redundancy is included such as backup power for air conditioners.
Preparedness for, and Facilitation of Appropriate Response	Precincts and buildings include cool spaces and systems to assist the vulnerable, such as cool spaces and safe means of getting to these.
Preparedness for, and Facilitation of Appropriate Recovery	Opportunities for retrofitting and improvement are identified, particularly in advance so that any opportunities for improvement can be fully taken up.

Severe Storm

Hail, strong winds, heavy rainfall, flash floods and storm tides can impact on structures and people.

Design Principle	Achieved by
Avoidance of Exposure or Separation from Hazard	Particularly risky locations such as hill tops, gullies, locations near to tall trees and other risk factors are avoided. Emphasis is placed upon vulnerable persons, assets and activities. Planned retreat is undertaken in identified locations.
Reduction or Modification of Hazard	Site specific action are used if necessary, such as flood levees and water diversions, wind protection bunds.
Reduction of Vulnerability to Hazard	Structures are constructed to a high standard according to the location and nature of storms. High risk elements can be modified, such as hail damage prone skylights, or improved overflow systems for box gutters.
Preparedness for, and Facilitation of Appropriate Response	Structures and infrastructure are designed to facilitate preparedness to respond, such as electricity cut-offs, evacuation plans and identification in advance of vulnerable persons and structures.
Preparedness for, and Facilitation of Appropriate Recovery	Retrofitting, rebuilding and ongoing maintenance ensure high standards of design and specification are achieved.

Coastal Erosion

Coastal erosion is the loss of coastal lands due to the net removal of sediments or bedrock from the shoreline, and the action of waves and currents can impact on structures or beneath them.

Design Principle	Achieved by
Avoidance of Exposure or Separation from Hazard	New structures or infrastructure is located well away from areas identified as potentially or actually experiencing erosion or is relocated if necessary.
Reduction or Modification of Hazard	Engineering works may be appropriate in some circumstances, or harmonious working with natural systems to avoid negative impacts such as maintaining natural flows and storm systems.
Reduction of Vulnerability to Hazard	Improved design of structures of infrastructure, (e.g. certain port facilities) may be appropriate to improve resistance. Alternatively, appropriate management of land use activities to allow only those less likely to be impacted by erosion such as casual recreation (as opposed to allowing structures) may be appropriate.
Preparedness for, and Facilitation of Appropriate Response	Ensure appropriate warning and evacuation systems, allied with long term relocation and resettlement planning.
Preparedness for, and Facilitation of Appropriate Recovery	Do not allow inappropriate rebuilding investment and expensive attempts prevent likely future erosion.

Cyclone

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. Destructive winds and heavy rainfall with flooding and damaging storm tides impact on structures and people through direct contact.

Design Principle	Achieved by
Avoidance of Exposure or Separation from Hazard	Do not allow or relocate persons and structures away from areas that will suffer storm surge flooding or be particularly exposed to high winds, such as cliff tops.
Reduction or Modification of Hazard	Where appropriate, modify storm surge and wind effects via engineering or earthworks.
Reduction of Vulnerability to Hazard	Ensure construction occurs to cyclone standards, or retrofitting occurs where appropriate.
Preparedness for, and Facilitation of Appropriate Response	Response and warning systems are facilitated via relevant human, infrastructure and technical systems.
Preparedness for, and Facilitation of Appropriate Recovery	Ensure rebuilding and recovery integrate risk treatments.

Tsunami

A tsunami is a water wave generated by a sudden change in the seabed resulting from an earthquake, volcanic eruption or landslide. 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.

Design Principle	Achieved by
Avoidance of Exposure or Separation from Hazard	In identified area, avoid structures and vulnerable persons being in locations that have risks unable to be treated.
Reduction or Modification of Hazard	Possible use of engineering, landscaping and other wave modifications may be appropriate.
Reduction of Vulnerability to Hazard	Ensure communities are knowledgeable, and safe evacuation routes and assembly points are established, signed and communicated. Some structures may be designed to withstand impacts if appropriate to location and land use activities.
Preparedness for, and Facilitation of Appropriate Response	Improve communications, early warning systems, decision processes and immediate post event processes are prepared.
Preparedness for, and Facilitation of Appropriate Recovery	Ensure rebuilding and recovery achieves high standards as above.

Earthquake



Earthquakes are the vibrations of the Earth caused by the passage of seismic waves radiating from some source of elastic energy. Structures are impacted by ground shaking that can destroy or damage them; in their turn, structures' damage or collapse can threaten human lives. Other impacts such as liquefaction, flooding, landslip and rockfall may also occur.

Design Principle	Achieved by
Avoidance of Exposure or Separation from Hazard	Structures and persons are located away from high risk areas, including those potentially affected by seismic shocks, liquefaction, landslip or other negative impacts. Relocation may need to occur.
Reduction or Modification of Hazard	In some circumstances engineering processes may reduce likely impacts such as protections against falling rocks, liquefaction, flooding or landslip.
Reduction of Vulnerability to Hazard	Structures may in some circumstances be designed or retrofitted to reduce earthquake impacts.
Preparedness for, and Facilitation of Appropriate Response	Design of buildings and settlements is undertaken in ways that facilitate early response, warning, evacuation and refuge.
Preparedness for, and Facilitation of Appropriate Recovery	Rebuilding occurs in a manner that treats risk appropriately.

THE PLANNING FRAMEWORK: THE ENABLING REGULATORY SYSTEM AND ITS MAINTENANCE

Human settlements, sometimes known as the built environment, are the result of many processes occurring simultaneously over time. If settlements are to include the characteristics necessary to manage natural hazard risks, the processes and decision-making systems of urban planning need to be integrated with Disaster Risk Reduction.

