ENVIRONMENT PLANNING POLICY

Planning for a more resilient NSW

Strategic Guide to Planning for Natural Hazards

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Part 1 – Overview

Introduction

Like much of Australia, NSW is exposed to natural hazards on a recurring basis. The state was affected by 198 natural disasters, declared between 2009 and 2019[1]. Between 1970 and 2015, natural disasters across NSW have claimed more than 550 lives and affected thousands of people. Natural hazards also have significant financial and economic costs with the total economic cost of natural disasters in NSW estimated to be $3.6 billion per year[2].

The impacts and costs of extreme weather events are expected to increase as our population grows and areas exposed to natural hazards such as floodplains, the coast and lands adjacent to bushland are urbanised. In the context of a changing climate, natural hazards are also becoming more frequent and intense, making them increasingly unpredictable.

Natural hazard resilience is the collective responsibility of all levels of government, business, the non-government sector and individuals. Together with hazard and emergency management responses, strategic land use planning is one among a suite of tools and approaches than can address risk associated with natural hazards.

The NSW planning system plays an important role in limiting the growth in risk from natural hazards and climate change from development and redevelopment by adopting a risk management approach to strategic planning. While it isn't practical for strategic planning to eliminate all risks from natural hazards to the community, it does play an important role in reducing how vulnerable communities are to these types of risks. Strategic planning can also help to limit how frequently communities may be exposed to risks from natural hazards. Risk avoidance, reducing growth in risk, and risk reduction are a fundamental subset of overall sustainability[3].

An effective strategic land use planning system considers natural hazards early and avoids creating expectations for development that is not suited to current or likely future natural hazards. As identified by the Royal Commission into National Natural Disaster Arrangements[4]:

> Land-use planning decisions have far-reaching and long-lasting consequences as to how exposed and vulnerable the community will be to future natural hazards. Where land-use planning decisions do not effectively incorporate natural hazard risk, future impacts of natural disasters will be higher

The need for guidance

Throughout much of 2019, NSW experienced prolonged and widespread drought conditions, with 99.9% of the state in drought and up to 54.2% categorised as in 'intense drought'[5]. During the 2019-2020 bushfire season, the Premier announced three consecutive States of Emergency citing

[1] Office of Emergency Management (2019), Natural Disaster Declarations, accessed 13 December 2019 at https://www.emergency.nsw.gov.au/Pages/publications/natural-disaster-declarations/2009-2010.aspx
[2] Deloitte Access Economics, 2017, Building resilience to natural disasters in our states and territories Accessed 13 December 2019 at https://www2.deloitte.com/au/en/pages/economics/articles/building-australias-natural-disaster-resilience.html NB: this figure is conservative as the modelling that underpins it does not include consideration of climate change impacts on the frequency, severity and duration of extreme weather events, or chronic climate changes.
[3] AIDR Land Use Planning for Disaster Resilient Communities 2020
[4] The Royal Commission into National Natural Disaster Arrangements, 2020, Report to the Governor-General, p. 70, accessed 24 November 2020, https://naturaldisaster.royalcommission.gov.au/publications/royal-commission-national-natural-disaster-arrangements-report
[5] DPI, 2019, Combined Drought Indicator, accessed 13 December 2019 at https://edis.dpi.nsw.gov.au/

"the most devastating bushfire season in living memory"[6]. Now is a time to reflect on how strategic land use planning can contribute to our resilience to natural hazard risk.

These guidelines have considered the natural hazard risks that NSW is historically most affected by[7]. The frequency and intensity of a range of these is also increasing due to climate change.

Further, as settlements expand into areas constrained by natural hazards - such as coastal zones, floodplains and bushland areas – people, buildings and infrastructure (and the environment, communities and economies they live in) will be increasingly exposed to risk. Some of our most disadvantaged communities are already located in at-risk areas.

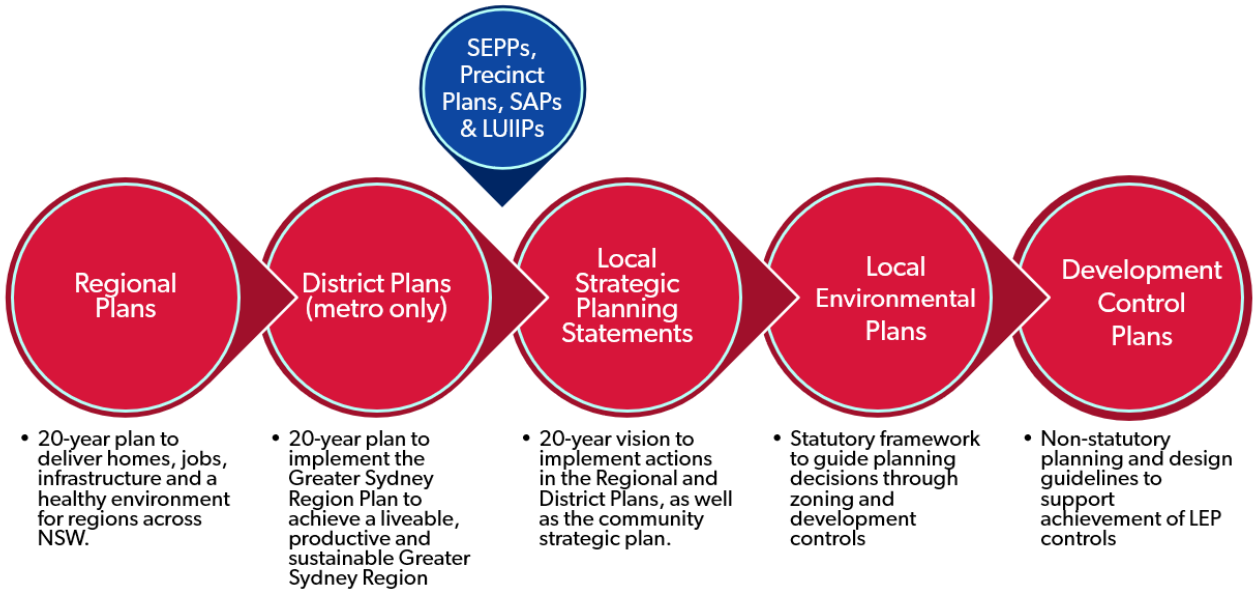
The social, economic and environmental costs associated with natural disasters are high and increasing. In addition to evident loss of life or property, economic disruption and environmental impacts, disaster events also have 'intangible' costs. These include increased family violence, mental health impacts, chronic disease, alcohol and drug use, short and long-term unemployment, changes to school academic outcomes, and crime[8].

For more background information that has informed the development of this guideline, refer to **Appendix A.**

Purpose and scope of this guideline

The Department of Planning, Industry and Environment (the department) has developed this guideline to inform the preparation of regional, district and local strategic plans, planning proposals and other strategic planning activities.

Figure 1 – Strategic planning in NSW



[6] NSW Government, 2020, Premier declared third State of Emergency, Media release, accessed 10 January at https://www.nsw.gov.au/your-government/the-premier/media-releases-from-the-premier/premier-declares-third-state-of-emergency/

[7]NSW Department of Justice, 2017, State Level Emergency Risk Assessment

[8] Deloitte Access Economics, 2016, The economic cost of the social impact of natural disasters, accessed on 16 December 2019: https://www2.deloitte.com/au/en/pages/economics/articles/building-australias-natural-disaster-resilience.html

The purpose of this guideline is to improve the way we use strategic planning to build long-term resilience to natural hazards in our communities. Critical to this is multidisciplinary collaboration with the experts in specific natural hazard risks and emergency managers. These people can provide reliable natural hazard information and expert advice to support State government agencies and councils as they engage in strategic planning activities.

In this guideline we:

- discuss, at a high level, the connection to existing policies, acts, regulations, guidelines and responsibilities
- set out eight guiding principles to inform land use planning decisions and manage natural hazard risk
- explain key concepts related to natural hazard risk management
- identify the natural hazards relevant to NSW that should be considered in strategic planning activities

Relationship to other risk frameworks

Within NSW, there is a suite of legislation dealing with various natural hazards risks and emergency management. A number of state government agencies, as well as local councils, have statutory roles in natural hazard risk and emergency management.

Examples of existing frameworks include, but are not limited to, NSW's flood risk management, bushfire, coastal management and emergency risk management frameworks. This guideline should be read in conjunction with NSW Government policies such as Planning for Bush Fire Protection, the NSW Flood Prone Land Policy, Coastal Management Manual, and others which provide hazard-specific guidance for minimising community exposure and vulnerability to natural hazard risk.

This guideline is not intended to be a technical document and does not replicate or replace the existing legislation, statutory functions and policies that deal with natural hazards or emergency management. This document is a tool with which strategic planning for the most relevant natural hazards can be looked at in a more integrated, multi-disciplinary way.

This guideline will be supported by a toolkit of resources the Department will collate and update to help plan-making authorities find relevant natural hazard data, risk management information, other guidance, case studies, standards, and tools. The Department will build on this toolkit of resources over time with the assistance of key stakeholders including relevant state agencies.

Natural hazards covered by this guideline

This guideline refers to natural hazards identified as posing a high or extreme risk to NSW[9]. These include (listed below in alphabetical order):

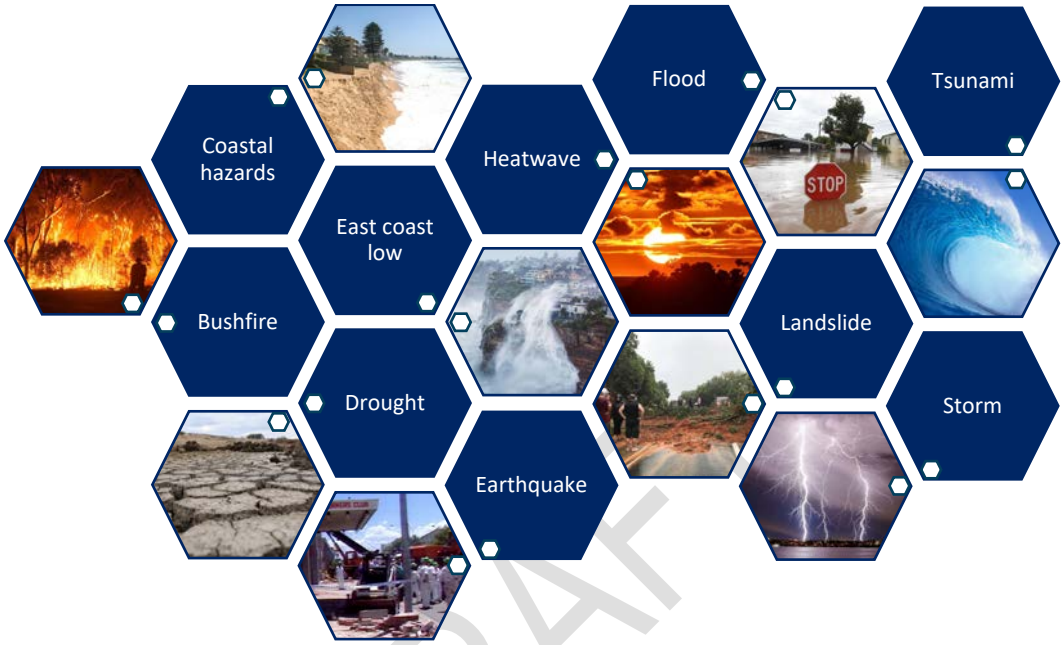
- bushfire
- coastal hazards including coastal erosion
- drought
- earthquake
- east coast low
- flood
- heatwave

[9] State Level Emergency Risk Assessment (NSW Office of Emergency Management, 2017)

- landslide
- storm
- tsunami.