It is recommended assumed that the cross-cutting themes guide enquiry relating to the hazard, in addition to the focussed diagnostic criteria below.

Legislation

Urban planning, emergency management and related laws set out general powers, responsibilities and rights of various parties of land use planning, including establishing processes for plan development and implementation. They require or enable local governments to administer land use planning. Other related legislation may also have an influence on planning matters and risk reduction, such as environmental or building legislation.

Specific Enquiry Criteria: Legislation includes, enables or requires the following as appropriate:

1. Enable and provide context for land use planning for disaster resilient communities by containing goals for community safety or resilient development.
2. Specify that disaster resilience is to be included in all land use planning levels tiers.
3. Specify the need to consider natural hazards in land use planning decisions.
4. Establish direct links to risk assessment processes and advice from natural hazard leaders and emergency managers for all planning decisions.
5. Specifies that risk assessments must consider existing and future risks and may include scenario testing of future settlement patterns.
6. Consider other disaster management or emergency legislation that have impact on planning matters.

Policy

Policies include the range of documents that set out future directions and intentions and provide overarching directions for further detailed or ongoing decisions and actions. These may include fire, flood, landslide and water quality management or other policies; coastal, environmental, agricultural and wetlands protection policies, and management of urban expansion policies.

Specific Enquiry Criteria: Policy includes, enables or requires the following as appropriate:



1. Policy is aligned with the direction of other overarching national and state policies or international agreements, establishing clear links and hierarchies between them.
2. Clear articulation of how disaster resilience and risk information is considered in land use planning, guiding decision-making processes and selection of future development or growth patterns.
3. Articulates guidance on the level of risk tolerance that will frame the system and guide decision-making.

Regulation

Subsidiary regulation establishes detailed decision-making processes and criteria to achieve the goals and requirements of legislation and policy are to be achieved. These may be called planning schemes, ordinance, codes or town plans. They include a mix of spatial and non-spatial mechanisms and influence various activities conducted on land and physical outcomes; seeking social, economic and environmental goals.

Specific Enquiry Criteria: Regulation includes, enables or requires the following as appropriate:

1. Links planning decisions to advice from natural hazard leaders and emergency managers.
2. Specifies the need to consider natural hazards in land use planning decisions, including in strategic planning decisions, and their implementation.
3. Requires assessment of strategic alternatives when appropriate.
4. Includes guidance on the level of risk tolerance that frames the system and guides more detailed decision-making.
5. Provides clear decision-making criteria relating to risk, based on appropriate data and understanding of contributory factors.
6. Achieves the objective of disaster risk reduction and processes of resilience processes as appropriate, according to the level of risk tolerance framing the system or sub-system.

Standards and Codes

Standards and codes can be technical or functional and typically cover the physical characteristics, materials and components for new developments – even while these have significant implications for social, environmental and economic aspects. They specify what is considered satisfactory in a given context. An example may be the National Construction Code of Australia, which includes the AS3959 Construction in Bushfire Prone Areas.

Specific Enquiry Criteria: Standards and Codes include, enable or require the following as appropriate:

1. Standards, codes and provisions relevant to natural hazard information and risk assessments are included and utilised.



2. Restrict certain uses, building types, and occupancy density in hazard prone areas where risk is considered to exceed acceptable standards.
3. Restrict certain uses, building types, and occupancy density in hazard prone areas to that compatible with the relevant natural hazard and its constraints.
4. 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 wider system's level of risk tolerance.

TYPES OF PLANS

Urban and regional plans establish and coordinate the overarching intentions of policies and regulations that apply to land, linking higher order goals and objectives to broad and locally specific outcomes. Plans can establish broad and detailed directions and locations for various kind of development, preservation or control. They seek to positively influence the location, type and characteristics of places. Local planning schemes are the main mechanism of detailed development control and include tools such as policy, zoning, overlays and provisions based on decisions and performance criteria. These geographically specific land use planning instruments allow the management of change play to achieve disaster resilient communities, while balancing other development requirements and priorities. Spatial plans seek to assess existing and future risks, identifying hazard exposure, vulnerability and risk generally and for specific locations via mapping.

State, regional and metropolitan plans

State regional and metropolitan plans provide broad strategic directions for land use and development patterns across territories and for regions or metropolitan settlements. They contribute to the coordination and guidance of growth, preservation, services and infrastructure provision.

Specific Enquiry Criteria: State regional and metropolitan plans include, enable or require the following as appropriate:

1. Contribute to understanding hazard and risks at a wider territorial scale, such as consideration of rural-urban or interactions between different and their impacts.
2. Promote regional coordination of growth and change including infrastructure networks
3. Set priorities and directions based on a regional vision.
4. Identify and protect areas of special importance to the region.
5. Promote the need to consider natural hazards, whether mapped or not.

Strategic growth or expansion areas

Future growth or expansion areas (many different names are used) are strategic plans guiding the way that land for expansion on the edge of large settlements is generally managed over time, along with areas identified for preservation or other restrictions to growth.

Specific Enquiry Criteria: Strategic growth or expansion areas include, enable or require the following as appropriate:

1. Provision of adequate space for expected future growth in areas that are identified as suitable for development after considering natural hazards.
2. Test 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.



3. 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 local contexts.

Specific Enquiry Criteria: Legislation includes, enables or requires the following as appropriate:

1. Ensure that the policy is aligned with the direction of overarching policies. Clearly articulate how natural hazards and associated disaster resilience are 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.

Specific Enquiry Criteria: Structure plans include, enables or requires the following as appropriate:

1. Allow merging of scenario testing and risk analyses in detailed planning exercises.
2. Identify sector-specific actions to reduce risk and facilitate adaptation to natural hazards.
3. Incrementally drive resilience outcomes and desired urban forms that respond to hazard exposure and consider impacts of development on natural hazards and the existing community.
4. Contribute to managing areas with more serious hazard exposure, such as urban-rural interfaces or coastal areas.

Zones, overlays and associated controls

Zones, overlays and their associated controls or reference to resource documents set limits on the type and extent of development and/or the activities that can occur in a given area, including whether permits are required.

Specific Enquiry Criteria: Zones, overlays and associated controls enable or require the following as appropriate:

1. Implement resilience provisions for hazard-prone areas.
2. Articulate risk tolerances through parameters for acceptable development.
3. Limit development or certain uses/ activities in areas identified as inappropriate to accommodate new development due the natural hazards or impacts of development on natural hazards.



4. Address acceptable/residual risk through appropriate built form or land use/activity controls.
5. Limit density or types of development or activity that are inconsistent with the risk profile and intent of the zone.
6. 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 where risks are excessive.

Hazard and risk mapping

Hazard mapping spatially represents where and in what form or intensity hazards occur in relation to the natural landscape and built environment. Risk mapping considers the likely consequences of an event on the community, depending on the nature of human settlement and occupation of land. These risks are a function of levels of exposure to the hazard and levels of vulnerability. These may entail existing or expected future conditions.

Specific Enquiry Criteria: Hazard and risk mapping includes, enables or requires the following as appropriate:

1. Integration with (but are different from) 'overlay mapping' that provides a mechanism of control in planning schemes or a trigger for detailed analysis on planning schemes and ordinance.
2. Spatially represents hazards in a way that can be used as a basis for decision making.
3. Spatially determines risks for particular development or activity, or link to mechanisms to determine these risks.
4. Spatially articulating risk and risk tolerances to inform the direction (or otherwise) of new development or redevelopment and the specification of requirements for acceptable development.
5. Make clear underlying assumptions and assessment criteria.

PLAN MAKING

The processes used to create and update diverse types of urban and regional planning instrument are many and include a range of local variations. However, key elements can be found across all systems. Further, the processes used to prepare natural hazard risk management and urban plans are similar in many ways, even while the goals they seek may be different. Both processes require an understanding of context, objectives/vision, analysis of scenarios/strategies, evaluation of alternatives and the selection of options.

At a fundamental level, risk management follows the processes of assessing and analysing risk and implementing strategies and actions to address risk. Internationally, ISO 31000 (2018) is the International Standard guiding risk management. ISO 31000 (2018) and uses three overall stages: (1) establishing the context; (2) risk assessment; and (3) risk treatment. The context considers the external environment in which the organization aims to achieve its objectives, and the internal context associated with the organization's culture, structure, processes, and strategies. The overall process of risk assessment identifies, analyses, and evaluates risk. The risk treatment stage decides on the best alternative or alternatives for modifying risk, and their subsequent implementation²⁸.

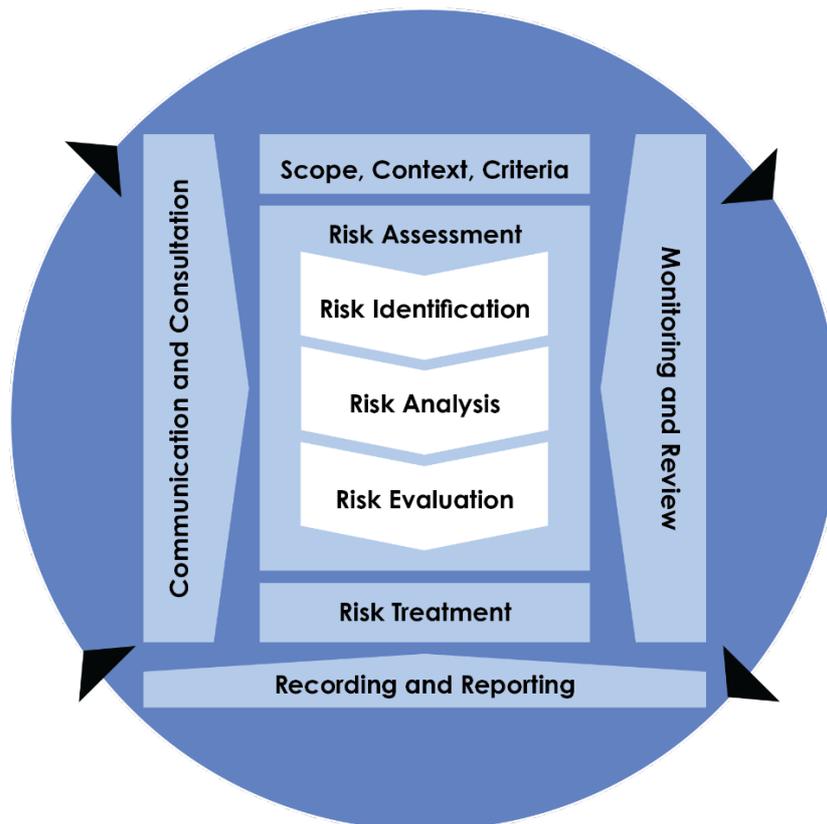


FIGURE 5. ISO 31000 - THE RISK MANAGEMENT PROCESS²⁹

Natural hazard risk assessment processes follow a procedural approach similar to the one established by ISO 31000 (2018), considering hazard, exposure, and vulnerability components. In general terms, natural hazard risk assessment

²⁸ See Australian Standards and New Zealand Standards (2009).

²⁹ Based on Australian Standards and New Zealand Standards (2009, p. 9).

includes the identification of hazards; a review of hazards' characteristics including their location, intensity, frequency and probability; the analysis of exposure and vulnerability, considering physical, social, environmental, health, and economic dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities for likely risk scenarios³⁰.