These terms are explained in **Appendix B.** Key natural hazard risk management terms are summarised at **Appendix C**.

Figure 2 – Natural hazards within scope for this Guideline



Issues that are beyond the scope of strategic planning and this guideline

This document provides guiding principles to inform how councils and other public authorities develop strategic land use plans with greater consideration of natural hazards. This includes:

- regional and district plans
- local strategic plans
- planning proposals
- other strategic planning activities that relate to land use planning.

The Department acknowledges that strategic planning is just one of many elements that contribute to effectively managing current and future natural hazards. One of the objectives of this guideline is to encourage more multi-disciplinary dialogue on how these elements interact with strategic planning. For example, the comprehensive statutory frameworks for managing emergencies and specific hazards such as bushfire, flood and coastal hazards play important roles in managing risks from natural hazard risks.

This guideline also recognises that strategic planning has a more limited role in managing risks associated with existing development, unless some form of urban renewal is envisaged for those developed areas.

Another issue that is not discussed in detail in these guidelines is building regulation. Building regulations work together with land use planning to assess development proposals and deliver buildings that are more resilient to natural hazards. The National Construction Code is administered at the federal level and subject to regular revision to ensure buildings are constructed

to a standard appropriate to their context. Together with various national and international standards, building regulations address natural hazards such as bushfire, flood, cyclone, and to a lesser extent earthquake.

Disaster response is also beyond the scope of this guideline, except where it relates to hazard mitigation that should be accounted for during strategic planning activities.

In terms of specific natural hazards, some risks such as poor air quality generated by drought-driven dust storms or smoke from bushfires, are remote from the source, making it difficult to manage through strategic planning. For this reason, these hazards are not captured by this guideline as they are more effectively managed using other tools.

What about climate change?

Climate change is not identified in this guideline as a standalone natural hazard. Climate change is increasing a wide range of natural hazard risks by altering their frequency and intensity, affecting our vulnerability to natural hazards and changing exposure patterns.

Australia's national climate projections at www.climatechangeinaustralia.gov.au indicate that over coming decades Australia will experience:

- Further increase in temperatures, with more extremely hot days and fewer extremely cool days
- Ongoing sea level rise
- Further warming and acidification of the oceans around Australia
- More frequent, extensive, intense and longer-lasting marine heatwaves, suggesting in turn more frequent and severe bleaching events on the Great Barrier Reef, and potentially the loss of many types of coral throughout the tropical reef systems of Australia and globally
- A decrease in cool-season rainfall across many regions of southern Australia, with more time spent in drought
- More intense heavy rainfall throughout Australia, particularly for short-duration extreme rainfall events
- An increase in the number of high fire weather danger days and a longer fire season for southern and eastern Australia, and
- Fewer tropical cyclones, but a greater proportion of high-intensity storms, with ongoing large variations from year to year.

For further information refer to the **NSW Climate Change Policy Framework 2016.**

Guiding principles

The guiding principles for integrating consideration of natural hazards into strategic land use planning activities will support local councils, planning authorities and others to make decisions that more effectively consider risks from natural hazards and build sustainable hazard-resilient communities.

These principles are discussed, with case studies, in **Part 2 Guiding Principles for strategic planning.**

Part 2 - Guiding principles for greater resilience

What is ‘disaster resilience’

As natural hazard risk increases, the capacity of communities and systems to be resilient is challenged. The United Nations Office of Disaster Risk Reduction (2017) defines resilience as follows:

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

Disaster resilience is the ability of individuals, communities, organisations and states to adapt to and recover from shocks or stresses associated with natural hazards without compromising long-term prospects for development. Disaster resilience is a long-term outcome that requires long-term commitment and is the collective responsibility of all levels of government, business, the non-government sector and individuals.

This guideline identifies eight guiding principles to support communities to be more resilient to natural hazards through strategic land use planning:

1. ***Be strategic, consider risks from natural hazards early***
2. ***Protect vulnerable people and assets***
3. ***Adopt an “all-hazards” approach***
4. ***Involve the community in conversations about risk***
5. ***Plan for emergency response and evacuation***
6. ***Be information driven***
7. ***Plan to rebuild for the future, not the present***
8. ***Understand the relationship between natural processes and natural hazards.***

Each of these principles requires multi-disciplinary collaboration. Strategic planning calls for engagement and collective decision-making across state and local government, including risk and emergency managers and asset owners, to manage risk in communities.

Guiding principles for strategic planning

These guiding principles are intended to support plan-making authorities and other agencies involved in strategic planning to make decisions that more effectively consider natural hazard risk, to build sustainable hazard-resilient communities.

1. Be strategic, consider risk from natural hazards early

Strategic planning authorities should adopt a risk management approach in identifying risks from natural hazards and how these may change in response to future development and climate change. Strategic land use plans should address how to increase the resilience of communities under increased threat, by considering the exposure and vulnerability of development to existing and likely future risk. Importantly, they should also consider cumulative risk over the long term and address both new development and legacy issues associated with existing development as these have distinct considerations.

Councils and state government agencies already undertake valuable work in climate change risk assessment as well as coastal, flooding and bushfire hazard management. Strategic planners must draw on this work and the expertise of hazard and emergency managers to help them prioritise their objectives – for example, protection of life and prioritising community wellbeing may be a fundamental objective in planning or renewing a community. These plans can, in turn, inform investment, infrastructure and capital works planning such as councils' Integrated Planning and Reporting framework under the *Local Government Act 1993*.

By considering natural hazards early, we can plan our settlements to avoid unacceptable natural hazard risk. Being informed about natural hazards can limit inappropriate development in areas due to natural hazard constraints. Having a good understanding of existing natural hazard risks also helps planners to anticipate where new development will likely increase risks to existing development, the community or its emergency response capability. This may mean, in some cases, avoiding increasing or intensifying development in areas of known hazards. Redevelopment also provides some ability to limit the growth in risks or potentially mitigate existing risk in the long term.

Key considerations:

- Are all relevant natural hazards identified in Regional and District Plans?
- Are all relevant hazards identified at the regional scale captured by Local Strategic Planning Statements with the appropriate level of detail that reflects the local context?
- Do strategic land use plans appropriately reflect the best available natural hazard information including hazard studies and risk management plans?
- Have any gaps natural hazard information been identified? Has filling these gaps been prioritised, especially for areas where development or redevelopment likely to be impacted by natural hazards is being planned?
- Do development controls and guidance provided in the relevant Local Environmental Plan and Development Control Plans require amendment to address relevant natural hazard risks, build resilience and reflect the outcomes of strategic planning processes?

Case Study: Greening our City Premier's Priority (to plant one million trees by 2022)

While some areas of Greater Sydney, such as Hornsby local government area, have tree canopy cover greater than 50 per cent, other areas have less extensive canopy cover (e.g. Fairfield has 13 per cent).

In 2018, the Five Million Trees for Greater Sydney Program was announced to plant five million trees by 2030. In 2019, the Premier nominated the planting of one of the five million trees by 2022 as part of the Greening our City Premier's Priority. These programs aim to increase canopy across Greater Sydney to 40% by 2036 (Objective 30 of the Greater Sydney Region Plan.

Enhanced tree canopy will help to store greenhouse gases and reduce urban heat effects by shading. However, trees can represent a risk in terms of bushfire risk and risk from tree fall due to severe storm. This illustrates the importance of an all hazards approach – see Guiding Principle 3.

2. Protect vulnerable people and assets

Risk from natural hazards is determined by a community's level of exposure and vulnerability to current and likely future hazards. Strategic planning, together with other risk treatment options, can facilitate more resilient communities by providing physical infrastructure, and socio-

economic support systems, to reduce the community's vulnerability to hazards when exposed to them.

Vulnerability is influenced by a range of factors. Among other things, age, gender, income group, disability, and access to social safety nets greatly affect the choices people have to anticipate, prevent and mitigate risks. In particular, we need to plan for transient and ageing populations as well as populations for whom English is a second language. When preparing strategic land use plans, it is also important to consider whether trends - such as population growth and climate change – will influence the exposure and vulnerability of a settlement over time, and what new considerations or measures this might give rise to.

Strategic land use plans should also identify vulnerable infrastructure assets and consider how they can be protected. Plans should consider whether there is, or will be, adequate essential infrastructure - such as roads, water, energy, waste management and evacuation capacity - to serve both existing and planned settlements.

Strategic planners should undertake this analysis in collaboration with lead agencies for relevant hazards, asset owners, and other responsible agencies and take into account these stakeholders' advice on hazard information and risk management plans. These discussions should factor in a range of scenarios, such as if multiple, concurrent or consequent natural disaster events were to occur – see also Guiding Principle 3.

Key considerations:

A vulnerable community is one that is exposed to a hazard. Communities of greater vulnerability may have one or more of the following characteristics:

- growing in population
- significant numbers of aged or young persons
- lower socio-economic groups
- regional or remote from emergency services
- people with mobility issues
- people with language barriers
- isolation during and after a hazard event
- infrastructure located in an area of high risk or that will fail/must cease operating when an event occurs.

These communities require detailed analysis and planning to increase their resilience to hazard events.

Case Study: Challenges for vulnerable communities and assets during 2019/2020 "black summer" bushfires

During the black summer bushfires, areas of NSW's South Coast became isolated for periods up to three weeks due to the closure of the Princes and Kings Highways.

Road closures prevented people from evacuating dangerous areas, left tourists displaced and locals isolated, and also put pressure on local businesses' supplies of fuel and food. Some businesses closed as they were unable to restock, contributing to the distress of the community, which could not access essential supplies. Woolworths in Bermagui, for example, was closed from 2-7 January due to resupply challenges and power outages.

Lessons from past events can help plan-making authorities identify vulnerable assets and communities and plan for risk reduction. Key road corridors, for example, can be upgraded to a higher standard of resilience so they are able to remain open or be cleared and reopened more quickly to enable more efficient evacuation and transportation of essential services and supplies.

3. Adopt an "all-hazards" approach

An all hazards approach to land use planning means careful consideration of all hazards when developing strategic land use plans in collaboration with relevant natural hazard and emergency managers. It also involves using the best available hazard information, which may come from a range of sources.

NSW's emergency management arrangements reflect a commitment to an all-hazards, all-agencies approach which includes coordination and information sharing across prevention, preparation, response and recovery phases. The all-hazards approach is based on the principle that operational systems and methods that work for one hazard are likely to work for others. Importantly, it does not prevent the development of specific plans and arrangements for hazards that require specialised approaches.

Planning authorities must consider the risks of each relevant natural hazard on its own, together with relevant coincident events occurring at the same time and location. They should also add to this consideration of compounding and cascading events.

Examples of coincident extreme events include a storm event that generates both storm surge and rainfall leading to flooding that is worse than if no storm surge was present. Compound extreme events can describe the confluence of climate and weather extremes of varying timescales, such as a drought period intersecting with a prolonged heatwave, or record high daily temperatures — an occurrence which typically results in large impacts on agriculture, human health, fire weather and infrastructure. An example of cascading events is an earthquake that triggers a tsunami or landslide.

Plan-making authorities are also encouraged to consider other known hazards beyond natural hazards, including things that may become hazardous following a natural disaster event such as large energy storage systems, critical or sensitive infrastructure, or asbestos-containing buildings. This will help ensure risk assessment and mitigation strategies are adequate and can aid in planning the recovery process – see also Guiding Principle 7.

In considering the above, strategic planners should take into account both the likelihood and consequences of the full range of natural hazard events to ensure the strategic response is proportionate. Strategic planning does not aim to eliminate all risk to the community as this is not always possible or practical, particularly for existing settlements. Rather, planning seeks to reduce community vulnerability and limit the frequency of a community's exposure to natural hazard risk.

Key considerations:

- What are the natural hazards relevant to my LGA?
- What areas do they affect and how do these effects vary?
- What are the likely consequences of coincident, compound or cascading events?
- Would a settlement, its physical infrastructure and formal and informal socio-economic supports withstand such an event? What contingencies need to be put in place?

Impact of coincident natural hazards on energy security in NSW

The Australian Energy Market Operator (AEMO) now identifies climatic conditions as the most important input into forecasting of demand and supply of electricity generation.

NSW electricity demand peaks in the summer months as households simultaneously switch on air conditioners to cool their homes. Hot temperatures trigger an increased demand for power but also impact supply as generators, power lines, and transformers fail or run at suboptimal operating levels. In the context of a warming climate and increased frequency of extreme heat events, NSW's electricity network

- How will climate change influence existing natural hazard risk over time?
- Has the interaction of risk from natural and other known hazards been considered and/or mapped to ensure strategic planning considerations are adequate?
- Do strategic plans respond proportionately to the likelihood and consequences of each scenario?

is under pressure and risk from extreme demand peaks or equipment failure is heightened.

Other climatic events such as bushfires, lightning strikes and high winds can also directly impact generators and transmission networks as well as limit the transmission network power transfer capability. Drought increases the likelihood and severity of dust storms, generating dust particles that impact the operation of PV systems and transmission lines. Drought can also lead to shortages of water supply, which impacts the output of hydro generation. Hydroelectricity relies on water for fuel. Thermal electricity also uses water in cooling.

This can lead to heightened risk of load shedding events, where AEMO directs power companies to switch off customers' power supply to protect the system.

4. Involve the community in conversations about risk

Planning authorities need to regularly engage residents, businesses, healthcare, community services, community leaders, educational institutions, and other similar stakeholders in the strategic planning and how it relates to natural hazard risk. This develops a community's civic engagement and facilitates better informed community discussions and a partnership approach to decisions about acceptable risk, building resilience and shaping future settlement patterns.

It is essential to involve residents and other community partners in planning for natural hazards such as where we build, what we build and how we build. This process should be a continuation of community engagement by hazard and emergency managers as they develop risk management plans for the community. The link between hazard studies, risk management plans, and strategic land use plans should be clear to the community.

Strategic land use plans must incorporate community consultation, be based on community preferences and should adopt a risk-management approach. Well-informed communities will more meaningfully contribute to better strategic planning outcomes and tailored, local solutions. It is important to avoid creating expectations for development that is not suited to current or future natural hazards, or that will create legacy issues that future generations will be burdened with.

Strategic planning decisions should be transparent in how they incorporate natural disaster risk identified through hazard studies and risk management plans, especially advice received from combat agencies and lead agencies for relevant hazards. Strategic planning processes should apply a consistent risk management framework that sets out how trade-offs between managing natural disaster risks and other competing objectives will be made. This process should reflect a clear understanding of community values and risk appetite.

Risk preferences are inherently local as it is the local community who will bear the risk in the long term. The politics around making difficult decisions can either paralyse a community or create the collective will to create change – see also Acceptable Risk in Part 3. The ability to

provide a series of data-driven facts and to create an environment in which discussion of these facts and their consequences can take place makes change more likely – see also Guiding Principle 6.

Key considerations:

- Has local knowledge about impacts and lessons learnt from past events, especially in communities that face unique challenges such as remoteness, been captured?
- Have local indigenous groups been consulted regarding indigenous knowledge systems and land management practices?
- Have partnerships been established to promote regional-scale coordination for natural hazard risks and infrastructure networks that are regional in scope?
- Have natural hazard risks that may originate in other jurisdictions, such as flooding flow-on impacts, been considered?
- Have combat agencies including Ambulance NSW, Fire and Rescue NSW, NSW Police Force, NSW Rural Fire Service, NSW State Emergency Service as well as natural hazard lead agencies been consistently involved in land use planning to ensure collective-decision making that considers the best available natural hazard information?

Case Study: FloodSmart Parramatta

FloodSmart Parramatta offers a free flood warning service that provides early warning messages, to residents and businesses, when flood warnings are issued by the Early Warning Network.

Users can choose to receive warning messages in any combination of text, email, or automated voice message. There are seven warning areas that cover different communities in the City of Parramatta. Each warning area will receive its own individual warning message in the event of a possible flood.

Users can sign up to warnings for their home, workplace, children's school or any area that interests them in the City of Parramatta local government area.

This service is primarily serving to reduce people's exposure to flood. It also helps to educate the community about flood risk and normalises discussions around a relevant natural hazard. This may make it easier for people to relate to and engage with the council on strategic planning issues that relate to flooding.

5. Consider emergency response and evacuation

The elimination of all natural hazard risk from our communities is rarely, if ever, possible, particularly in existing settlements. It is therefore essential that strategic land use plans consider emergency response including evacuation. This serves the purpose of prioritising protection of life but also minimising demands on emergency responders and complexity of emergency response to ensure combat agency personnel are not placed at avoidable risk. For example, if the community has several transportation pinch points that make emergency response difficult under ideal conditions, the plan needs to consider the implications to the population if these existing pinch points are put under additional pressure during a disaster event.

Evacuation needs are addressed in emergency management planning via the Local Emergency Management Committee (LEMC). Evacuation needs may be different for different hazards as they affect areas in different ways and may have substantially different times for response. The combat agency is responsible for the emergency management strategy including evacuation. It is their call on the day depending on a variety of considerations as to where and how the emergency response strategy (including evacuation) will be implemented.

When preparing strategic land use plans, in consultation with the relevant LEMC, planning authorities should consider evacuation routes that take into account vulnerable communities, seasonal changes in population density, location of evacuation or recovery centres and other community facilities that can be mobilised following a disaster event to assist with the recovery process.

In light of their emergency response and recovery function during an event, the location of key community infrastructure such as power supplies, communication centres, emergency response headquarters and evacuation centres may also require additional protection and need to be carefully considered in terms of accessibility, servicing, and proximity to high risk areas to ensure that they are fit for purpose in emergency response and recovery.

Key considerations:

- Have long-term population trends such as increases in populations of the very young, elderly or those with language barriers been considered?
- Have shorter-term changes such as seasonal traffic flows and transient populations (e.g. workforce and tourists) been considered?
- Has the location of evacuation centres and other key community infrastructure been considered?
- Are there pockets of increased density or intensity of development that may require specific evaluation planning?
- Is more than one transit route provided in different directions to ensure people do not become trapped in a locality?

Case Study: Ingleside Land Use and Infrastructure Strategy

The department released the draft Ingleside Land Use and Infrastructure Strategy in December 2016 for community consultation in conjunction with the Northern Beaches Council. The strategy proposed 3,396 homes to accommodate 9,000 residents supported by a school, community centre, parks and neighbourhood centre.

An independent review into the proposed plan found the location, which is flanked by national park, would expose residents to extreme existing bushfire risk and evacuation challenges as most evacuation routes required residents and fire services to traverse bushland. The Department determined the proposal represented unacceptable bushfire risks and did not proceed with the draft plan.

The Department is working with local council, the Rural Fire Service and the community to identify a future for Ingleside that is built around bushfire protection. The development will be at a lower scale, ensure the road network can accommodate appropriate evacuation volumes, and include upgrades to the existing road network and bushfire defences.

6. Be information driven

This principle emphasises that using and sharing high quality data, evidence and information is a prerequisite for incorporating natural hazard risk into strategic planning and, ultimately, good planning outcomes. Examples include natural hazard risk and settlement vulnerability mapping in land use planning decision-making, or analysis of previous natural disaster events. Strategic land use plans that are informed by the best available natural hazard information and multi-disciplinary expert advice can also identify information gaps that a council needs to address to inform future planning decisions. This may include economic and social impact modelling for natural hazard events and evaluation of critical infrastructure exposure to natural hazards.

Hazard mapping products and data sets need to be updated on a timely basis and available in easily accessible formats. Community risk and vulnerability profiles are subject to change not only seasonally but for a range of other socio-economic factors, which may be sudden changes or 'shocks' and longer-term trends. Coastal settlements, for example, are susceptible to influx of people including tourists, and the uncertain impacts of climate change. In the southern highlands and southern inland forests, the combined impacts of heat, drought, water security, narrow economic focus and changing community resources lead to a constantly evolving risk profile, particularly bushfire risk.

Plan-making authorities should keep their strategic plans current through periodic evaluations and reviews. Where new data becomes available, strategic planners should consider how this data informs strategic land use plans and triggers for specific decisions. For example, data may inform an assessment of long-term viability of certain infrastructure, which may need to be reinforced or relocated in the future. The trigger may be when sea level rise achieves a certain height.

Strategic planners are encouraged to consider and address the potential impacts of development or hazard behaviour in one local government area (LGA) on another. Where this potential exists, councils should collaborate to ensure that natural hazard risks and development impacts on these assets have been effectively understood and considered in a coordinated way across LGAs.

Critical information that individuals and businesses need to make informed decisions is often not easily understood or attainable by the community. Governments at all levels must prioritise making critical information easily understandable and readily accessible on multiple platforms before, during, and after an event. Accurate mapping of hazards for all areas of the impact zone provides more detailed information on the risk of both current and future hazards.

Key considerations:

- Any relevant hazard information, including hazard studies, risk management studies and risk management plans
- Hazards identified in a relevant environmental planning instrument or development control plan
- Relevant hazard, risk and vulnerability studies prepared by an appropriately qualified expert
- Historical data

Case study: Urban Heat in Parramatta LGA

The Western Sydney region is recording an increasing number of days reaching temperatures of 35℃ and over.

The City of Parramatta identified urban heat as a key priority in its *Environmental Sustainability Strategy 2017*. The council aims to improve liveability by cooling the City and protecting its people and communities from heat stress.

Council's Heat Vulnerability Index guides the protection of established tree canopy via the *City of Parramatta Local Strategic Planning Statement 2020* and has also informed Council's contribution to projects seeking to

- Relevant scientific modelling (such as relating to sea level rise and climate variability)
- Relevant advice in best practice guides such as those identified in the Toolkit
- Indigenous knowledge systems and land management practices

improve water quality and make Parramatta River swimmable.

Council also has prepared City Heat Maps to provide its community with accessible data illustrating how the Urban Heat Island impacts their local area during the day and overnight.

7. Plan to rebuild for the future, not the present

If a natural disaster event results in significant impacts on the community, and this leads to the need to rebuild, we need to consider how this can be done successfully. There is an understandable desire to rebuild in place as quickly as possible following a disaster event. However, this is not always in the long-term interest of a community or region where an existing hazard is likely to recur or intensify over time.

The protection of life is a fundamental objective of land use planning and the goal of an all-hazards planning process in the aftermath of an event is to enhance community resilience. Strategic land use plans should provide for recovery in a way that enhances future resilience and does not simply replace what existed with the same thing, unless there are overarching safety or economic considerations that necessitate this approach. For example, to prevent or mitigate the effects of any future disasters, strategic plans can identify where communities would need to be built to contemporary and more resilient standards.

Whether or not a council needs to strategically plan to "build back better" will depend on the exposure of the community, the scale of impacts and their frequency of occurrence. Significant investment in this work may not be warranted in some communities. Relevant risk management processes for specific natural hazards may identify appropriate, practical and feasible mitigation actions that can address risk at the location and allow rebuilding to occur to more contemporary building standards. However, where natural hazard risk assessment identifies areas where structures may be destroyed in a disaster event and should not be rebuilt as the risks cannot be effectively managed, it may be appropriate to reflect this in strategic land use plans.