Operationalization of these broad steps is often challenging, particularly when they require integration with other systems seeking multiple separate goals, such as urban planning. Further, assessment of plan-making itself is often complicated by processes being "partial", ongoing and representing only one element of wider ongoing and locally unique plan making systems. However, a useful overarching blueprint is provided by the Planning Institute of Australia's "National Land Use Planning Guidelines for Disaster Resilient Communities"³¹:

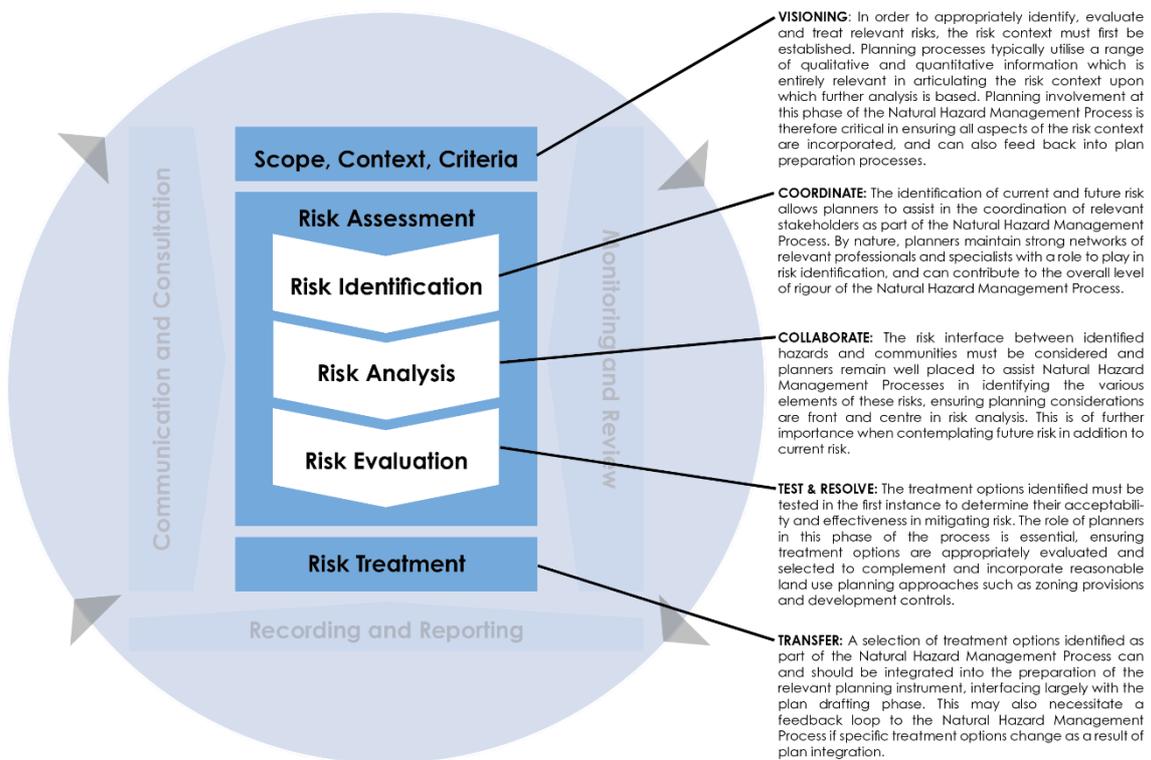


FIGURE 5. INTEGRATING PLANNING INTO THE NATURAL HAZARD MANAGEMENT PROCESS³²

The assessment guide below (Figure 6) adapts the principles above and other learning from recent BNHCRC research. These are key elements of best practice for the integration of urban planning plan making with natural hazard risk reduction as basis for critical examination that can be adapted critically to various circumstances.

Typical Planning Steps		Integration with DRR
Consult & Engage	Vision, Goals and Objectives	Natural hazard risks are also considered in a balanced way alongside other planning concerns.
	Data Collection, Analysis & Representation	Alongside other data, natural hazard data are collected and analysed as "baseline" data.

³⁰ See UNDRR (2019).

³¹ See PIA and Australian Government Attorney-General's Department (2016).

³² Based on Australian Standards and New Zealand Standards (2009, p. 9) and PIA and Australian Government Attorney-General's Department (2016, p. 45).



Develop Options & Strategies	Prior to determining the desired outcome, various options are developed and including assessment against a range of criteria, including natural hazard risks.
Choose Best Option	The "best" option is chosen by measurement against its likely achievement of the initial goals and objectives, including natural hazard risks. This may include scenario modelling of options.
Prepare Plan	Detailed plans are prepared. This may include policy, regulation, rezoning or detailed designs. Feedback loops into prior stages may be necessary if plans cannot achieve expected results.
Implement	Ongoing development processes, including development control and assessment of detailed plans against predetermined criteria such as achievement of risk standards and buildings codes. This may include further detailed risk assessment processes.
Evaluate	Plans require ongoing evaluation to ensure they are achieving intended goals, and indeed that goals remain appropriate.
Revise	Ongoing changes to all or part of plans continues as further information comes to hand, conditions evolve (such as climate change) and goals are adjusted over time.

FIGURE 6. PROPOSED PLAN-MAKING ASSESSMENT GUIDE

Specific Enquiry Criteria: Plan making processes includes, enables or requires the following as appropriate:

1. Integration with wider plan making principles described above
2. Are hazards identified, spatialised and represented meaningfully for decision makers, based on quality data?
3. Are risk acceptance levels established, including being meaningfully considered against other goals and objectives, and at detail appropriate to the "tier" of action? Are these used to assess proposed decisions and actions?
4. Do risk assessment and treatment approaches meet the general expectations of ISO31000 and seek to develop and include new knowledge?
5. Are the risks of various potential plans actively identified and understood prior to decisions, including the appropriateness of treatment options? This may include the hazard itself (and therefore risks) being modified by change processes, while also applying understandings of exposure and vulnerability, as well and likelihood and consequences.
6. Have stakeholders been consulted and empowered appropriately?
7. Will a given decision lead to creation of subsequent untreatable risks, or unknown future distribution of risks to other parties, some of whom may not be capable of understanding or treating them?
8. Is the type of plan used appropriate to the task, and to the needs/operations of other actors? If not, are inadequacies addressed via feedback mechanisms?
9. Do the actions integrate with other plans and processes needed to manage risks?
10. Are treatment options chosen adequate and appropriate, and have a reasonable likelihood of being applied in the long term?



11. Are there are other risk drivers that require consideration, such as Socio-economic factors, climate change, cultural matters or legacy issues? Who or what “owns” risk at each step – and can/do they take responsibility?
12. Are key steps omitted or circumvented?

PLAN IMPLEMENTATION

For urban planning to be effective, the goals and directions of higher tier legislation, policy, plans and other mechanisms needs to be implemented as development and change occurs. Planning achieves this when settlement change is directed and coordinated through the processes of development being compliant or being granted planning permits. These projects may range in scale, purpose, and ownership.

Planning permit application process

Planning permit application processes ensure that policies, regulations and development controls set by the planning scheme are complied with when new development occurs. All uses/activities and developments are categorised 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 and perhaps modify marginal cases³³.

Specific Enquiry Criteria: Planning permit and compliance processes include, enables or requires the following as appropriate:

1. Undertake risk assessment at the appropriate levels to promote context-specific decision-making based on pre-determined processes.
2. Ensure compliance with the regulatory framework and corresponding spatial plans.
3. Trigger a permit and DRR provisions based on spatial information about the hazard/risk (usually through ‘overlays’).
4. Require a detailed risk assessment at the appropriate scales.
5. Ensure projects are designed to withstand a hazard and implementing mitigation strategies.
6. Consider back-up measures (such as civilians’ evacuation alternatives).
7. Integrate the relevant government agencies in the decision-making process (usually as referrals).
8. Ensure compliance with provisions and include mechanisms to address non-compliance.

³³ See Rowley (2017).



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.

Specific Enquiry Criteria: Urban development and infrastructure projects include, enables or requires the following as appropriate:

1. Undertake previously established tests to avoid the impact of natural hazards on infrastructure.
2. Ensure compliance with the regulatory framework and corresponding spatial plans.
3. Incorporate disaster resilience requirements and measures early in the conceptualization of the project.
4. Consider redundancy and back-up measures.
5. 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 government where warranted as a mechanism to reduce natural hazard risk.

Specific Enquiry Criteria: Land reclamation and buy back schemes include, enables or requires the following as appropriate:

1. Alter settlement patterns and built form more directly to treat existing or future risks, based on processes previously established.
2. Expand resettlement options for displaced people.

Extraordinary Processes

The complexity of urban planning systems, combined with pressures for achievement of wider goals such as expeditious facilitation of economic growth, sometimes leads to the use of extraordinary mechanisms that do not follow typical processes. These extraordinary processes may circumvent application of typical risk assessment and treatments.

Specific Enquiry Criteria: Use of extraordinary, fast-track or, enables or requires the following as appropriate:

1. Fast-tracking is avoided except where it essential and is then scrutinised carefully and openly.
2. Ensures that risk assessments and treatments are not compromised.



CONCLUSIONS

Urban planning is a complex and dynamic process. The tools are scalable and adaptable ways into the diversity of various circumstances and needs applied to particular hazards, certain geographical places, parts of or the entire planning system, or specific challenges associated with disaster risk reduction. To fully harness its potential as a mechanism to assist in Disaster Risk Reduction, there is a need to engage deeply with the challenges of integration, building and harnessing new knowledge, and translating this to action. The diagnostic tools described here are only the start – the real work is ongoing, long term and inherently challenging.



TEAM MEMBERS

The Integrated Urban Planning for Natural Hazard Mitigation Project comprises an interdisciplinary team of researchers with expertise in the fields of urban planning, natural hazard mitigation, resilience, decision support systems, climate change, governance, disaster risk management and public policy.

PROF ALAN MARCH

Alan March is Professor in Urban Planning. He is also Director of the Bachelor of Design across the Faculties of Architecture, Building and Planning; Engineering; and, Faculty of Fine Arts and Music. Alan has twice won the Global Planning Education Network's prize for "Best Planning Paper" (2007, 2011). His teaching includes urban design, planning law and planning theory subjects, and he was awarded a Faculty teaching prize in 2007. Alan has successfully supervised over 60 students' theses encompassing a range of urban design and planning research topics. He won the Planning Institute of Australia's Victoria division "planner of the Year" prize in 2016 and won a National Commendation in the same category in 2017.

Alan has practised since 1991 in a broad range of private sector and government settings and has had roles in statutory and strategic planning, advocacy, and urban design. He has worked in Western Australia, the UK, New South Wales and Victoria. Alan's early career included projects as diverse as foreshore protection plans, rural to urban subdivision approval and design, the Mandurah Marina and Urban Design Guidelines for the Joondalup City Centre. In England, he has worked in brownfield and inner-city redevelopment, including land assembly and urban regeneration projects. Alan has extensive experience in inner city redevelopment projects in Melbourne since 1996.

Alan's publications and research include examination of the practical governance mechanisms of planning and urban design, in particular the ways that planning systems can successfully manage change and transition as circumstances change. He is particularly interested in the ways that planning and design can modify disaster risks, and researches urban design principles for bushfire. His current work also considers the ways that urban planning is seeking to establish new ways to spatialise urban management.