Before disaster strikes, strategic planning at the local level should identify areas of existing development that may be become increasingly exposed or vulnerable to natural hazards over time and, therefore, increasingly unacceptable levels of risk. This allows for approaches to recovery to be developed with effective and extensive community consultation, dovetailed with other community plans, that can be more quickly implemented after an event. This may involve a move away from existing development patterns, changes or upgrades to infrastructure, financial and other support, and long-term resettlement visions for the community.

Strategic planners can play a part in promoting disaster recovery that enhances long term community resilience by working with the community to learn from disaster events, and encouraging them to participate in strategies for building back better with avoidance and risk mitigation measures in mind, rather than simply rebuilding.

Key considerations:

- Ask the key questions:
  - How do we adapt to reoccurring events?

Case Study: Tweed Shire Industry Central Land Swap Project

Following unprecedented floods cause by ex-tropical Cyclone Debbie in 2017, Tweed Shire Council established the Industry Central Land Swap project to assist businesses located

  - What lessons have we learnt from previous events?
  - How do we recover better, stronger and more resilient from events so that the next and subsequent events are less disruptive and damaging?
- Anticipate risks and systematically scope out land use planning issues that will likely need to be rectified post disaster, identifying recovery options
- Use the expertise of emergency management and disaster recover agencies to help inform future options
- Actively involve the community to develop post-disaster settlement recovery options
- Review land use and building policy/regulation following an event to identify areas that need improvement or redress

within the high risk flood zone of the South Murwillumbah industrial precinct to relocate to a Council-owned flood free site located above the 1 in 100 year flood level.

Under the deal, Council will prepare the site for development including subdivision and infrastructure works, such as roads, water and sewer. Landowners were invited to enter an expression of interest and, if successful, have up to 10 years to relocate.

Infrastructure and buildings on vacated properties will in most cases be removed and those allotments rezoned to allow for public open space or other community purposes. By removing impediments from the floodplain, impacts from future flood events will be reduced.

This was a strategic solution to mitigate against natural hazard risk and create resilience for local businesses and the broader economy.

8. Understand the relationship between natural processes and natural hazards

Development doesn't exist in a vacuum, so it's important to understand the environmental context in which our settlements exist or may exist in the future. Many environmental assets and natural processes have a beneficial impact on settlements and communities. Coastal communities, for example, socially and economically benefit from their proximity to beaches and their dramatic and dynamic oceanic processes. We can support the environment to mitigate against some of the risks these processes give rise to - for example, through protecting vegetated beach dune systems which absorb wave energy, control erosion and mitigate against the impacts of salt and sand-laden winds.

Flood is another natural hazard that can have a devastating impact on communities. Floods are natural and areas of the floodplain provide different functions, such as the conveyance and storage of floodwater during flood events. Siting development in areas away from important flood functions and considering the other constraints that flooding can place on land in strategic land use planning decisions can make our settlements more resilient to the impacts of flood.

Floods can also provide water to flood dependent ecosystems and recharge surface and ground water supplies, that support the environment, settlements agriculture and recreational uses. Floods also prompt significant biodiversity events, such as bird migration and breeding, attracting tourism to a region after the flood waters have started to subside. Understanding flood behaviour helps us to build more flood-resilient communities. For example, by protecting the environmental assets (i.e. green infrastructure) that act as natural sinks for floodwaters, such as wetlands and riparian corridors, and siting development in areas least susceptible to flood impacts, we can make our settlements more resilient to the impacts of flood.

Strategic planning can increase the resilience of communities and the environment, by giving green infrastructure equal status with the built environment, and better integrating the two. An example of this in practice is including tree canopy, green roofs and green walls on new residential developments to cool development and increase resilience to heatwaves. The Government Architect's Greener Places design framework provides relevant guidance:

> Well-designed green infrastructure connects vital life support systems for urban environments. It needs to connect with other elements of a well-designed built environment created through urban design processes, involving a range of disciplines from architecture, urban planning, and landscape architecture.

Strategic planning can improve our resilience to natural hazard risks through decisions that are supported by an understanding of the social, economic and environmental value of our environmental assets and the associated natural processes that do or could occur.

Strategic planning should also seek to integrate, and learn from, Aboriginal knowledge of Country. Aboriginal people across the state maintain a continuing connection to Land and Sea Country, and a deep understanding of the many natural processes that may impact our settlements and how this can be managed. By seeking out the knowledge of our Traditional Custodians, we can better understand the natural conditions of a place and ensure that development is well-adapted to these conditions.

Key considerations:

- Is the relationship between biophysical features, environmental assets and 'green infrastructure' in the landscape, and the natural processes they support, understood?
- Has a holistic view of what social, economic and environmental risks and opportunities may arise from natural processes that occur in the area been adopted?
- Have opportunities to improve resilience by better accommodating natural processes, especially if the landscape has been disturbed in the past, been identified?
- What lessons of past events have been learned, so that the factors that contribute to natural processes becoming natural hazard risks or disasters are better accounted for in strategic planning?
- Has the integration of green infrastructure with the built environment been prioritised to enhance community and environmental resilience?
- Have indigenous knowledge systems and land management practices been considered?

Case study: Sydney Water

Sydney Water is Sydney's water supply authority, and it also provides sewerage and stormwater drainage systems and services.

Sydney Water's infrastructure assets include concrete lined stormwater drainage channels and canals, which are spread across a highly urbanised environment. Where these channels need to be repaired, Sydney Water has identified that better social and environmental outcomes can be achieved through naturalising those assets, using natural looking banks made of rocks and native plants. The project also offers the opportunity to improve public access to those waterways, by incorporating bike tracks, footpaths and seating areas.

Channel or canal naturalisation involves the conversion of drainage channels to look more natural and to function more like a natural waterway. In addition to providing recreational amenity and scenic values, naturalised channels with appropriate buffers can improve the ecology of the waterway and also mitigate the effects of flood by improving the capacity of the waterway to absorb more water and to slow the flow of storm and flood waters.

Part 3 – Understanding natural hazards and risk management

Understanding natural hazard risk

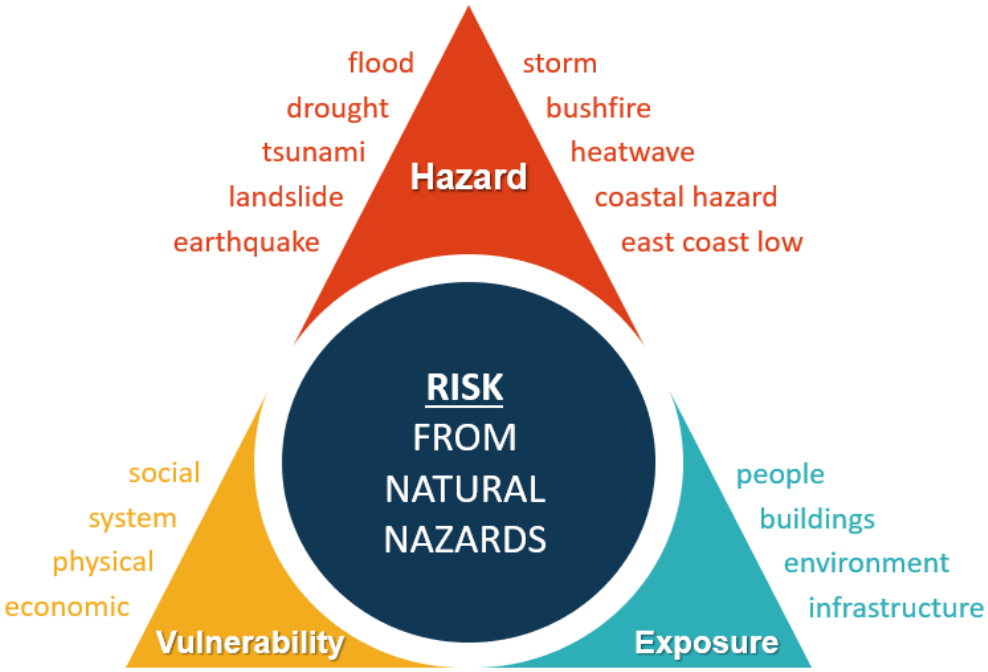
A natural process has the potential to turn into a natural hazard risk when three elements interact:

- there is a presence or probability of a *natural* ***hazard*** (such as those described in **Table 2**),
- people and/or property are ***exposed*** to the hazard, and
- characteristics of a community make it ***vulnerable*** to the damaging effects of the hazard.

Risk reduction is achieved by decreasing the contribution from one or more of these three components, whilst not increasing others or increasing these to the same extent or less. Sustainable development seeks to reduce long-term risk to people and property from natural hazards. Even where little can be done to reduce the probability of natural hazards, it may be possible to reduce the exposure and / or vulnerability of a community to those hazards, and hence the risk.

The concept of a natural hazard risk is depicted in **Figure 4**, which provides an example of how hazard, vulnerability and exposure contribute to risk.

Figure 1 – Example of a natural hazard risk triangle



For these reasons, strategic planning plays a significant role in shaping future growth and development, and community resilience. Strategic planning that effectively considers the impacts of natural hazards at an early stage in decision-making limits exposure and vulnerability to risk through appropriate zoning and development controls that consider the constraints that natural hazards place on land. It is important to consider all hazards prior to zoning or rezoning land to avoid creating the perception that the land is suitable for purposes that are incompatible with existing or likely future constraints on the land.

Appropriate zonings and development controls manage:

- the impacts of development on natural processes including natural hazard behaviour
- the impacts of development on the risks of natural hazards to the existing community, and
- the impacts of these hazards on future development and its users.

Decisions relating to what land uses or development types are permitted in an area can influence our exposure to natural hazards. For this reason, land use planning is an essential aspect of

hazard risk reduction. In NSW, for instance, if we allow more people to live in floodplains, they are more likely to be exposed to floods and their consequences. And if more people live in bushland areas, they are more likely to be exposed to bushfires. Although it is unrealistic to plan communities that are entirely risk-free, strategic planning is a key tool in helping to take account the significant variation in natural hazard risks. Strategic planning strives to achieve compatibility of land use with natural hazard risk and ensure development outcomes that limit the frequency of exposure to natural hazards.

There are many aspects of vulnerability, arising from physical, social, economic, and systemic factors – see Box 3.1. Planning authorities can make decisions now that will reduce the vulnerability of communities and buildings exposed to hazards. For example, they can undertake a social impact assessment when preparing strategic land use plans for their communities to assess vulnerability to and prepare for hazard events. These plans should be developed by working with natural hazard experts to understand the natural hazards relevant to the community and their potential consequences. Planning authorities can also develop a framework for understanding climate change vulnerability to help prioritise climate change adaptation initiatives.

Box 3.1 – Vulnerability to natural hazards

Vulnerability is integral to understanding the true extent of natural hazard risk and can be divided into four main areas:

- **Physical vulnerability** – potential for physical impact on people as well as the built environment. Physical vulnerability of people is influenced by, among other things, age, health, and mobility. Physical vulnerability of buildings and infrastructure is influenced by building standards and construction techniques. These, in turn, also influence the physical vulnerability of people to injury in the event of building damage or failure.
- **Social vulnerability** – potential for communities to experience social losses such as disruption of social interactions, loss of identity and family breakdown. Relevant factors include a population's age, income, social capital (i.e. strength of social networks), as well as physical and mental wellbeing.
- **Economic vulnerability** – potential for economic losses including (i) direct tangible costs such as physical damage to buildings and their contents, (ii) indirect tangible costs following an event such as business disruption and clean-up, and (iii) intangible costs such as death and injury, loss of memorabilia, or loss of environmental assets.
- **System vulnerability** – potential for loss of critical infrastructure systems such as electric power stations, water treatment plants or telecommunication hubs.