DR LEONARDO NOGUEIRA DE MORAES

Leonardo Nogueira de Moraes is a postdoctoral research fellow in resilience and urban planning at the Faculty of Architecture, Building and Planning of the University of Melbourne. He is part of the research team for the Integrated Urban Planning for Natural Hazard Mitigation project, funded by the Bushfire and Natural Hazards Cooperative Research Centre.

His background includes a Bachelor of Tourism (Development and Planning) degree and a Specialisation in Tourism and Hospitality Marketing Management from the University of São Paulo, Brazil. His PhD in Architecture and Planning at The University of Melbourne focused on the effects of tourism development and



the implementation of protected areas on the resilience of small oceanic islands, from a social-ecological complex adaptive systems perspective.

His current research on resilience and urban planning also includes the effects of tourism development to the resilience of local communities to natural hazards. This is being developed with the aid of grounded theory methods, coupled with social media analysis and data visualisation by means of interactive timelines.

DR GRAEME RIDDELL

Graeme is a researcher and consultant across the fields of urban planning, disaster risk and resilience. His work revolves around developing and applying innovative modelling and participatory approaches to tackle complex planning and policy issues. Graeme is currently a research fellow at the University of Adelaide (Australia) and associate consultant at RIKS, the Research Institute for Knowledge Systems (the Netherlands).

He is also a PhD Candidate at The University of Adelaide researching how to develop effective policies under conditions of complexity and uncertainty considering both robust and adaptive approaches. His aim is to develop decision support systems to assist policy development. Graeme is also involved with the BNHCRC Project Decision support system for policy and planning investment options for optimal natural hazard mitigation led by Professor Holger Maier.

EMERITUS PROFESSOR STEPHEN DOVERS

Emeritus Professor Steve Dovers was originally trained as an ecologist and natural resource manager and worked in local government and heritage management. He later studied geography at graduate level and gained a PhD in environmental policy in 1996. He became an academic member of staff at the then Centre for Resource and Environmental Studies at the ANU in 1997. From 2009-2017 he was Director of the Fenner School of Environment and Society at the ANU, and an inaugural ANU Public Policy Fellow. He is a Fellow of the Academy of Social Sciences in Australia, was inaugural Chair of the Management Committee of Future Earth Australia; a member of the Advisory Council of the Mulloon Institute, Associate Editor of the Australasian Journal of Environmental Management, and member of the editorial Boards of the journals Local Environments, Environmental Science and Policy, and Resilience. Steve is a Senior Associate with the advisory firm Aither.

A/PROF JANET STANLEY

Janet Stanley is a Principal Fellow at the Faculty of Architecture, Building & Planning, visiting Professor at the University of Hiroshima, Japan and a Director of Stanley & Co., consultants in sustainable policy. Prior to this, Janet was Chief Research Officer at Monash Sustainability Institute, Monash University.

Originally specialising in child protection and family violence, Janet now focuses on the interface between social, environmental and economic issues in climate change and sustainability, across policy, system design, and at community



levels. This work particularly focuses on sustainability issues for those people experiencing social exclusion and disadvantage. Most recent work has been on transport and land use in a 20-minute city, social policy and climate change and the prevention of bushfire arson. Janet has been an advisor to state and federal governments, is on the Board of the charitable trust, the George Hicks Foundation and is a member of the Future Melbourne Network. Janet has been an advisor to state and federal governments on climate change and adaptation, and is on the Board of the charitable trust, the Mornington Peninsula Foundation.

A/PROF HEDWIG VAN DELDEN

Hedwig van Delden is Director of the Research Institute for Knowledge Systems (RIKS) in the Netherlands and Adjunct Associate Professor in the School of Civil, Environmental and Mining Engineering at the University of Adelaide.

Her work focuses on applying research into planning and policy practice, and in particular on understanding and modelling of land use dynamics, integrating socio-economic and bio-physical processes, bridging the science- policy gap and the development of strategic scenarios. In doing so she focuses on the integration of disciplines as well as techniques (analysis, modelling, participation).

Hedwig has managed and contributed to a vast range of projects with multiple partners and objectives, for various governmental organisations worldwide. Her work in Australia includes the development of integrated models to support long-term decision-making for disaster risk reduction policies as part of the Bushfire & Natural Hazard CRC project.

PROF RUTH BEILIN

Ruth Beilin is an internationally recognised expert in community based resource management, in urban and non-urban resilience studies—especially in the area of social and environmental resilience and in complexity theory and the application of uncertainty to the everyday experiences of those on the ground—whether in fire, flood, sea rise, or drought. As examples: she has co-authored in excess of 90 peer-reviewed papers in high quality, international journals, including ecological and social journals. She co-designed and authored four chapters in the textbook *Reshaping Environments*, used by upwards of 6000 students to-date. In 2015 she co-edited two Special Issues of high impact international journals, *Sustainability Science* and *J of Urban Studies*, on *Governance for Urban Resilience*. She is an Associate Editor of *Society and Natural Resources*, among others. Since 2015, Professor Beilin has been a member of the New Zealand Science Advisory Panel for Land and Water. Her lab at the University of Melbourne is based on interdisciplinary research and her leadership in Australian Research Council Linkages and in the CRC Bushfires has involved applied and theoretical outcomes. For example, in the project *The Social Construction of Fire and Fuel in the Landscape* (CRC Bushfires) CFA and equivalent agency staff across the country can use the social-ecological/visual mapping techniques she co-developed.



PROF HOLGER MAIER

Holger Maier is Professor of Integrated Water Systems Engineering and Deputy Head of the School of Civil, Environmental and Mining Engineering at the University of Adelaide. Prior to joining the University in 1999, he worked as a consultant in the private and public sectors in South Australia, as a senior civil engineer with the Western Samoa Water Authority and as a postdoctoral research fellow at the University of British Columbia.