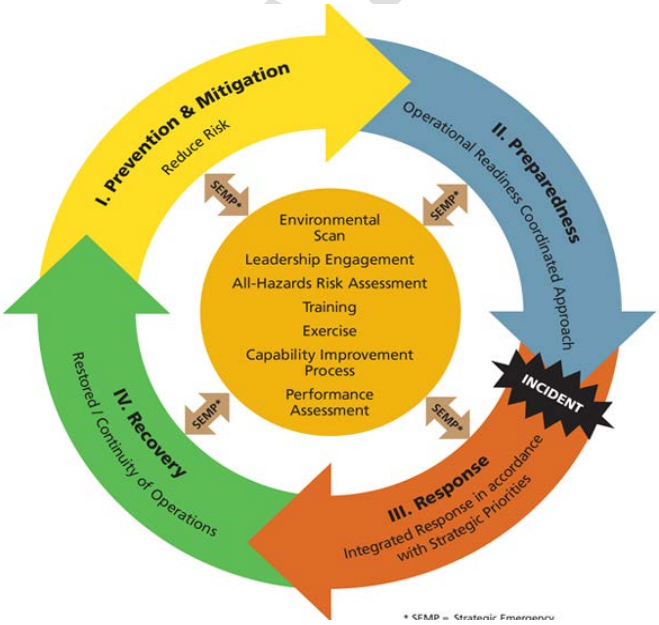
Managing natural disaster risk

Risk management techniques can be used to reduce the impact of natural hazard risk and manage the consequences when disasters occur. The NSW Government adopts a risk management approach and a broad risk management hierarchy of avoidance, minimisation and mitigation consistent with ISO 31000:2018 Risk Management – Guidelines (International Organization for Standards, 2018). Natural hazard risk management is the organisation and management of resources and responsibilities to reduce the harmful effects of all hazards.

Risk management is not just about responding to an emergency; it begins well before an emergency occurs and continues through to well after the emergency has passed. A comprehensive emergency management cycle comprises four phases[10]:

- **Prevention**: eliminate or reduce the level of the risk or severity of emergencies. It includes identifying hazards, assessing threats to life and property and taking measures to reduce potential loss to life or property.
- **Preparation:** build the capacity of communities to cope with the consequences of emergencies. It includes arrangements or plans to deal with an emergency or the effects of an emergency
- **Response:** ensure the immediate consequences of emergencies to communities are minimised. It includes the process of combating an emergency and providing immediate relief for persons affected by an emergency
- **Recovery:** support individuals and communities affected by emergencies in reconstructing physical infrastructure and restoring physical, emotional, environmental and economic wellbeing. It includes the process of returning an affected community to its proper level of functioning after an emergency

Figure 5 - Emergency Management Cycle[11]



Actions that take place before and after a natural hazard event can significantly impact the scale of the crisis. Research and inquiry findings conclude that early consideration of natural hazards in decisions and investment in resilience - before disaster strikes - is many times more effective in reducing overall loss of life and property than continually responding to emergencies[12]. As identified by the 2014 Productivity Commission inquiry into Natural Disaster Funding (2014, p. 4):

[10] Office of Emergency Management, Key Elements of Emergency Management, accessed at https://www.emergency.nsw.gov.au/Pages/publications/guides-factsheets-brochures/emergency-management-arrangements/key-elements.aspx on 14 January 20120
[11] Public Safety Canada, Emergency Management Planning Guide 2010–2011, accessed https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/mrgnc-mngmnt-pnnng/index-en.aspx on 15 January 2019
[12] Productivity Commission, 2014, Natural Disaster Funding Arrangements, Inquiry Report (74), Retrieved from Canberra: https://www.pc.gov.au/inquiries/completed/disasterfunding/report/disaster-funding-volume1.pdf

There is a longstanding concern that governments underinvest in mitigation and spend too much on recovery, leading to higher overall costs for the community.

Furthermore, government responses to natural disasters can be ad hoc and emotionally and politically charged, resulting in reactive 'policy on the run' and inequitable and unsustainable outcomes.

This inquiry identified land use planning as a potent policy lever for influencing the level of future natural disaster risk. To improve levels of resilience to disaster, we must change how we think and operate as strategic policy makers. This will require long-term behavioural change to recalibrate our 'response and recovery' mindset to one of 'preparation and mitigation'[13].

Acceptable risk

The need to treat risk from natural hazards depends on whether the current level of residual risk is acceptable to the community. In some instances, NSW government guidelines and policy instruments define a standard for acceptable risk, such as the 1 % Annual Exceedance Probability (AEP) flood, beyond which development controls are applied to new development to limit the increase in risk.

In cases where there is no defined standard, the level of risk that is acceptable will need to be determined by local government in consultation with experts such as hazard leaders, risk and emergency managers and the community. This process should be a continuation of community engagement by hazard and emergency managers as they develop risk management plans for the community. Members of the community must be involved as they will take on the long-term risk that may impact their lives and homes.

Acceptable risk is a risk management decision that involves balancing risk from natural hazards, and the costs of living with this risk, with the benefits of occupying the at-risk areas (such as the floodplain, bushland, or coastal areas) in consideration of a reasonable level of service to the community. Identification of an acceptable level of risk should consider the best available hazard information including past events and the full range of natural hazard events, taking into account relevant standards and guidance from government and industry.

Risk analysis is a systematic approach to developing an understanding of the nature, drivers, and level of risk to rank the relative seriousness of risks – see for example *ISO 31000:2018, Risk management – Guidelines*. Risk analysis may involve a combination of quantitative and qualitative measures. It can be used to inform decisions on both the acceptability of the residual risk and the effective and efficient use of resources to better understand and manage risk to the existing and growing community.

There can be instances where adopting the general standard for development controls results in a residual risk that continues to be intolerable to the community. In these circumstances, additional localised development constraints may be warranted to reduce residual risk further. Examples of situations where this can arise include:

- certain community groups and the types of development they inhabit are more vulnerable and may need additional constraints;
- key community infrastructure such as power supplies, communication centres, emergency response headquarters and evacuation centres require additional protection; and
- the consequences of the same magnitude of flood can vary greatly between locations.

[13] COAG, 2011, National Strategy for Disaster Resilience, accessed 8 January 2020 at https://knowledge.aidr.org.au/media/2153/nationalstrategyfordisasterresilience.pdf

Planning for natural hazards in NSW

Land use planning, together with building regulation and emergency management, can increase community wellbeing by reducing natural hazard risk and increasing resilience.

> The safety and protection of human life and wellbeing of communities, and the wider systems that support them in their various forms, is the core objective of land use planning for disaster resilient communities[14].

The challenge for planning authorities is to balance competing priorities such as growing risk from natural hazards and pressure to increase the availability of land for various uses. Equally, the planning process needs to be cognisant of not only the multiple natural hazard programs that may underway but also significant information already available that can inform the land use planning processes and this needs to be used in a fit for purpose way

The role of strategic planning

Incremental changes to the NSW planning system in recent years have increased our strategic planning capacity through the introduction of regional and district planning, local strategic planning statements and local environmental plan reviews. Strategic planners should account for the full range of natural hazard risk early in the strategic land use planning stage, locating new development in suitable locations to avoid or reduce exposure to natural hazards and the impact of new development on natural hazards.

In 2017, the Department finalised a suite of Regional Plans, which set out a 20-year vision and direction for strategic planning and land use in regions across NSW. This was followed, in 2018, by the finalisation of the Greater Sydney Region Plan and District Plans, marking the first time the entire State has been covered by strategic land use plans.

Most local councils have prepared local strategic planning statement (LSPS) to implement actions in the regional and district plans consistent with the community strategic plan which, in turn, preserves local character and values into the future.

In envisaging a new future for their settlements, communities should consider the natural hazards they face and how their settlements might need to adapt to address risks. Ideally, hazard studies should be completed prior to the commencement of a new land use strategy, so that the outcomes can be incorporated into the planning process keeping resilience considerations ‘front of mind’ during land use strategy development.

Opportunities to strengthen our resilience

The NSW planning system provides for both strategic and statutory planning at the state, regional and local levels. As discussed in the previous section, consideration of natural hazards is provided for in various plans and policies. However, we must continue to search for new and improved ways to help communities have conversations on how they adjust to the natural hazard and climate change outlook to create adaptive management pathways that guide future decisions.

Building resilience relies on establishing new or enhanced multi-disciplinary partnerships between natural hazard managers, emergency managers and land use planners, key stakeholders and the community. Strategic planning is not the only tool for strengthening resilience, but it is an important one that needs to be well-integrated with the suite of tools available to local and emergency planning and response authorities.

[14] AIDR, 2020, Land Use Planning for Disaster Resilient Communities, Australian Disaster Resilience Handbook Collection

Strategic land use planning must be an ongoing process of learning, adjustment and adaptation to achieve ongoing risk reduction. The planning system must evolve to address NSW's changing risk profile, including identifying and responding to hazards of growing significance such as heatwave.

Together with hazard and emergency management responses, strategic land use planning is one among a suite of tools and approaches than can address risk associated with natural hazards. A change in approach to land use planning alone cannot ensure we build communities that are as safe and resilient as possible. The NSW Government is committed to providing guidance and tools for councils to use as they move toward an evidence-based approach and implementation of contemporary risk-management to planning for natural hazards.

Appendices

Appendix A – Background to these guidelines

Natural processes and natural hazards

Natural processes exist in or are produced by nature (rather than human beings). Natural processes are vital to our environment and have shaped the NSW landscape as we know it today.

Many of our natural ecosystems have evolved with fire and a number of Australia's native plants species such as banksias depend on bushfires to regenerate. Bushfire clears the forest floor of excess vegetation and enriches it with ash, removing competition and enabling replacement plants to quickly regenerate.

Coastal erosion is another example of a natural process. Natural wave action can transport material such as sand and rocks away from our shorelines and distinct habitats for shorebirds and marine life as well as creating natural landmarks.

We derive many important benefits from natural processes such as photosynthesis, which removes carbon dioxide from the atmosphere and replaces it with oxygen, as well as flooding, which creates rich soils full of nutrients brought in by floodwaters.

Describing natural hazards

Natural hazards can be grouped by their causative elements:

- **Meteorological hazards** – storm, east coast low, tornado, cyclone, heat waves, hail
- **Hydrological hazards** – flood, snow avalanche
- **Oceanographical hazards** – storm surge, erosion
- **Geological hazards** – earthquake, volcanic eruption, mass movements (landslide, landslip etc.), tsunami
- **Vegetation hazards** –bushfire
- **Space hazards** – meteor strike

Natural processes operate almost continually but we notice them most when they interact with a community that has become exposed or vulnerable to their operation. That is, when the natural process has the potential to affect lives or property and becomes a hazard. Natural hazards are:

> Shocks caused by a natural process or phenomenon that may cause loss of life, injury, damage and disruption. Natural hazards include bushfires, floods, cyclones, storms, heatwaves, earthquakes and tsunamis[15].

Natural hazards are distinct from anthropogenic or man-made hazards such as radiation leaks and oil spills.

Natural hazards that are significant for NSW

Natural hazard risk is a concern in many areas across NSW. In the 10 years from 2009 to 2019, bushfires, floods, landslides and severe storms led to the declaration of 198 natural disasters in NSW[16]. Bushfires were the most frequently occurring natural disaster accounting for 121 declarations during this period.

[15] National Resilience Taskforce, 2018, National Disaster Risk Reduction Framework, accessed https://www.homeaffairs.gov.au/emergency/files/national-disaster-risk-reduction-framework.pdf on 16 December 2019

[16] OEM, 2019, Natural Disaster Declarations, accessed https://www.emergency.nsw.gov.au/Pages/publications/natural-disaster-declarations/2019-2020.aspx on 16 December 2019

In NSW, many communities have experienced disruption or disaster from natural events. Recent examples include the Hunter and Central Coast flood (2007), Hunter flood (2015), Western floods 2016, Cyclone Debbie (2017), and the 2019/2020 bushfires - see further examples below.

NSW communities also face risks from coastal erosion, severe winds, and the potentially catastrophic impacts of earthquakes or tsunamis. Climate change is expected to compound the risks many communities face, especially those on floodplains and along low-lying coastal areas, as sea level and the intensity and frequency of severe storms increase. Prolonged droughts and heatwaves are also expected to become more frequent, driven by a changing climate.

The State Level Emergency Risk Assessment (SLERA) identified nine hazards that pose a significant risk to NSW, each receiving a risk rating of high to extreme. In addition, drought has emerged as a natural hazard of growing significance for NSW following the Millennium Drought 2001-2010 and in the context of the present drought, which began in mid-2017, and our changing climate.

These hazards and their definitions are summarised in **Appendix B**.

Why planning for natural hazards is essential

Natural hazards are becoming more frequent and intense

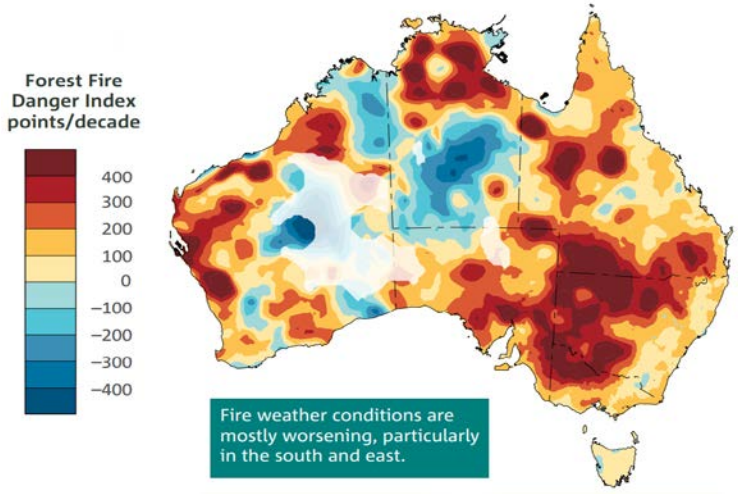
Australia is the world's driest inhabited continent and is considered one of the developed countries most vulnerable to global warming as natural hazards become more frequent and intense.

According to the Bureau of Meteorology and CSIRO, Australia's climate has warmed by over one degree since 1910 leading to an increase in the frequency of extreme heat events[17]. Sea levels are also rising around Australia, increasing the risk of inundation. There has been a decline in April–October rainfall in the southeast of Australia of around 11 per cent since the late 1990s with 17 of the last 20 April–October rainfall periods recording below-average rainfall. Over time there has also been an increase in extreme fire weather and the length of the fire season across large parts of Australia – see Figure 6**.**

These changes affect many NSW communities, particularly those changes associated with increases in the frequency or intensity of heat events, bushfire risk and drought. It is predicted that these changes will continue while new natural hazard threats emerge and there is growing potential for cumulative or concurrent, large-scale natural hazards to occur. Our communities need to plan for and adapt to some level of climate change.

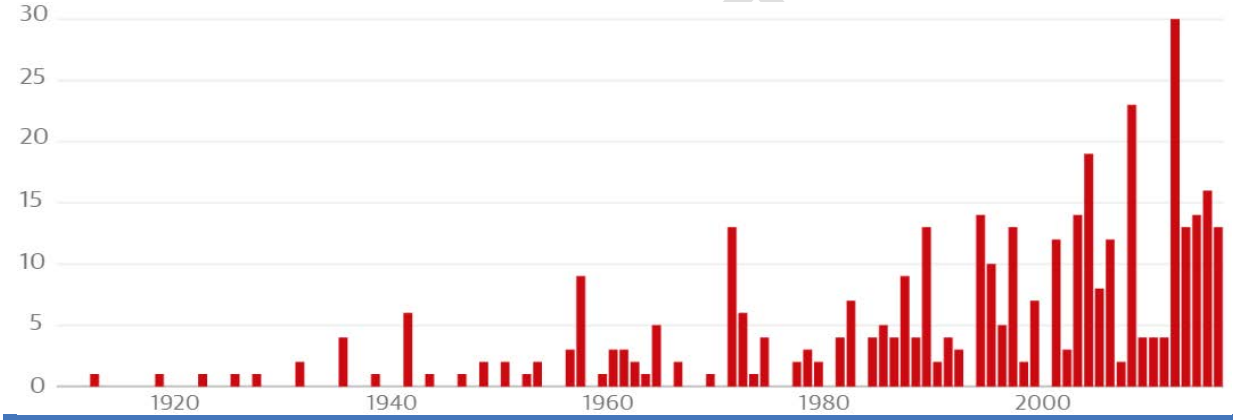
[17] BOM and CSIRO, 2018, State of the Climate 2018, accessed http://www.bom.gov.au/state-of-the-climate/State-of-the-Climate-2018.pdf on 16 December 2019

Figure 6 –Trends from 1978 to 2017 in the annual summary of the Forest Fire Danger Index



In NSW the bushfire season has extended; starting earlier and finishing later[18]. In November 2019, amid prolonged drought conditions, NSW RFS issued a 'catastrophic' fire danger warning for greater Sydney for the first time since the introduction of the Forest Fire Danger Index.

Figure 7 – Number of days per year where the Australian area-averaged daily mean temperature is extreme i.e. above the 99th percentile of each month from the years 1910–2017



The frequency of extreme heat events is increasing across Australia. Very high monthly maximum temperatures that occurred around 2 per cent of the time in the past (1951–1980) now occur around 12 per cent of the time (2003–2017). Similarly, very warm monthly night-time minimums that occurred around 2 per cent of the time in the past (1951–1980) now occur around 12 per cent of the time (2003–2017). This shift has occurred across all seasons, with the largest change in Spring.

Some populations are becoming more exposed to risk

The Department's 2019 Population Projections show that NSW will continue to grow, with the population increasing by 2.8 million to 10.6 million people by 2041[19]. The projections tell us people in NSW are living longer and Sydney will see more babies than ever before due to the number of potential mothers living in the city. These trends will lead to growth in our more vulnerable demographic groups who are more at risk when a disaster strikes including the elderly, infants, and pregnant women.

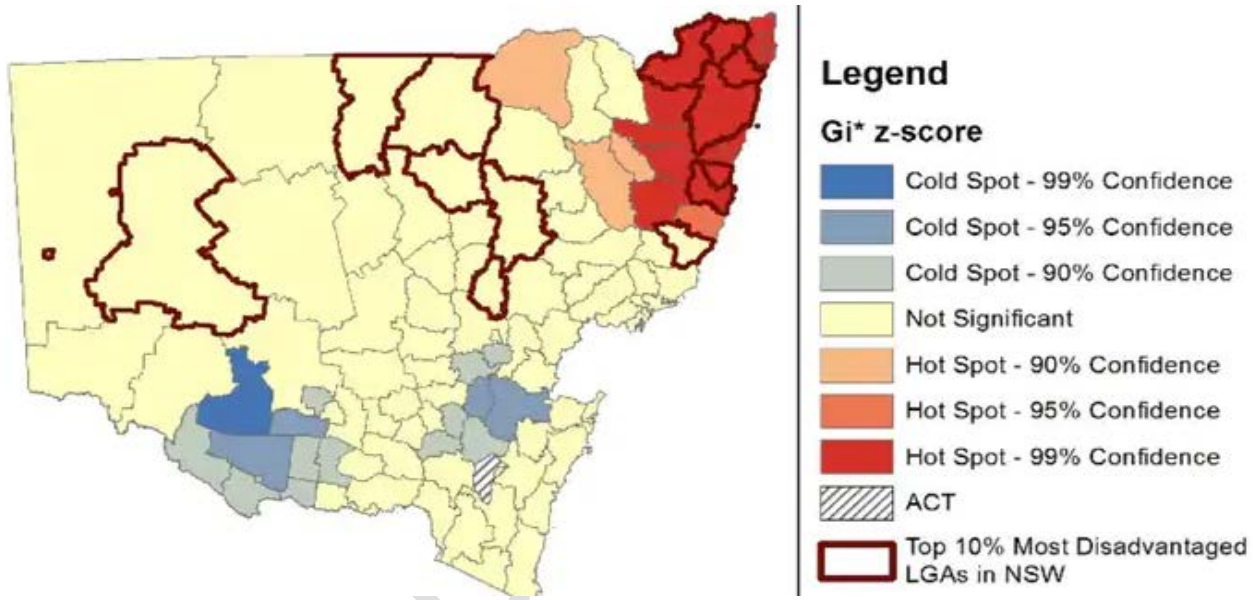
Based on medium-level growth assumptions, the number of people aged 65 and over in NSW will increase by 70% from 2017 to 2066 while the number of people aged 85 and over will increase by

[18] Bureau of Meteorology
[19] DPIE, 2019, Population Projections, accessed https://www.planning.nsw.gov.au/Research-and-Demography/Population-projections on 16 December 2019

60%[20]. Importantly, there is growth in regional hubs with border and coastal regions emerging as retirement havens. As settlements expand into areas of higher natural hazard risk such as coastal zones, floodplains and bushland areas, buildings and infrastructure will be increasingly exposed to natural hazards.

In NSW, our overall standard of living has improved yet socioeconomic differences among communities remain and some of our most disadvantaged communities are located in at-risk areas – see **Figure 8**. This overlap of disadvantage and disaster declarations presents a challenge to communities, disaster managers and governments.

Figure 8 - Clustering of natural disaster declarations by LGA in the period 2002-2014



Analysis of natural disaster declarations in NSW in the period 2002-2014 identified a "hotspot" in northern NSW, which includes some of the state's most socio-economically disadvantaged communities[21]. 43% of the most disadvantaged Local Government Areas in NSW were found in the NSW disaster hotspot.

The cost of disaster is growing

Over the 10 years to 2016 natural disasters cost the NSW economy some $3.2 billion per year with 49% of the costs attributed to storms and 23% to flooding[22]. Today, based on the history of natural disaster events over the past 50 years, the total economic cost of natural disasters in NSW is estimated to be $3.6bn per year. The economic cost of natural disasters in NSW is growing and is projected to reach $10.6 billion per year by 2050. This forecast does not account for the effects of a changing climate, which are expected to magnify these costs.