Holger's research is focussed on developing improved techniques for the sustainable management of water resources and infrastructure in an uncertain environment and includes elements of modelling, optimisation and multi criteria and uncertainty analysis. He has co-authored more than 10 book chapters and in excess of 100 refereed papers. He has received a number of national and international awards for his teaching and research.



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APPENDICES



APPENDIX 1. BASIC RISK TREATMENT CONSIDERATIONS AND THEIR APPLICATION

The following considerations can inform how treatments of risk can be designed and employed:

What are we trying to protect?

Community members, livelihoods, critical assets, agents, landscape features and ecosystems/ecosystem services, including and not limited to fauna and flora.

From which hazards are we trying to protect these elements?

Bushfires, Floods, Severe Storms, Coastal Erosion, Cyclones, Tsunamis, Extreme Heat and Earthquakes.

Which elements should we prioritise?

Those most vulnerable and critical to the community's survival and thriving, including community members themselves, critical infrastructure and resources, critical system agents and processes.

Who is part of this equation?

Individuals and community groups, visitors, first responders, government agencies, developers, planning authorities, building councils, emergency managers, etc.

Whose responsibility is it and to whom/what?

Disaster risk reduction, community wellbeing and building community resilience to disasters are shared responsibilities between governments, communities, individuals, the private sector and NGOs.

When should disaster risk reduction occur?

Prior to, during, and after disaster events.

What does disaster risk reduction comprise?

DRR comprises disaster prevention and preparedness (prior to hazard events), disaster response (during hazard events), and disaster recovery (after hazard events).

How can disaster risk reduction be generally implemented?

Through treatments of risk that translate as avoidance/reduction of exposure, reduction of vulnerability, hazard reduction and increase of adaptive capacity.

Where should we locate the elements we are trying to protect in relation to sources of hazard?

As far from sources of hazard as possible, attending to a good balance between dispersal and concentration.

What connections and disconnections between system elements should we avoid or foster?

Connections between sources of hazard and elements we want to protect should be avoided. The same logic applies for sources of ignition and sources of hazard. Connections between vulnerable groups and emergency managers should be fostered. The same applies for connections between individuals and communities and between them and the places they are located on. Transport connection between elements to be protected and resources to be employed in prevention, response and recovery is also essential.

Following are examples of the application of these considerations onto treatments to bushfire hazard risk:

Avoidance of Exposure

Critical Agents, Vulnerable Populations, and Critical Assets are placed away from high bushfire risk areas, especially when hazard mitigation is not economically feasible, socially desirable or environmentally appropriate. This applies to decision-making on the location of buildings and settlements before and after a disaster event but also on urban design features that allow the safe evacuation of people and critical mobile assets during a hazard event.

Reduction of Hazard or Exposure to It

Buffer areas or containment lines limit the contact between sources of hazard and existing/future development as well as between sources of bushfire hazard and potential sources of ignition (e.g. electrical powerlines). As a determinant of hazard intensity potential, vegetation fuel load is constantly monitored and managed in areas surrounding development. Buildings and lots are also kept with low fuel loads to lower their potential to become sources of fire hazard themselves. During a hazard event, the settlement's overall design allows the expedite deployment of firefighting through redundancy in resources (including firefighters, firefighting equipment, water tanks and water points) and available routes connecting different parts of the settlement internally and externally, thus allowing safe evacuation and the use of regional firefighting resources. Areas with high fuel load that cannot be treated should have controlled access to limit the possibility of arson or accidental lighting of fires when bushfire risk is high (e.g. National Parks internal zoning and road and track design in light of potential for campfires). A high-level of socio-economic equity, education and social cohesion is achieved in communities living at the edge of urban areas in the interface with forested areas, helping decrease levels of arson.

Reduction of Vulnerability to Hazard or Exposure to It

The community is internally and externally well-connected, including the way it connects with visitors. Critical agents, vulnerable community members and visitors, and critical assets are located in buildings and places that are less exposed to bushfire hazards and that can withstand levels of bushfire attack that are beyond their potential for exposure, including the provision of an appropriate level of shelter to occupants that cannot evacuate and to protect critical assets that cannot be easily evacuated or replaced. When it comes to their distribution within the settlement, vulnerable groups, critical assets and critical agents are placed at an appropriate level of concentration/dispersion³⁴.

³⁴ High concentration of vulnerable groups and critical assets/agent can lead to catastrophic outcomes if these are exposed to a bushfire. Their high dispersion can also overwhelm responders and spread thin their response capacity.



Preparedness for, and Facilitation of Appropriate Response

Landscape features have been widely assessed prior to a bushfire event, in relation to their importance to essential social-ecological system functions, their bushfire and cascading hazard risks and potential to intensify and contain escalating risk. Outputs of this process generates hazard mapping and the identification of critical locations for protection in the case of a hazard event. Vulnerable groups, critical agents and assets have also been identified prior to a bushfire event, helping to identify critical locations for protection and the logistics and scale of evacuation measures, should that be necessary. The location of necessary response resources has also been mapped

Preparedness for, and Facilitation of Appropriate Recovery

Critical aspects of recovery are co-designed prior to a disaster event occurring, especially those elements that involve lengthier processes that are necessary for good outcomes in terms of disaster risk reduction and community wellbeing. This is necessary to ensure recovery can be an instrument of building resilience to future disasters and can include buy-back schemes, retreat from high-risk areas and social cohesion strategies. Planning for recovery should include ways to record the process to ensure learning opportunities can inform future recovery planning. Re-building incentives also apply to properties that have not been damaged, but that are not up to current building standards. A network of containment lines, buffer areas and priority new roads is identified and agreed upon prior to a hazard event occurring and can help guide response decisions that can positively impact recovery without creating undesirable path of dependency. By being highly prepared to recover, the community can harness political capital when it is at its peak during and right after a disaster.

APPENDIX 2. CONTRIBUTIONS OF RISK TREATMENTS TO PPRR

For a more detailed understanding of the potential outcomes of direct treatments of risks and their enablers, these can also be described in terms of their contribution to the different domains of emergency management, namely Prevention, Preparedness, Response and Recovery.

The following questions are guiding examples that can be utilised to develop a comprehensive matrix describing the interactions between these concepts:

1. What does improved prevention look like in terms of avoidance of exposure, or separation from hazard?

Vulnerable populations and assets are located away from high bushfire risk areas, especially when hazard mitigation is not economically feasible, socially desirable or environmentally appropriate. In some settings and for particular hazards, this might relate to more site specific separation to an appropriate distance that reduces risks to an acceptable level, such as siting a structure sufficiently away from vegetation to reduce bushfire impacts.

2. What does improved preparedness look like in terms of avoidance of exposure?

Vulnerable populations are prepared to be evacuated early as risks escalate. There is a plan and the necessary structures to protect key assets from exposure should an event occur. The settlement has been designed to allow alternative and traditional ways of communication that are shared by the settlements' residents and emergency management personnel. The settlements' landscape has been used to the advantage of establishing alternative ways of communication between its parts to allow better response in the event of equipment failure (e.g. the location of public infrastructure allowing critical viewpoints is considered as part of master planning).

3. What does improved preparedness look like in terms of preparedness for, and facilitation of appropriate response?

Stakeholders are prepared to respond according to a plan that allows and ensures the recording of procedures, events, decisions, challenges and opportunities that can inform future training and preparedness for future events (e.g. Emergency management logbooks and entries, social media, Council minutes, state planning department's contributions, etc.). It includes recordings of response decisions and their analysis, as well as expectations and reactions to decisions and their consequences. Future events can be seen as new events or those cascading from the event in question.

4. What does improved response look like in terms of reducing bushfire hazard?

The settlement's road network is designed to allow expedite deployment of emergency management personnel to allow back burning and the establishment of containment lines as part of response. Properties are sited in a way that facilitates the access of firefighting vehicles and their access to water as part of reducing buildings' and the settlements' exposure to bushfires.

APPENDIX 3. RISK ASSESSMENT AND TREATMENT TYPICAL EMPHASIS IN MAJOR PLANNING PROCESSES

#	Major Planning Processes	Spatial Scale	Planning Level	Risk Emphasis	Risk Treatment Emphasis
1	Changes to the Planning System, including changes in Legislation, Regulation, Codes, VPPs and Directions	State	System	Risk Assessment and Treatment	Allow implementation of all five treatments of risk
2	Hazard Mapping	State	Strategic	Risk Assessment	
3	Scenario Forecasting	Metropolitan/ Growth Corridor	Strategic	Risk Assessment	
4	Strategic Metropolitan and Settlement Planning	Metropolitan	Strategic	Risk Assessment and Treatment	
5	Proposals and studies on urban growth boundary changes and government responses	Metropolitan/ Growth Corridor/ Precinct	Tactical	Risk Assessment and Treatment	Avoidance of exposure
6	Framework Planning targeting each growth corridor	Growth Corridor	Tactical	Risk Assessment and Treatment	Avoidance of exposure ; Preparedness for, and facilitation of appropriate response ; Reduction of vulnerability to hazard
7	UGB Changes and rezoning of land in the metropolitan edge through planning scheme amendments	Growth Corridor	Tactical	Risk Assessment and Treatment	Avoidance of exposure ; Preparedness for, and facilitation of appropriate response ; Reduction of vulnerability to hazard
8a	Preparation of Precinct Structure Plans to guide subdivision and development of land zoned as UGZ1 or preparation of development plan overlays for the same purpose	Precinct	Operational	Risk Assessment and Treatment	Avoidance of exposure ; Preparedness for, and facilitation of appropriate response ; Reduction of vulnerability to hazard
8b	Planning Scheme Amendments including rezoning, application of overlays and schedules	LGA	Operational	Risk Assessment and Treatment	Avoidance of exposure ; Preparedness for, and facilitation of appropriate response ; Reduction of vulnerability to hazard
9	Planning Permit Applications including subdivision and development in Urban Growth Corridors	Precinct/ Site within Precinct	Operational	Risk Assessment , Treatment and Compliance	Preparedness for, and Facilitation of Appropriate Response ; reduction of hazard
10	Building Permit Applications (Including BAL Assessment and Building Design) for new buildings or for rebuilding after disasters	Lot	Operational	Risk Assessment , Treatment and Compliance	Reduction of vulnerability to hazard
11	Occupancy Permit Applications for new buildings	Lot	Operational	Risk Treatment Compliance	Reduction of vulnerability to hazard
12	Enforcement and Maintenance of buildings, lots and common areas	Lot	Operational	Risk Treatment Compliance	Reduction of hazard ; Reduction of vulnerability to hazard
13	Prescribed burning to lower fuel levels in public land	Growth Corridor/ Precinct	Operational	Risk Treatment	Reduction of hazard
14	Residential Bushfire Planning and Retrofitting	Lot	Operational	Risk Assessment and Treatment	Reduction of vulnerability to hazard
15	Buying Back of Property in Extreme Hazard Areas	Lot	Operational	Risk Treatment	Avoidance of exposure
16	Selling of Crown Land after adding of covenants	Lot	Operational	Risk Assessment and Treatment	Avoidance of exposure ; Reduction of vulnerability to hazard
17	Rebuilding post-disaster (Build Back Better) or processes 10 & 11	Lot	Operational	Risk Assessment and Treatment	Preparedness for, and facilitation of appropriate Recovery