In addition to the tangible costs of natural disasters such as loss of life or property, there are many 'intangible' costs of natural disasters. These include increased family violence, mental health impacts, chronic disease, alcohol and drug use, short and long-term unemployment, changes to

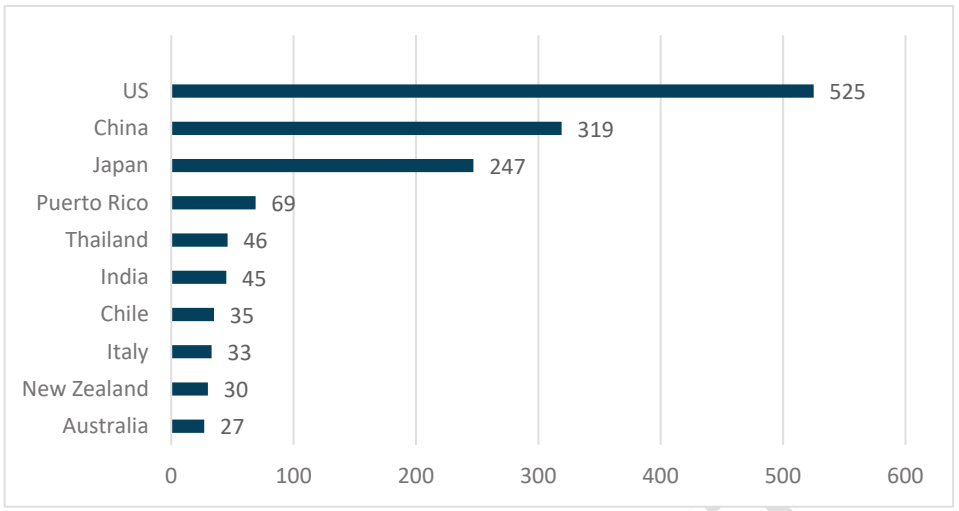
[20] ABS, 2017, 3222.0 - Population Projections, Australia, 2017 (base) – 2066: NSW, accessed at https://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/3222.0Main%20Features62017%20(base)%20-%202066?opendocument&tabname=Summary&prodno=3222.0&issue=2017%20(base)%20-%202066&num=&view=# on 17 December 2019

[21] Sewell, T., Stephens, R., Dominey-Howes, D. et al. Disaster declarations associated with bushfires, floods and storms in New South Wales, Australia between 2004 and 2014. Sci Rep 6, 36369 (2016) doi:10.1038/srep36369

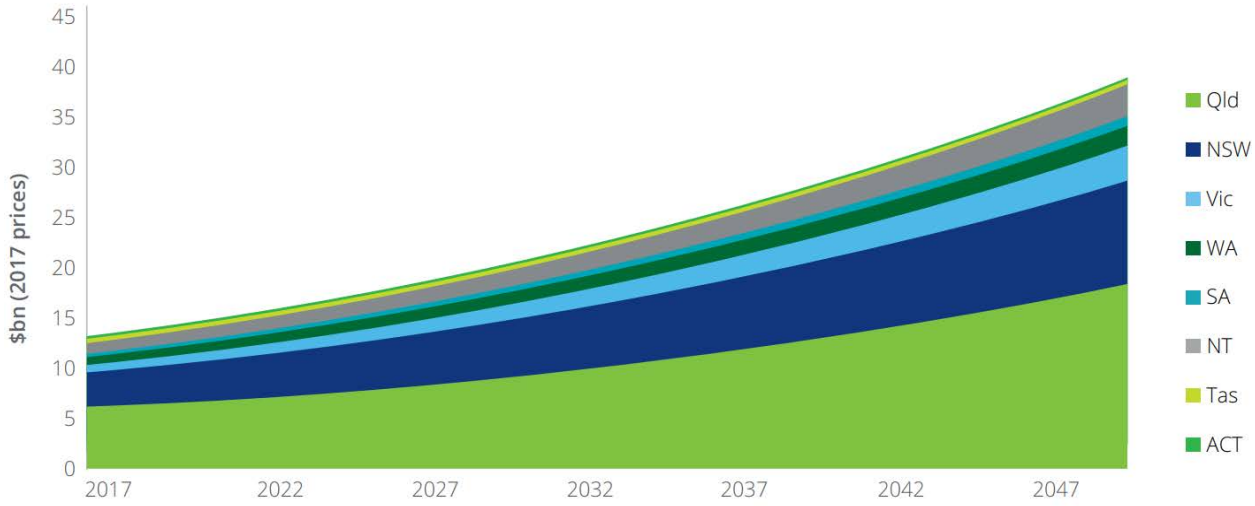
[22] Deloitte Access Economics, 2017, Building resilience to natural disasters in our states and territories, accessed https://www2.deloitte.com/au/en/pages/economics/articles/building-australias-natural-disaster-resilience.html on 16 December 2019

school academic outcomes, and crime. Intangible costs were found to be at least equal to, if not greater than, tangible costs[23].

Figure 9 - Estimated cost in $US billion for natural disasters across the globe 2008-2017 (above); forecast of the total economic cost of natural disasters across Australia 2017-2050 (below)



The 2018 International Federation Red Cross and Red Crescent Societies' World Disasters Report found Australia's damage bill over the past decade came in at $37 billion (or $US27 billion). This places Australia 10th in the world in terms of economic damage caused by natural disasters.



[23] Deloitte Access Economics, 2016, The economic cost of the social impact of natural disasters, accessed on 16 December 2019: https://www2.deloitte.com/au/en/pages/economics/articles/building-australias-natural-disaster-resilience.html

Policy context

These guidelines are consistent with key policy documents that have emerged in recent years as summarised in **Table 1** below.

Table 1 - Relevant policy documents

Policy	Purpose	Relevance
The Sendai Framework for Disaster Risk Reduction 2015-2030 (United Nations Office of Disaster Risk Reduction)	Aims to achieve the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the 15 years to 2030	The Sendai Framework guides Australia's approach to disaster risk reduction both here in Australia (led by the Department of Home Affairs) as well as support provided through the Australian aid program to assist other countries to reduce disaster risk.
The National Strategy for Disaster Resilience (COAG 2011)	Acknowledges the increasing severity and regularity of disasters in Australia and the need for a coordinated, cooperative national effort to enhance Australia's capacity to withstand and recover from emergencies and disasters.	Provides the basis for governments to shift from the traditional emphasis of response to and recovery from emergencies to one which emphasises the need for a greater focus on prevention, mitigation, preparedness and building capability.
National Disaster Risk Reduction Framework 2018	Outlines a national approach to proactively reducing disaster risk, now and into the future.	National Priority 2 calls for the introduction of robust frameworks to assess and reduce disaster risk in land use and development planning
Building Momentum: State Infrastructure Strategy 2018-2038	Sets out strategies to deliver infrastructure to meet the needs of NSW's growing population and economy over the next 20 years.	Objective 5 seeks to ensure that existing and future infrastructure is resilient to natural hazards and human-related threats and, among other things, recommends a state-wide policy to embed resilience in strategic land use planning.
State Level Emergency Risk Assessment 2017	Presents the findings of a state-wide emergency risk assessment consistent with the National Emergency Risk Assessment Guidelines.	The State Level Emergency Risk Assessment identifies land use planning as a priority to be addressed in the five years to 2023 for the mitigation and prevention of natural disasters in NSW.

Policy	Purpose	Relevance
A New Approach to the NSW Planning System	Introduces 14 strategic policies that seek to reorientation of the NSW planning system away from a regulatory focus toward an increasingly strategic-led and principles-based approach to planning	The framework identified three Disaster Risk Reduction Goals: • Take action to reduce existing disaster risk • Minimise creation of future disaster risk through decisions taken across all sectors • Equip decision-makers with the capabilities and information they need to reduce disaster risk and manage residual risk

Appendix B – Natural hazards significant to NSW

Hazard	Description
Bushfire	A fire that breaks out in forest, scrub or grassland[24]. Bushfires and grassfires are common throughout NSW but different fires exhibit different behaviours. Grassfires are fast moving, passing in five to ten seconds and smouldering for minutes with a low to medium heat output while bushfires are slower moving with a higher heat output.
Coastal erosion	The loss of coastal lands due to the net removal of sediments or bedrock from the shoreline. Coastal erosion can be either a rapid-onset hazard occurring over a period of days / weeks or a slow-onset hazard occurring over many years. Coastal erosion is widely recognised but is not the only coastal hazard. Other coastal hazards include: shoreline recession, coastal lake or watercourse entrance instability, coastal inundation, coastal cliff or slope instability, tidal inundation, and erosion and inundation of foreshores caused by tidal waters and the action of waves (*Coastal Management Act 2016*).
Drought	A prolonged, abnormally dry period when the amount of available water is insufficient to meet normal use[25]. There is no universal definition of drought and it is generally difficult to compare droughts as they differ in seasonality, location, size and duration. This is, in part, due to the different climate drivers from the Pacific, Indian, and Southern Oceans that can influence variations in rainfall (such as the El Niño-Southern Oscillation and Indian Ocean Dipole).
Earthquake	An intense shaking of Earth's surface caused by a sudden slip on a fault or fracture in the tectonic plates of that comprise the Earth's crust[26]. This shaking is caused by vibrations generated as rocks break under stress. Tectonic plates are slowly moving and can become stuck at their edges due to friction[27]. When the stress on the edge overcomes the friction, there is an earthquake that releases energy in waves that travel through the Earth's crust and cause a sudden slip.
East Coast Low	Intense low-pressure systems that occur several times each year off the eastern coast of Australia[28]. East Coast Lows will often intensify rapidly overnight making them one of the more dangerous weather systems to affect the NSW coast. These storms can bring damaging winds and surf and heavy rainfall. They can also cause riverine flooding, major flooding, coastal erosion and other coastal impacts.

[24] GeoScience Australia, 2019, Bushfire, accessed 18 December 2019 at https://www.ga.gov.au/scientific-topics/community-safety/bushfire
[25] DPI, Drought in NSW, accessed 18 December 2019 at https://www.dpi.nsw.gov.au/climate-and-emergencies/droughthub/drought-in-nsw
[26] USGS, What is a fault and what are the different types?, accessed on 18 December 2019 at https://www.usgs.gov/faqs/what-a-fault-and-what-are-different-types?qt-news_science_products=0#qt-news_science_products
[27] GeoScience Australia, 2019, Earthquake, accessed 18 December 2019 at https://www.ga.gov.au/scientific-topics/community-safety/earthquake
[28] BOM, About East Coast Lows, accessed 18 December 2019 at http://www.bom.gov.au/nsw/sevwx/facts/ecl.shtml

Hazard	Description
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunamis[29]. These also relate to storms and east coast lows, inland troughs, and cyclone drop-outs.
Heatwave	A period of at least three days where the combined effect of excess heat and heat stress is unusual with respect to the local climate. Both maximum and minimum temperatures are used in this assessment[30].
Landslide	The movement of a mass of rock, debris, or earth down a slope under the direct influence of gravity[31]. The term "landslide" encompasses five types of slope movement: falls, topples, slides, spreads, and flows. These are further subdivided by the type of geologic material (bedrock, debris, or earth). Debris flows (mudflows or mudslides) and rock falls are examples of common landslide types.
Severe thunderstorms	While we experience many types of thunderstorms in NSW, some more intense thunderstorms are referred to as “severe thunderstorms”. Severe thunderstorms can produce damaging wind gusts, large hail, tornadoes and heavy rain which may cause flash flooding and these phenomena can all cause significant damage. Thunderstorms which produce any of the following are classified as severe in Australia[32]: • large hail (2 cm in diameter or greater) • damaging wind gusts (90 km/h or greater) • tornadoes • heavy rainfall conducive to flash flooding Severe thunderstorms also relate to flooding.
Tsunami	Tsunamis are ocean waves triggered by large earthquakes near or under the ocean, volcanic eruptions, submarine landslides, and by onshore landslides in which large volumes of debris fall into the water[33]. Tsunami waves are unlike typical ocean waves generated by wind or storms and typically consist of multiple waves that rush ashore causing fast-rising inundation and powerful currents.

[29] Floodplain Development Manual at https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Floodplains/floodplain-development-manual.pdf
[30] Bureau of Meteorology, 2013, Defining heatwaves: heatwave defined as a heat impact event servicing all community and business sectors in Australia, accessed at https://www.cawcr.gov.au/technical-reports/CTR_060.pdf on 12 December 2019
[31] USGS, What is a landslide and what causes one?, accessed on 18 December 2019 at https://www.usgs.gov/faqs/what-a-landslide-and-what-causes-one?qt-news_science_products=0#qt-news_science_products
[32] BOM, Severe thunderstorms, accessed on 18 December 2019 at http://www.bom.gov.au/weather-services/severe-weather-knowledge-centre/severethunder.shtml
[33] USGS, What are Tsunamis?, accessed on 18 December 2019 at https://www.usgs.gov/faqs/what-are-tsunamis?qt-news_science_products=0#qt-news_science_products

Appendix C – Key terms and definitions

Term	Definition
Disaster	A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts. Emergency is sometimes used interchangeably with the term disaster, as, for example, in the context of biological and technological hazards or health emergencies. These, however, can also relate to hazardous events that do not result in the serious disruption of the functioning of a community or society
Disaster risk	The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined as a function of hazard, exposure, vulnerability and capacity. Annotation: The definition of disaster risk reflects the concept of hazardous events and disasters as the outcome of continuously present conditions of risk. Disaster risk comprises different types of potential losses which are often difficult to quantify. Nevertheless, with knowledge of the prevailing hazards and the patterns of population and socioeconomic development, disaster risks can be assessed and mapped, in broad terms at least. It is important to consider the social and economic contexts in which disaster risks occur and that people do not necessarily share the same perceptions of risk and their underlying risk factors.
Acceptable risk	Acceptable or tolerable risk, is the extent to which a disaster risk is deemed acceptable or tolerable depends on existing social, economic, political, cultural, technical and environmental conditions. In engineering terms, acceptable risk is also used to assess and define the structural and non-structural measures that are needed in order to reduce possible harm to people, property, services and systems to a chosen tolerated level, according to codes or “accepted practice” which are based on known probabilities of hazards and other factors.
Residual risk	the disaster risk that remains even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained. The presence of residual risk implies a continuing need to develop and support effective capacities for emergency services, preparedness, response and recovery, together with socioeconomic policies such as safety nets and risk transfer mechanisms, as part of a holistic approach.
Exposure	The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas. Annotation: Measures of exposure can include the number of people or types of assets in an area. These can be combined with the specific vulnerability and capacity of the exposed elements to any particular hazard to estimate the quantitative risks associated with that hazard in the area of interest.

Term	Definition
Hazard	may be natural, anthropogenic or socio-natural in origin. Natural hazards are predominantly associated with natural processes and phenomena. Anthropogenic hazards, or human-induced hazards, are induced entirely or predominantly by human activities and choices. This term does not include the occurrence or risk of armed conflicts and other situations of social instability or tension which are subject to international humanitarian law and national legislation. Several hazards are socio-natural, in that they are associated with a combination of natural and anthropogenic factors, including environmental degradation and climate change.
Disaster	means an occurrence, whether or not due to natural causes, that causes loss of life, injury, distress or danger to persons, or loss of, or damage to, property. (Source: Community Welfare Act, 1987).
Hazard Mitigation	in this plan means a potential or existing condition that may cause harm to people or damage to property or the environment.
Risk	a concept used to describe the likelihood of harmful consequences arising from the interaction of hazards, communities and the environment
Risk assessment	the process used to determine risk management priorities by evaluating and comparing the level of risk against predetermined standards, target risk levels or other criteria
Risk Management	the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, evaluating, treating and monitoring risk.
City Resilience	The capacity of cities to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter City Resilience Framework, Rockefeller Foundation and ARUP, 2014
Resilience	Resilience is 'the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management'.

Appendix D – Strategic planning mechanisms for considering natural hazard risks NSW

Certain natural hazards, typically more frequent and well-known hazards such as bushfire and flood, are already addressed by the NSW land use planning system. The table below highlights key plans and policies within the planning system and how these currently address natural hazards.

Policy / Plan	Comment
Coastal Management Act 2016	• Instrument that establishes a statutory framework and overarching objects for coastal management in NSW. • Manages the use and development of the coastal environment in an ecologically sustainable way, for the social, cultural and economic well-being of the people of NSW. • Defines the coastal zone, comprising 4 coastal management areas: - coastal wetlands and littoral rainforests area - coastal vulnerability area - coastal environment area - coastal use area. • Establishes management objectives specific to each of these management areas, reflecting their different values to coastal communities. • The coastal vulnerability area means land subject to coastal hazards. The objectives within this management area include ensuring public safety, preventing risks to human life, and mitigating current and future risk from coastal hazards.
Rural Fires Act 1997	• The primary legislative instrument that regulates the co-ordination of bush fire fighting and bush fire prevention throughout NSW • Seeks to achieve the prevention, mitigation and suppression of bush fires and the protection of people, property and other assets from damage arising from fires
Planning for Bushfire Protection 2019	• Provides standards and guidance for: - strategic land use planning to ensure that new development is not exposed to high bush fire risk; - creating new residential and rural residential subdivision allotments; - special fire protection purpose (SFPP) development taking account of occupant vulnerability; - bush fire protection measures (BPMs) for new buildings; and - upgrading and maintaining existing development.
NSW Floodplain Development Manual	• Supports the NSW Government's Flood Prone Land Policy • Provides councils with a framework for implementing the policy • Presents general principles and a process for floodplain risk management

Policy / Plan	Comment
Environmental Planning & Assessment Act 1979	• The primary legislative instrument that regulates land use within NSW and provides a context for risk reduction • The objectives of the Act include facilitation of ecologically sustainable development through integration of relevant economic, environmental and social considerations in decision-making. • Part 3 requires the preparation strategic and statutory planning documents including regional, district and local plans as well as LSPSs. • Part 4 sets out, among other things, matters for consideration in the assessment of a development proposal including site suitability and the public interest. Relevantly, section 4.46 provides that development for which RFS approval is required under s. 100B of the Rural Fires Act 1997 is 'integrated development'. • Section 10.7 provides for the disclosure of some natural hazards on Planning Certificates such as flood, bushfire and other hazard risks. In conjunction with the Conveyancing Act, this enables property buyers to be made aware of relevant natural hazards at the time of purchase.
Greater Sydney Commission Act 2015	• A legislative instrument that, among other things, constitutes and confers functions upon the Greater Sydney Commission (GSC). • Importantly, the GSC Act also amended the EPA Act in relation to strategic planning. • The principal objectives of the Commission set out at Section 9 explicitly include encouraging development that is resilient and takes into account natural hazards
Regional Plans	• A strategic policy prepared by the Department that sets out a 20-year plan for delivery of homes, jobs, community infrastructure and a healthy environment in regions across NSW. • Regional Plans acknowledge the challenge natural hazards and climate change pose and the need to balance future growth with achievement of sustainable and resilient communities. • Most plans include actions to continually incorporate natural hazards and climate change data to reduce the exposure and vulnerability of communities to natural hazards.
Metropolitan Plan	• A strategic policy prepared by the GSC that sets out a 10 Directions to achieve a liveable, proactive and sustainable Greater Sydney Region over the 40 years to 2056. • The plan includes Direction 10: Adapting to a Changing World, which includes objectives addressing climate change and natural hazards, with a particular focus on heatwave.

Policy / Plan	Comment
District Plan	• A strategic policy prepared by the GSC that sets out a 20-year vision and plan to implement the Greater Sydney Region Plan across Greater Sydney's five districts. • Consistent with the Greater Sydney Region Plan, all District Plans include a Planning Priority to adapt to the impacts of urban and natural hazards and climate change. • Some District Plans address specific hazards such as heatwave, flooding, and climate change and include mapping.
Local Strategic Planning Statement	• A strategic planning policy prepared by local councils to set out a 20-year vision that implements actions in the regional and district plans as well as the community strategic plan. • DPIE has prepared guidance to assist councils as they prepare their LSPSs. This includes Planning Priority 15: Adapt to natural hazards and climate change. • Greater Sydney councils are required to commence public exhibition of their draft local strategic planning statement by 1 October 2019 with the final version to be made by 31 March 2020. Regional councils must have their statement in place by 1 July 2020.
State Environmental Planning Policy	• An environmental planning instrument prepared by the Department. SEPPs deal with matters of State or Regional environmental planning significance. • Some SEPPs address natural hazards. The Coastal Management SEPP, for example, provides for the mapping of land subject to identified coastal hazards and requires planning authorities to consider these when assessing development within the coastal zone. • Currently within NSW there is a program of reviewing and consolidating the number of SEPPs that are in force.
Local Environmental Plan	• An environmental planning instrument prepared by local councils to guide planning decisions through zoning and development controls, which provide a framework for the way land can be used. • DPE has developed a Standard Instrument LEP (**SI LEP**) to provide a template for the development of these plans. The SI LEP includes a dictionary of terms that may not be altered by councils. • A number of local governments have adopted model provisions relating to flood planning, foreshore building line and acid sulfate soils. • A number of local governments have also chosen to include local provisions that address hazards relevant to their LGAs such as landslip and bushfire.
Development Control Plan	• A non-statutory plan prepared by local councils to provide detailed planning and design guidelines to support the planning controls in the LEP. • A number of local councils have included provisions relating to natural hazards in their DCP, establishing building requirements and / or exclusion areas to address hazard risk.

Appendix E - References

Bushfire & Natural Hazards CRC, 2018, “Practical and Theoretical Issues: Integrating Urban Planning and Emergency Management”, retrieved from https://www.preventionweb.net/publications/view/60932

Council of Australian Governments, 2011, “National Strategy for Disaster Resilience’,

Emergency Management NSW. NSW Disaster Assistance Guidelines (NSW Government: Sydney). https://www.emergency.nsw.gov.au/publications/guidelines-legislation-policies/recovery/disaster-assistance-guidelines.html [accessed: 23 March 2019] (2010).

EMA, 2015, “Handbook 10 - National Emergency Risk Assessment Guidelines”, Retrieved from Canberra: https://www.aidr.org.au/media/1489/handbook-10-national-emergency-riskassessment-guidelines.pdf

Productivity Commission, 2015, Natural Disaster Funding Arrangements, Inquiry Report (74), Retrieved from Canberra: https://www.pc.gov.au/inquiries/completed/disasterfunding/report/disaster-funding-volume1.pdf

Queensland Government, Queensland Strategy for Disaster Resilience 2017: Making Queensland the most disaster resilient state in Australia, accessed 17 April 2019, from https://www.qra.qld.gov.au/publications-resources/plans-policies-and-strategies

Saunders, W & Kilvington, M, 2016, "Innovative land use planning for natural hazard risk reduction: A consequence-driven approach from New Zealand", International Journal of Disaster Risk Reduction, vol. 18, pp 244-255

Sewell, T. Stephens, R. E. Dominey-Howes, D. Bruce, E. Perkins Kirkpatrick, S. (2016) “Disaster declarations associated with bushfires, floods and storms in New South Wales, Australia between 2004 and 2014”, Scientific Reports, volume 6, Article number: 36369.

UNISDR,2009, Terminology on Disaster Risk Reduction. Retrieved from Geneva, Switzerland: https://www.preventionweb.net/files/7817_UNISDRTerminologyEnglish.pdf

UNISDR, 2015, Sendai Framework for Disaster Risk Reduction 2015 - 2030. Retrieved from Geneva: http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf