From:	NSW Government
To:	Flood Inquiry
Subject:	Floods Inquiry
Date:	Friday, 13 May 2022 5:05:59 PM
Attachments:	FMA Submission - NSW Independent Flood Inquiry.pdf

Your details

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Submission details

I am making this submission as	Other
Submission type	I am submitting on behalf of my organisation
Organisation making the submission (if applicable)	Floodplain Management Australia
Your position in the organisation (if applicable)	Executive Officer
Consent to make submission public	I give my consent for this submission to be made public

Share your experience or tell your story

Terms of Reference (optional)

The Inquiry welcomes submissions that address the particular matters identified in its Terms of Reference

1.6 Any other matters

Dear Inquiry Team

Please find attached the submission from Floodplain Management Australia which provides information for consideration in making the following recommendations:

2 b. preparation and planning for future flood threats and risks
2 e. land use planning and management
2 f. appropriate action to adapt to future flood risks.

Regards

Glenn Evans
Executive Officer
Floodplain Management Australia

Supporting documents or images

Attach files

- FMA Submission - NSW Independent Flood Inquiry.pdf

Floodplain Management Australia
Supporting Wise Planning and Development
www.floods.org.au ABN 67 007 279 179

President: Ian Dinham

13 May 2022

The NSW Independent Flood Inquiry
(**Submitted on line**)

Dear Inquiry Team

Submission – NSW Independent Flood Inquiry

Thank you for the opportunity to contribute to the Inquiry. This submission provides information for consideration in making the following recommendations:

2 b. preparation and planning for future flood threats and risks
2 e. land use planning and management
2 f. appropriate action to adapt to future flood risks

About Floodplain Management Australia
Floodplain Management Australia (FMA) is the peak national body for flood risk practitioners in Australia. FMA promotes wise management of development on floodplains, and community awareness of flood-related issues, helping to reduce the risks of flooding to life and property. FMA provides professional development and information sharing opportunities and represents the interests of Local Government at state and federal levels. Members include over 170 councils, catchment management authorities, government agencies, businesses and professionals involved in all aspects of urban and rural flood risk management.

Our members are at the front-line of flood risk assessment, flood management planning, decision making, emergency management and community engagement – please see: floods.org.au

FMA has strong partnerships with key State/Territory and Commonwealth Government agencies including NSW State Emergency Service, NSW Department of Planning and Environment, ACT State Emergency Service, Victorian Department of Environment, Land, Water and Planning, Queensland Reconstruction Authority and the Bureau of Meteorology. In addition, we have links to equivalent organisations in the United States, the United Kingdom and New Zealand. Our international network is invaluable in sharing flood management experience and expertise from other nations with our members for the benefit of their communities.

FMA National Conference
FMA convened its first annual Conference in 1961, to promote sound and responsible flood risk management, and the Conference continues to be the primary means of assisting Local Government and flood professionals achieve best practice management of flood risks.

This year's Conference, *Integrated Floodplain Management: Creating safer, stronger communities*, will be held at Toowoomba, Queensland, from 17 to 20 May. The program will include extensive discussion of recent flooding events by experts from across Australia, and may be of assistance to members of the Inquiry – please see: floodplainconference.com

The 2022 Floods
The 2022 east coast floods affected unusually large areas of the state, and some locations such as Lismore experienced their worst flood in recorded history. Many areas were flooded on multiple

occasions, but could have been protected had appropriate pre-emptive actions been taken. FMA's submission focuses on preparation for floods, and resource allocations for activities to reduce flood risks.

Preparing for Floods

The Insurance Council of Australia's news release of 3 May 2022 states "The recent flood event is estimated to be Australia's costliest flood ever. Using actual claims costs from 197,000 claims across both states, the event is estimated to have cost $3.35 billion in insured losses."

However flooding from rivers and local catchments is the most manageable of natural disasters, and FMA has consistently advocated reducing the costs of flood disaster response, recovery and reconstruction by implementing well planned pre-emptive actions.

These include well designed and maintained mitigation works to manage existing risks, sound land use planning based on reliable flood data to avoid future risks, and development of more resilient communities to deal with unavoidable risks.

FMA's Local Government members have been diligently striving to reduce their flood risks, however they have consistently identified the following as the highest priority issues which need to be addressed to enable the necessary outcomes to be achieved:

- There is inadequate funding for flood studies, and development and implementation of risk mitigation projects

- More technical and land use planning guidance is needed.

These issues are addressed below.

Funding for Flood Risk Mitigation

At present Australia's expenditure on post flood clean up and recovery far outweighs the investment on pre-emptive measures, with around 97% of natural disaster expenditure on recovery and just 3% on planning and mitigation.

FMA supports the recommendation of the 2014 Productivity Commission Inquiry into Natural Disaster Funding Arrangements for Commonwealth Government investment in pre-disaster initiatives to be increased to $200 million per year, to be matched by the States and Territories.

Our members have implemented a range of flood mitigation and management measures which have led to substantial savings in flood damages and recovery and reconstruction costs. Just one example is the Deniliquin levee which for a $15.8 million investment will avoid $85 million in flood damages in a flood which has a 1 in 100 chance of occurring in any one year.

Reduction in flood risks should also provide immediate financial community benefits, in the form of lower costs of flood insurance. There have been several examples of public mitigation leading to reduced flood insurance premiums. These include the Queensland towns of Roma, St George and Charleville where levees were constructed to provide protection from frequent flood events.

Other risk reduction measures such as property buy-backs and house-raising, as well as the development and implementation of planning and building controls/codes which support flood compatible building, also can require significant funding allocations.

The requirement for matched funding contributions from Local Governments for studies and works is a major concern for many councils which have limited financial capacity to meet increased funding obligations. There is a need for flexibility for projects with a significant cost-benefit ratio to be funded without matching Local Government funding.

Technical Guidance
FMA Members have consistently identified that councils need direct assistance in the implementation of the floodplain management process. Not just funding, but more technical support and project management assistance.

Guidance is provided by a limited number of very experienced experts from the Department of Planning and Environment (DPE), and also by the *NSW Flood Prone Land Policy* and *Floodplain Development Manual*.

Our council members are very appreciative of the assistance provided by DPE's dedicated flood program staff, and these comments should not be construed as criticism of the efforts of current staff, however their effectiveness is hampered due to under-resourcing. There has been a steady decline in the number of government floodplain management specialists over the last 25 years. Prior to the late 1990s the NSW Floodplain Management Program was core business of the Department of Public Works, but since then this role has been passed through various agencies, to its present downsized position buried within DPE.

Recent events have demonstrated the need to understand the complexities of flooding, and to develop cost effective solutions in a timely manner. This should be an ongoing high priority of the NSW Government, and FMA considers the current DPE technical expertise needs to be expanded substantially to support councils in management of their present and future flood risks.

After a lengthy and complex review of the current *Floodplain Development Manual* DPE released the draft *Flood Risk Management Manual and toolkit* for comment earlier this year. This new set of documents contains valuable guidance to assist councils in management of their flood risks, and DPE is to be congratulated on undertaking this project.

FMA is very supportive of this revised Manual, and has provided comments on the draft documents and some recommended refinements, which we believe will assist in producing a more robust and effective set of guidance.

Land Use Planning and Building Controls
FMA endorses a holistic approach to flood risk management which includes, in addition to physical infrastructure, land use planning and building controls.

Attention has been given to improving the understanding of flood risk management among land use planners in recent years, however there remains a lack of detailed knowledge within the profession. To assist in remedying this situation FMA developed the FMA Position Policy ***Flood Risk Management in Land Use Planning*** in 2014/2015. The current edition was adopted by the FMA Membership in 2021, and is attached at **Appendix 1**.

The most significant change that has occurred in flood risk management (FRM) practice over the last 36 years is a movement away from a singular flood standard to a risk management based approach. For example the level of a 1 in 100 chance per year flood (or 1 in 100 Annual Exceedance Probability (AEP) flood), plus freeboard, might remain the typical standard for residential floor levels in most locations, but higher floor levels could be appropriate for more sensitive land uses and emergency management considerations across the range of land uses in all floods.

Also, in catchments where there are large ranges in flood depths, there exists the potential for substantial risk to life and flood damage between 1 in 100 chance per year flood level and the Probable Maximum Flood level. Planning policies need to support the use of appropriate risk-based controls for development above the 1 in 100 chance per year flood level in such circumstances.

We are conscious of the difficult debate occurring in the Northern Rivers region of NSW, in particular at Lismore, in regard to whether homes and businesses should be rebuilt or relocated.

These should be mandatory considerations for Floodplain Risk Management Studies where such consequences are identified in situations including extreme floods, in order that these complex decisions can be pre-emptively made. This would provide a platform for better strategic planning of areas subject to high flood risks.

FMA has also recently completed a draft Position Policy: *Consideration of Climate Change Flood Risk in Land Use Planning*, which will be presented to members at the FMA National Conference in May 2022. Please see **Appendix 2**.

There are some differences in approach between the FMA *Flood Risk Management in Land Use Planning* Policy and the new draft *Flood Risk Management Manual* and we have offered to assist in resolving these issues with DPE.

Conclusion
FMA considers that improved preparation and planning for floods is essential for building safer, more flood resilient communities, and this can only be achieved by allocating increased funding and technical assistance to Local Government Councils to enable them to expedite effective mitigation, planning and community engagement programs.

FMA brings together expertise and experience from all aspects of flood protection, preparedness, response and recovery from across Australia, which we would be pleased to contribute further as the Inquiry progresses.

Yours Faithfully

Ian Dinham
President

Appendix 1: FMA Position Policy ***Flood Risk Management in Land Use Planning***

Appendix 2: Draft FMA Position Policy ***Consideration of Climate Change Flood Risk in Land Use Planning***

Please address correspondence to:
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Floodplain Management Australia

Supporting Wise Planning and Development

www.floods.org.au ABN 67 007 279 179

27 May 2021

Position Policy
Floodplain Risk Management in Land Use Planning

Summary

FMA members are committed to ensuring that the planning system optimises floodplain risk management (**FRM**) outcomes. Flooding causes the most damage of all natural disasters but is also the most predictable. Planning can therefore be pivotal in managing flood risks associated with the development and redevelopment of urban and rural areas.

This Policy sets out recommendations for the preparation of planning strategies and development controls, and in the dissemination of flood related information through the planning system. This Policy was originally prepared for NSW, based on generic principles, and has been updated to be nationally applicable.

Introduction

The planning system should have regard to best FRM practice. Planning can have significant benefits in minimising and reducing flood risks to property and persons as part of the planning of new areas and the redevelopment of established areas.

Flooding is Australia's costliest natural hazard-related cause of disasters when both tangible and intangible losses are taken into account[1]. Australia's total economic exposure to flooding is estimated to be around $100 billion. Approximately 7% of households have flood risk, with 2.8% being located in high risk areas; that is, up to 170,000 buildings are in locations exposed to floods with a 1 in 20 chance of occurring annually[2].

There is often uncertainty in the planning process about what FRM issues and outcomes are expected to be addressed, at what stage in the hierarchy of plan making to do this, and who should do it. While overall guidance on FRM is provided at a national level through the Australian Emergency Management Handbook 7: *Managing the Floodplain Best Practice in FRM in Australia* (**AEM Handbook**) better integration of FRM and planning processes is required.

Purpose of this Policy

To present a concise FMA endorsed position that can be used in advocating best practice about how land use planning should address FRM issues.

Scope of this Policy

This Policy:

- applies to all planning documents including studies, non-statutory planning strategies, and local, regional and state land use planning controls (**planning policies**)

[1] Deloitte Access Economics, Building resilience to natural disasters in our States and Territories, 2017.

[2] AXCO, Insurance Market Report. Australia: Non-Life (P&C) 2018, as cited in Flood Risk Management in Australia, 2020, Neil Dufty, Andrew Dyer and Maryam Golnaraghi, Geneva Association, pg.24.

- provides a position on what FRM issues should be addressed when undertaking planning studies and preparing planning strategies, the content of planning policies and the format of flood risk maps prepared for planning purposes
- recognises that planning studies and policies inadvertently convey information to the public in regard to the nature and location of flood risks
- has been prepared to apply nationally.

As planning systems vary from state to state, generic terms are used where possible to describe planning studies, strategies and policies to reflect those relevant to the current and possible future planning systems. FRM planning terms as defined in the AEM Handbook are relied upon when needed.

Position Statement

FMA considers that the overall approach to addressing FRM in the planning system should be based on a risk based approach tailored to meet the social, economic and environmental context of individual floodplains and the communities within them. This must include recognition that climate change is changing the nature and frequency of flooding.

This application of FRM within the planning system should be undertaken as a partnership between all levels of government. State and local governments have a primary role in land use planning while the federal government should contribute by directing financial resources to maximise mitigation, aiding in recovery, and providing nationally consistent policy direction.

The attached table outlines the FMA policy position.

FMA Action

FMA will:

- liaise with all levels of government to achieve the above policy outcomes
- encourage its Members to promote and make decisions consistent with the above policy outcomes
- work with governments and industry to refine the above policy position
- continue to develop training opportunities to assist in improving the FRM knowledge and skills of those professionals who are involved in town planning.

Policy Review

This Policy Statement is to be reviewed every 2 years or where required to reflect changes in planning policies.

Policy Status

This Policy Statement was initially prepared by a working group of FMA members comprised of engineers and town planners from local Councils and consultants based in NSW. The decision to prepare the Policy was originally initiated by a resolution adopted at the 2014 Annual General Meeting (AGM) of FMA and endorsed at the following Annual General Meeting in 2015.

FMA members were invited to provide comments after 12 months from when the Policy was adopted. The Policy was subsequently reviewed in 2016 and updated on 25 January 2017.

The Policy was more substantially reviewed for the FMA Quarterly Meeting at the National Conference in May 2021, to provide a nationally applicable approach.

Planning Documents	Comment on Existing and Possible Future Planning Studies, Strategies and Policies	FMA Policy Position
	State Level	
Planning Information	Planning polices inadvertently provide a source of information on flood risks. Some jurisdictions also provide written certification of planning controls and constraints that affect the development potential of a property. However, this information is commonly limited to the flood related development controls that apply to the property and not necessarily to flood risk that a property may be exposed to. The public can wrongly rely on this information as reflective of all known flood risks. All legislation, directions, guidelines and practices associated with how the planning system allows for the presentation of flood related development controls, is important to how the community is informed about flood risks. The community should be fully informed about flood risks to allow an opportunity for individuals to decide what are acceptable risks (particularly where planning policies retain some residual risks) and to provide awareness that aids emergency management and recovery.	1. The form and content of planning policies and certification should be reviewed to: • avoid misleading the public who may believe there are no flood risks when only advising if flood related planning controls apply • ensure that the same and more complete information is communicated to all enquirers • ensure the public is fully informed of known flood risks or if there is insufficient information to know whether a flood risk exists.
Directions for deciding on land use zones and planning controls	Government policies may explicitly or implicitly direct the form and content of statutory planning schemes (local environmental plans in NSW) and supplementary planning controls (such as development control plans and codes).	2. These should be either superseded by, or amended to be consistent with the direction provided by the AEM Handbook. 3. Directions for deciding on land use zones and planning controls should be based on a risk based approach as opposed to relying on a singular defined flood event.

State level planning policies -	State level planning policies in some states provide high level direction as to how to manage the development of land affected by natural hazards, including flooding. In some cases state level policies embody detailed planning controls for development in the floodplain such as specifying development that may be permitted without development consent of through a private certification system.	4. Each state should have a state policy to provide direction for the management of natural hazards, including flooding, that: • incorporates direction consistent with that advocated by this FMA policy; • references the AEM Handbook, and relevant state level FRM guidelines[3] as relevant to plan making; • requires other state policies and subordinate planning policies to adopt FRM terms defined in the AEM Handbook; • specifies that matters identified in this policy statement be addressed prior to the preparation of a plan that significantly changes development potential in floodplains; • ensures that planning addresses flood risks to private and public property, infrastructure and to life; • requires FRM planning to be based on a holistic risk based approach and not reliance on a single defined flood. • requires consideration of measures to maximise the resilience of the community post flooding; and • considers climate change related flood risks. 5. That the relevant state planning authority be responsible for preparing the policy in consultation with other relevant government agencies in particular those involved with the management of the natural environment, emergency services, local government, utility authorities, FMA and the Bureau of Meteorology. 6. In states where no state level FRM planning policy currently exists, this should be prepared as a priority. 7. Related state policies, should also be revised to provide consistency[4].

[3] Such as the Floodplain Development Manual and NSW Flood Prone Land Policy in NSW.

[4] For example in NSW, State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 contains provisions that rely on the definition of areas of high flood risk to determine where development can be approved through private certification or is permitted without development approval.

Regional Level		
Regional Plans & Strategies applicable across all NSW regions	Typically each state produces a hierarchy of plans that seek to satisfy government goals and policies. At the top of this hierarchy are regional and metropolitan plans that set out key policies, targets and the structure of future development patterns to guide the making of lower order plans.	8. These documents should: • Identify the floodplains within the planning region and the key FRM considerations for development (eg evacuation and private and public damages due to significant flood depths). • Include a Regional Flood Planning Map that shows the extent of the floodplain(s) defined by the AEM Handbook, and associated elements relevant to FRM. • Identify regional stakeholders (eg. local Councils, state planning agencies, emergency services, insurance companies, transport infrastructure owners, dam/irrigation authorities, etc). • Consider regional evacuation including the location and capacity of evacuation routes and centres. • Where flood modelling at the regional level is appropriate, determine suitable development areas having regard to cumulative flood impacts. The cumulative impact of land filling and development should not increase flood levels in existing urban areas. • Identify regional FRM mitigation measures that are required to ameliorate the impact of future development (eg augmented capacity to evacuation routes).

Subregional		
Subregional Plans & Strategies (Subregional Delivery Plan or District Plans within the Sydney Metropolitan Region)	Subregional planning links growth in population and housing to the infrastructure that supports communities, such as schools, health services, transport, and electricity and water projects. It also delivers planning outcomes across local Council boundaries and sets specific plan making actions such as for the making of local planning schemes to achieve a regional planning outcome.	9. These documents should: • Address the FRM items required for a regional growth plan where not undertaken as part of that plan. • Consider FRM principles in the process of determining land use patterns[5]. • Identify responsible authorities and funding sources for the delivery of regional FRM mitigation measures.
Local		
Local Plans (such as Local Planning Schemes or Local Environmental Plans)	Local plans are typically statutory planning instruments that should have a line of sight back to higher order plans and reflect local strategic planning objectives. Local plans provide the basis upon which the majority of development is approved. A local plan might contain the following provisions that contribute to the way flood risks are considered in the assessment of a development proposal: • The zoning of land, and key associated planning controls such as minimum lot size, can reflect the acceptability and appropriate density of development in locations subject to unmanageable flood risk. • Definitions of terms, such as floodplain, or identification of the extent of flood affected land on a flood overlay map land guide the way that flood	10. The provisions of a local plan should: • provide for the management of flood risks to life, property and public infrastructure • apply a risk based approach that reflects a graded level of control dependent on the vulnerability of different land uses and the degree of hazard identified for different floodplains and different parts of a floodplain • adoption definitions consistent with the AEM Handbook, in particular the definition of a floodplain • apply to the whole of the floodplain • include climate change considerations. 11. The permissibility of development should be determined by the land use zoning applied to property having regard to all planning considerations including FRM. 12. Where resources allow, a flood planning map should be incorporated into an LEP, with the following attributes:

[5] See principles outlined in the AEM Handbook and other publications such as 'Managing Flood Risk Through Planning Opportunities' prepared for the Hawkesbury-Nepean Floodplain Management Steering Committee, NSW Government, April 2007.

risk management considerations apply. Local plans identify either the whole (ie up the extent of the probable maximum flood) or part of floodplain (ie a flood planning level based on defined flood event lower than the probable maximum flood) as subject to flood related development controls.

- Flood overlay maps can identify areas subject to flood risk and trigger matters to be considered in the assessment of a development proposal.

- Clauses that outline matters that need to be taken into consideration when assessing the acceptability of development identified as within the area requiring consideration of flood risks.

- An overlay to land zoning maps.
- Divide the floodplain into precincts of flood risk for planning purposes (preferably 3) that trigger appropriate planning controls. These maps may show, for example, areas:
- where most development is undesirable because of the existing hazard which is unlikely to be able to be mitigated due to cost or environmental impact. These areas should coincide with those where exemptions from development consent or private certification of development is not allowed.
- where most development would be acceptable subject to flood mitigation measures.
- where controls apply to only especially vulnerable development except emergency management considerations that apply to all development.

13. Include both riverine and major overland flooding and tailor planning controls to the hazards associated with each.
14. The above maps should be used to inform the preparation and review of the LEP land zoning maps.
15. The zoning and development potential of land should be checked to ensure that it would not facilitate development that would be incompatible with the flood hazard or require environmentally unacceptable mitigation measures.
16. The local FRM provisions should be applied even if a flood planning map is not included in the LEP for the whole or part of the area to which it applies. In this situation guidance should be provided as to what criteria Council will apply to determine whether to apply the LEP clause, preferably as a part of more detailed development codes or control plans.
17. Include electronic links between flood related planning controls and mapping to more comprehensive FRM information sources where available.

Development Codes, Guidelines or Control Plans	These provide detailed controls that supplement higher order planning instruments (normally planning schemes or local environmental planning schemes).	18. Model controls should be prepared by state agencies to assist Councils in preparing FRM provisions for development codes/plans. 19. These controls should be expressed as performance criteria and acceptable solutions, and cover: • Floor Levels • Building material & methods • Structural soundness • Impact on others • Parking and access • Evacuation & refuge in place • Environmental management. 20. The development codes/plans should specify situations where further flood investigations should be undertaken, or not, at the development application stage and the specification for those investigations.

Floodplain Management Australia

Supporting wise planning and development

www.floods.org.au

ABN 67 007 279 179

Position Policy No.2

Version 1: 10 May 2022

Position Policy

Consideration of climate change flood risk in land use planning

Preface

Floodplain Management Australia (the FMA) is the peak national body for flood risk practitioners in Australia. The FMA promotes wise management of development on floodplains and community awareness of flood-related issues, helping to reduce the risks of flooding to life and property. The FMA represents the interests of Members at local, state and Australian government levels and provides professional development and information sharing opportunities for its members. FMA members include over 160 local councils, catchment management authorities, Australian, state and territory government agencies, businesses, and professionals involved in all aspects of urban and rural flood risk management.

FMA members are committed to ensuring that the planning system optimises floodplain risk management (FRM) outcomes. Flooding causes the most damage of all natural disasters but is also the most predictable. Land use planning is therefore pivotal in managing flood risks associated with the development and redevelopment of urban and rural areas.

In May 2021, the FMA released an update for its first Position Policy entitled '*Floodplain risk management in land use planning*'. The FMA is pleased to release its Position Policy No. 2 '*Consideration of climate change flood risk in land use planning*' as a partner document to its first Position Policy.

The FMA would like to thank and acknowledge the time and effort of the Working Group of FMA members who contributed to the preparation of this document. The final version of this document was edited by Sue Ribbons (Communications Director, Floodplain Management Australia).

This Working Group was composed of the following engineers, town planners and academics from across Australia.

Working Group Member	Organisation
Warwick Bishop	Water Technology Pty Ltd
Louise Collier	Rhelm Pty Ltd
Adam De Clouett	Shellharbour City Council
Andrew Dyer	IAG (Group Natural Perils)
Mike Edwards Fiona Coe	Vic Department of Environment, Land Water and Planning
Paul Fennell Gil Marshall (alternate)	Wimmera Catchment Management Authority Vic Department of Environment, Land Water and Planning
Paul Grech	Land Use Planning Director Floodplain Management Australia
Shannon Haines	Moreton Bay Regional Council (formerly Ethos Urban)
Bruce Rush	Melbourne Water
Peter Sheath Anumitra Mirti (alternate)	Central Coast Council Central Coast Council
Professor Seth Westra (Observer and Technical Advisor)	University of Adelaide Water Research Centre
Valerie Tulk	Northern Beaches Council

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1 Introduction

1.1 Aim of Policy

The aim of this Position Policy (the Policy) is to establish an endorsed position by Floodplain Management Australia (the FMA) on the consideration of climate change flood risk in land use planning, that:

- can be used in advocating best practice
- supports flood risk management practitioners and decision makers to take action to ensure that management of flood risk recognises the future effects of climate change
- encourages consistency across organisations.

1.2 Scope of Policy

This Policy is written for local councils, catchment management authorities, state government agencies and all flood risk management practitioners involved in undertaking studies, formulating policies and making decisions on managing flood risk. While the focus of the Policy is on providing guidance on climate change flood risk management (FRM) related to land use planning processes and decisions, it will also be relevant to broader aspects of FRM.

This is an FMA policy and does not imply or necessarily reflect the policies or position of any individual member or organisation.

The FMA accepts the scientific assessments of the Intergovernmental Panel on Climate Change (IPCC) that human activity is changing our global climate, that irreversible change is already locked-in, and that the reality of a changing climate must be taken into consideration as part of the FRM process.

This policy recognises the interplay between sea level rise and coastal flooding but does not address coastal hazard management or the inter-relationships between coastal inundation processes and other coastal processes such as beach erosion or long term shoreline recession. Local drainage issues are also not directly addressed.

While this policy does aim to provide guidance that, when implemented, has the effect of reducing and/or managing future flood hazards associated with climate change, it does not provide direction as to how this should occur for any specific situation. For example, detailed investigations of the viability of a development proposal may require hydrodynamic modelling to evaluate the effects of flooding. Solutions to mitigate the risk may include coastal engineering, design or setback responses necessary to demonstrate how assessed risks can be effectively managed in a sustainable manner. The potential for increased storm intensity is recognised as an important consideration and the manner by which this is factored into flood risk management will be a matter for technical guidance provided by publications such as *Australian Rainfall and Runoff: A Guide to Flood Estimation (ARR 2019)* (Ball J, et al. (Editors), 2019).

This policy does not address the increased frequency and ultimately the permanent inundation of coastal land areas due to sea level rise. However, it is recognised that permanent inundation from sea level rise will be a progressive occurrence unless there is some form of engineering intervention to alter or prevent that inundation.

1.3 Background

In 2019, the FMA undertook a survey to investigate what policies and planning controls relating to climate change had been adopted by councils in New South Wales, Victoria and Queensland. The results of the survey and anecdotal evidence identified considerable diversity between councils as to what planning documents contained climate change flood risk related policies, the nature of the policies, whether policies had been adopted and the gaps in state government direction.

Around 39 councils from New South Wales, Victoria and Queensland responded to the survey, spread across urban, regional, coastal and non-coastal locations. The results showed:

- there was about a 50/50 split between councils that do and do not have climate change flood risk provisions in their principal local statutory plan (for example, Planning Scheme or Local Environmental Plan).

- there was about a 50/50 split between Councils that do and do not have climate change flood risk provisions in their detailed planning controls (for example, Development Control Plans or Codes). Where there were existing controls, these were mainly limited to providing higher floor levels. This included greenfield sites (those that had not been built on before), brownfield sites (those that been built on before) and urban infill development within established urban areas.

- about one-third of councils do, and about two-thirds do not, have a climate change policy position to guide the assessment of planning proposals (rezoning applications). For those councils with a climate change policy position, about 90% of such policies refer to climate change flood risk and about 80% refer to permanent inundation due to sea level rise.

In February 2020, a workshop on Climate Change Flood Risk Provisions in Land Use Planning was held at the NSW/ACT FMA Quarterly Meeting to review the results of the survey and discuss the topic in more detail. The Workshop generated considerable discussion and members saw there would be benefit in the FMA developing a Climate Change Position Policy and so it was resolved at the Quarterly Meeting to prepare such a Position Policy.

Following the February 2020 workshop, a working group of FMA members was established, composed of engineers, town planners and academics from across Australia, to prepare a FMA Policy Position Paper on the consideration of climate change flood risk in land use planning (this policy). The members of this working group are listed in the Acknowledgements at the start of this document.

This Policy should be read in conjunction with the FMA Position Policy on Floodplain Risk Management in Land Use Planning.

1.4 Policy review

This Position Policy is to be reviewed every 2 years or where required to reflect changes in planning policies.

2 Principles for considering climate change flood risk in land use planning

This section outlines the FMA's principles for considering climate change flood risk in land use planning. The purpose of these principles are to:

- guide and align flood risk management practitioners when considering the implications of climate change flood risk in land use planning.
- help flood risk management practitioners to advocate that best practice includes considering climate change in land use planning

The core principles have been grouped into the following 3 categories:

- decision-making goals and values
- incorporating climate change into land use planning assessments
- implementation and learnings

Each of the core principles is described below.

2.1 Decision-making goals and values

Apply the precautionary principle

Responsible authorities should act now and not wait for greater certainty about the exact extent of future climate change related flood impacts.

Apply intragenerational and intergenerational equity principles

The social, economic, physical and ecological outcomes of flood risk management outcomes should be considered so that unintended consequences are avoided, and costs and benefits are shared fairly between and across generations.

Use consistent climate change assumptions within a floodplain and collaborate across jurisdictions

In many cases, a floodplain will extend across multiple local government or other administrative boundaries. While local responses to flood risk might vary across jurisdictions, a regionally consistent approach to climate change assumptions within a floodplain is important.

Ensure meaningful community engagement and participation

The community should be involved in conversations about climate change and flood risk. Meaningful engagement with impacted and potentially exposed communities and stakeholders is essential to understand and raise awareness of their current and future climate flood risk. This will enable their participation in flood risk planning including assessment of risk, tolerance and development of land use policy and other risk management responses.

Understand that flood resilience contributes to the economic, social, cultural and environmental sustainability of regions, cities, towns and communities

It must be recognised that land use planning has a key role in maintaining and improving the function, livability and resilience of regions, cities and towns. This includes purposeful, appropriate, risk-responsive land use strategies and development policies that will allow our settlements to

adapt and evolve over time so as to avoid growth that has unacceptable flood risks from climate change.

Ensure planning decisions protect vulnerable people and critical assets

It is important to ensure that strategic planning and development decisions are informed by an understanding of community vulnerability and exposure to future flood risk from climate change, particularly decisions where land uses involve vulnerable people, critical assets and critical infrastructure.

Protect and enhance natural environmental values and the functioning of ecological processes associated with catchments, floodplains and terrestrial, aquatic, marine and coastal environments

It is important to understand the unique environmental context of each floodplain and how the characteristics and natural processes of catchments, including 'green' and 'blue' assets, are integral to flood behaviour and flood function, and how these could be affected by climate change. Impacts to natural environment values and ecological processes should be recognised when undertaking land use planning and, where possible, action should be taken to minimise or manage these impacts.

2.2 Incorporating climate change into land use planning assessments

Consider climate change flood risk strategically and early on in land use planning processes

In order to plan our cities, towns, regions and communities in a way that avoids and limits unacceptable flood risk, it is important our settlement strategies and strategic planning are underpinned by an understanding of current and future flood risk from climate change. Considering climate change flood risk early on in strategic land use planning and policy processes, means land use planners and policy makers can identify implications for new development, as well as legacy issues with existing settlements. This is particularly important for land uses involving vulnerable people and those land uses which typically have a longer design life or critical function such as hospitals and airports.

Ensure climate change is integral to a risk based approach to flood risk planning

A risk-based approach to flood risk planning is best practice. This involves analysing the implications of flood hazards over a full range of potential floods with different likelihoods and providing planning responses that reflect the vulnerability of different land uses. Consideration of climate change will increase the range of potential floods to be considered.

Ensure climate change projections inform land use policy and development responses to flood risk

Good planning outcomes for strategic planning, policy formulation and development decisions, should be informed by good quality up-to-date data, technical information and an analysis of climate change scenarios and flood futures.

Correlate planning horizons and changing flood behaviour over time

To ensure a foundation for informed decision making on how to respond to current and future flood risk, it is important to understanding how future climate conditions will change flood risk profiles over time and the implications this will have on strategic land use planning and existing development.

Acknowledge that climate change is likely to alter the extent of the floodplain in coastal areas

Although the probable maximum flood (PMF), which defines the floodplain, is not predicted to change under climate change for riverine flooding, climate change will affect sea levels which in turn will impact the extent of coastal flooding. This means that for low-lying coastal areas, it is important to consider the implications of climate change risks associated with the coincidence of catchment flooding with coastal hazards such as storm tide inundation and sea level rise.

Ensure that flood hazard mapping includes climate change factors

Future climate conditions should be considered when preparing regional and local government flood hazard mapping to inform flood risk assessments, strategic planning processes and when formulating planning instruments and development controls.

Consider the role of Building Codes in perspective

It should be acknowledged that Building Codes used in Australia do not generally have a focus on a consideration of climate change. Resilient building design should consider climate change flood risks, together with all natural hazards, for the purposes of minimising flood damages for the expected life of buildings and infrastructure. This should also include a consideration of flood related risks to personal safety, such as evacuation constraints and how these may change with climate change.

Recognise the important but limited role of structural mitigation measures

Structural and engineered measures can be effective in mitigating flood risks, but have limitations, often related to land-take, high costs and environmental impacts. The effectiveness of these measures needs to take into account their performance and longevity over time under projected climate change. The focus of strategic land use planning is to make communities more flood resilient, rather than solely relying on structural mitigation measures.

2.3 Implementation and learnings

Encourage to build back better, more resilient communities following flood events

As a general principle, wherever practical, the FMA encourages resilient rebuilding following flood events, rather than replacing buildings and infrastructure with the same standard of flood immunity that has proven to be vulnerable. This is particularly relevant for areas sensitive to climate change flood risk where the level of flood immunity will erode further with time.

It is important to incorporate the long-term consequences of future increases to flood risk from climate change into the planning of rebuilding assets. The scale of such rebuilding should be considered at both an individual property scale and on a community wide basis, and could, for example, include land-swap deals or relocation of high-risk communities.

3 Considering climate change flood risk in land use planning

3.1 How will climate change impact flood risk?

Flooding is Australia's costliest natural hazard-related cause of disasters when both tangible and intangible losses are taken into account. Australia's total economic exposure to flooding is estimated to be around $525 billion (net present value) under a low emissions climate change scenario from AR5. The annual economic costs of floods in 2060 is projected to reach $30.7 billion under a low emissions scenario and $40.2 billion under a high emissions scenario. (Deloitte Access Economics, 2021).

Approximately 7% of households in Australia are directly exposed to flood risk, with 2.8% being located in high risk areas. Up to 170,000 buildings are in locations exposed to floods with a 1 in 20 chance of occurring annually. These consequences will inevitably be exacerbated by the effects of climate change. (Dufty et al. 2020).

Housing and infrastructure at risk from sea level rise alone in Australia was valued at more than $226 billion in 2015 (Australian Academy of Science, 2015).

The effects of climate change on flood risk will vary across Australia. As outlined in *ARR 2019*, climate change can result in the following changes to key contributing factors that affect flood risk:

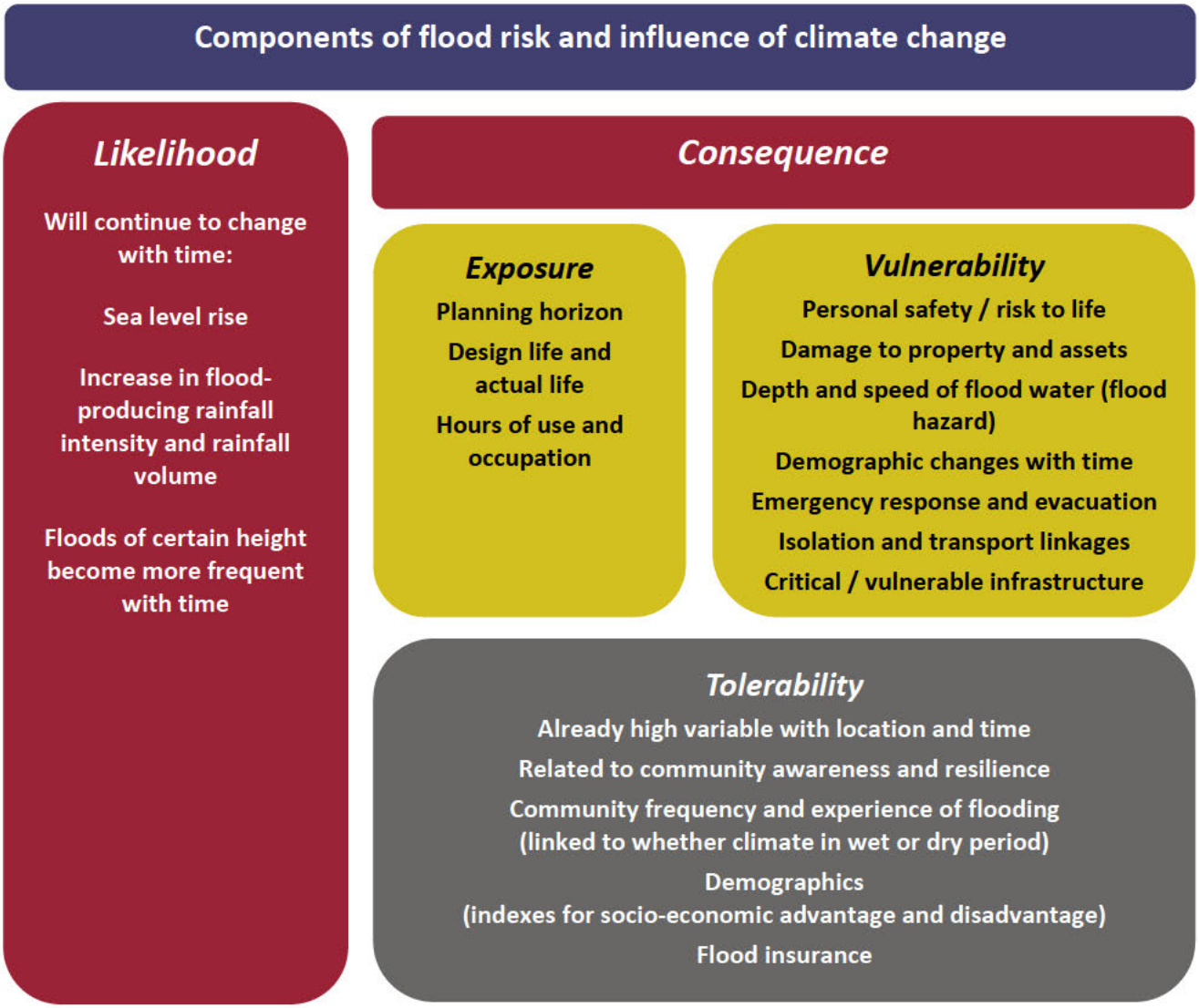
- rainfall Intensity-Frequency-Duration (IFD) relationships
- storm type and frequency
- rainfall spatial and temporal patterns
- antecedent conditions, including evaporation and baseflow
- sea level rise
- combined riverine flooding and coastal inundation (elevated tide, storm surge).

Away from the coast, flooding may either increase or decrease, depending on how surface runoff from storms changes. Near or at the coast, flood behaviour will also be affected by sea level rise, storm surge and tidal patterns. In areas affected by sea level rise, the effects can be an increase in flood frequency, and in some cases, the permanent inundation of low lying coastal areas.

Flood risk is defined by likelihood and consequence. The Queensland Reconstruction Authority's (QRA) *Planning for stringer, more resilient floodplains: Part 2 — Measures to support floodplain in future planning schemes* (2012) describes consequence as being evaluated in terms of exposure, vulnerability and tolerability — increases in exposure and vulnerability and decreases in tolerability all contribute to increasing flood risk.

Figure 1, adapted from QRA (2012), shows key elements associated with likelihood and consequence that are likely to change with time as a result of climate change.

Figure 1: Influence of climate change on the likelihood and consequences of flood risk



The relevance of these factors includes:

- ***likelihood*** — climate change will directly affect the likelihood of flooding over time, primarily related to sea level rise and increases in flood-producing rainfall intensity and rainfall volume, as listed above. These future changes will continue to change with time. This will cause the annual exceedance probability of floods will continue to change with time, meaning floods of a certain height will become more and more frequent with time. **Section 3.4** discusses how future sea level rise and increases in rainfall intensity can be quantified.

- ***exposure*** — appropriate design life and planning horizons are key planning considerations related to the changing exposure to the effects flooding over time due to climate change. For the purpose of this policy paper, the planning horizon is the length of time into the future that consideration of the effects of flooding are considered relevant. This is discussed in more detail in **Section 3.3**.

- ***vulnerability*** — vulnerability to property, people and other assets are also key planning considerations that will continue to change with time due to climate change. As shown in **Figure 1**, this includes:
    - flood hazard categorisation (H1 to H6) as outlined in *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (2017) (known as *Handbook 7*) (Australian Institute of Disaster Resilience, 2017) which is based on a combination of depth and speed of floodwaters
    - demographic data available from census data and population projection data from the Australian Bureau of Statistics (ABS, 2022a) and (ABS, 2022b)
    - emergency response and evacuation issues such as isolation, available transport linkages
    - vulnerability of critical infrastructure such as hospitals, community services, aged care and disability services.
- ***tolerability*** — tolerability of flooding, which is related to the community's resilience to flooding is already highly variable with location and over time. This will continue with the impacts of climate change. Tolerability often relates to the frequency and experience of flooding of a community as well as whether the climate is experiencing a wet or dry period. Demographics, together with indexes for socio-economic advantage and disadvantage of a community, contribute significantly to the tolerability of flooding. Flood insurance has a key impact on the tolerability of flooding and is discussed in more detail in **Section 3.5**.

3.2 Addressing a changing climate through land use planning

The planning system should have regard to best FRM practice. Ensuring our planning is informed by and integrates with best FRM practice is key to improving the resilience of our communities to flood risk. Planning can have significant benefits in minimising and reducing flood risks to property and persons as part of the planning of new areas and the redevelopment of established areas.

The Planning Institute of Australia (PIA), which is the national body representing land use planning and the planning profession, released its first *Climate Change National Position Statement* in 2007. This was updated in 2015 and again in March 2021 (PIA, 2021a). In June 2021, PIA released Climate-conscious Planning Systems (PIA, 2021b), a 'campaign' document calling for key reforms in planning systems across Australia to help give land use planners the tools needed to make meaningful decisions that address a changing climate.

As the effects of climate change are predicted to be gradual, land use planning can provide an effective and significant contribution to reducing the extent to which the natural environment, property and infrastructure (and consequently personal safety) is exposed to increasing flood risks. For example, a typical house built in the last 30 years with a floor level based on a 1% annual exceedance probability flood level will typically be subject to an increased probability of being flooded in the future, and may eventually not meet the originally applied immunity standard.

Planning by its nature works over time to guide the development and redevelopment of land. Consequently there is an imperative to ensure that planning policies today incorporate a meaningful consideration of the future effects of climate change.

3.3 Exposure — planning horizon

Because of climate change, it is likely that flood risk will be different in the future compared to when infrastructure is designed, planning instrument adopted or a development decision is made. There are some areas that may not be flood-affected now, but will be affected in the future because of climate change. There may also be some areas of a floodplain that are considered 'low risk' now, but will be 'medium', 'high' or 'extreme' risk in the future because of changes to flood behaviour from climate change factors.

For the purpose of this policy, the planning horizon is the length of time into the future that consideration of the effects of flooding are considered relevant. This will vary depending on what is being considered. For example, the strategic planning for a new area or design of critical infrastructure that is intended to have a long design or service life requires a distant planning horizon. Conversely, a closer planning horizon can be appropriate for a temporary use or infrastructure with a short design or service life.

An appropriate planning horizon should be adopted to suit the context of the planning exercise being undertaken. This requires consideration of a number of factors:

- ***probability of flooding*** — the probability that flooding will be equalled or exceeded over the service life and/or design life of the structure. This in turn depends on:
    - design flood level (and its associated likelihood of occurrence in any one year) — this is often called a flood planning level. Multiple flood planning levels may be used depending on differing vulnerability of land uses, building and infrastructure, and the level of flood hazard.
    - design life of the planned area, building or structure — for a house this may be 30 to 60 years. For a shed it might be 10 to 20 years. For a new or redeveloping area, public building or bridge it might be 100 years or more.
    - service life of the planned area, building or structure (or elements of) — the service life may well exceed the design life of a planned area, building or structure. Particular care and consideration may be required for items of heritage value where the service life may be well beyond the contemporary understanding of design life.
- ***consequences of flooding*** — which can be linked to the land uses in the planned area, the occupants of a building and the value of the contents, or the purpose of a structure and the cost of its restoration.

Without climate change, the probability of flooding being equalled or exceeded over the design life can be determined statistically. For example, the *NSW Floodplain Development Manual* (NSW Government, 2005) provides the probability of experiencing a given-sized flood in a certain period. For a 70 year period, which could represent the design life of a development, there is a 50% chance that a 1% AEP flood (or larger) would be experienced. This increases to a 97% chance for a 5% AEP flood over 70 year period (Gordon et al. 2019).

Consideration of the consequences of climate change flood risk should be dependent on the economic, social and environmental context of different circumstances. For example:

- Higher standards would be expected for Greenfield development compared to what might be applied to established areas.

- For infill areas, a higher risk tolerance may be acceptable. Building life may also be shorter if it is assumed that buildings or their internal elements are replaced more frequently.

- Consideration of avoiding areas where future permanent inundation is likely, given that sea levels are projected to continue to rise.

- The design life of well-designed and well-maintained infrastructure may last well beyond 100 years.

Regardless of the planning horizon adopted, it is recommended that the best available information be used to determine flood behaviour, including design flood levels, to assess the future impacts of climate change.

3.4 Likelihood and consequence — quantifying climate change flood risk

The two main aspects of climate change relevant to flood risk management are sea level rise and the increase in flood-producing rainfall volume / rainfall intensity. Those floodplains above the current tidal limit will be impacted by an increase in flood-producing rainfall, while those in estuary areas and below the current tidal limit will be impacted by both an increase in flood-producing rainfall and sea level rise. Both of these factors should be incorporated into flood modelling undertaken for flood studies.

This section provides an overview of how the impacts climate change on future flood behaviour can be quantified using the best available international, national and locally based information. Jurisdictions (referred to as Floodplain Management Entities in *Handbook 7*)[1] are generally advised to adopt the most locally relevant range of projections for sea level rise and increase in flood-producing rainfall. The time period adopted for considering these factors will depend on the planning horizon factors outlined above. These assumptions should also be applied consistently across the local area, particularly when evaluating other risks of climate change across a range of natural hazards and socio-economic factors.

3.4.1 Climate change — the science

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.

Thousands of scientists from all over the world contribute to the work of the IPCC. Review is an essential part of the IPCC process, to ensure an objective and complete assessment of current information. IPCC aims to reflect a range of views and expertise. The IPCC reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters.

[1] Floodplain management entity (FME) is defined in Handbook 7 as 'the authority or agency with the primary responsibility for directly managing flood risk at a local level'.

Approximately every seven years, the IPCC releases its Assessment Report. These are published materials composed of the full scientific and technical assessment of climate change, generally in three volumes, one for each of the Working Groups of the IPCC, together with their Summaries for Policymakers, plus a Synthesis Report. The most recent Assessment Report is the Sixth Assessment Report (AR6) (IPCC, 2021), which currently in the process of final release. The previous Assessment Report was the Fifth Assessment Report (AR5) released in 2014 (IPCC, 2014).

The IPCC's Assessment Reports can be considered as the most reputable source of scientific information related to climate change to provide governments at all levels with the best available scientific information to develop climate policies. This includes scientific assessments, the implication and risks of climate change, as well as adaptation and mitigation strategies.

A key headline statement from AR6 states:

- *"It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred."*

Representative Concentration Pathways and Shared Socio-economic Pathways

Scientists investigating how the earth's climate will respond to future conditions take into account a number of factors, including future greenhouse gas emissions, developments in technology, changes in energy generation and land use, global and regional economic circumstances, population growth and other socio-economic challenges.

So that outputs from different modelling systems can be compared, a standard set of scenarios are used to provide a consistent set of starting conditions, historical data and possible future emissions for use across the various branches of climate science.

For the IPCC Fifth Assessment Report (AR5), Representative Concentration Pathways (RCPs) were used to cover a range of emission scenarios with and without climate mitigation policies to 2100. There were four pathways: RCP8.5, RCP6.0, RCP4.5 and RCP2.6. RCP8.5 represents a high emissions scenario where there is a minimal effort to reduce emissions, and net carbon dioxide emissions continue to rise through the 21st century. RCP2.6 represents a low emissions scenario in which net carbon dioxide emissions start to decline by 2020 and fall to zero by 2100, relying on strong mitigation efforts, with early participation from all emitters followed by active removal of atmospheric carbon dioxide.

For the IPCC Sixth Assessment Report (AR6), a revised set of standard scenarios have been developed to describe potential future societal and climatic conditions to 2100, known as Shared Socio-economic Pathways (SSPs). The five scenarios are intended to span a range of future socio-economic challenges for mitigation and adaptation to climate change (CSIRO, 2022):

- SSP1: Sustainability — sustainability-focused growth and equality
- SSP2: Middle of the road — where world-wide trends follow historical patterns
- SSP3: Regional Rivalry — a degradation scenario with high challenges to mitigation and adaptation
- SSP4: Inequality — a degradation scenario with increasing inequalities and socio-economic division both across and within countries

- SSP5: Fossil-fuel development — a world of rapid and unconstrained growth in economic output and energy use.

AR6 uses a set of 5 consistent new possible climate futures that combine SSPs with greenhouse gas emissions used in AR5 (IPCC, 2021):

- SSP1-1.9 and SSP1-2.6 — which represent scenarios with very low and low greenhouse emissions and declining carbon dioxide emissions
- SSP2-4.5 — which represents a scenario of intermediate greenhouse emissions and fairly constant carbon dioxide emissions
- SSP3-7.0 — which represents a scenario of high greenhouse emissions and carbon dioxide emissions that roughly double by 2100
- SSP3-7.0 — which represents a scenario of very high greenhouse emissions and carbon dioxide emissions that roughly double by 2050.

Given the recent finalisation of AR6, the majority of resources for estimating the impacts of climate change are still based on RCPs from AR5.

3.4.2 Likelihood — sea level rise

As at May 2022, there are two useful online calculators that provide an estimate of sea level rise in Australia:

- CoastAdapt (https://coastadapt.com.au/tools/coastadapt-datasets#future-datasets) (NCCARF, 2017)
- NASA (https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool) (NASA, 2022)

The CoastAdapt calculation tool provides the following information for every coastal local council in Australia related to sea levels:

- observed sea levels from around the mid-1990s to the mid-2010s
- sea level rise predictions (relative to an average from 1986 to 2005) up to 2100 for the 4 Representative Concentration Pathways (RCPs) from IPCC Assessment Report 5 (AR5): RCP8.5, RCP6.0, RCP4.5 and RCP2.6
- inundation maps for 2050 based on very high greenhouse gas emissions (RCP8.5) and inundation maps for 2100 based on low greenhouse gas emissions (RCP4.5) and very high greenhouse gas emissions (RCP8.5). It should be noted that these inundation maps are based on a simple ‘bathtub’ or ‘bucket fill’ approach and do not include other tidal influences such as storm surge, protection from sea walls and other structures, and catchment flooding. The impacts of sea level rise can vary at even small distances from the coast (NCCARF, 2017)

The CoastAdapt online tool also provides information related to predicted changes in mean annual temperature and rainfall.

The NASA calculation tool provides the following information around the world, including around 40 locations around Australia:

- sea level rise predictions (relative to 1995–2014 baseline) up to 2150 for 5 key Shared Socio-economic Pathways (SSPs) from IPCC Assessment Report 6 (AR6): SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5. This includes a breakdown of the causal components of sea level rise.

- the projected year at which a given sea level rise would be expected for the same 5 key SSPs.

Depending on location and the potential number of properties that might be affected, flood modelling boundary conditions may need to make consideration of elevated sea level conditions associated not only with sea level rise but also coastal processes such as storm surge. This should consider the probability of the two events occurring at the same time when completing related risk assessments. Alternatively, coastal inundation modelling may be required.

Note that coastal boundary conditions can vary significantly depending on the characteristics of the waterway connection to the sea (for coastal creeks this is referred to as the 'entrance') and can be costly to model. Weighing up the degree of sophistication against the accuracy required may help decide whether a simplistic but conservative approach is warranted.

3.4.3 Likelihood — rainfall intensity

Increased rainfall intensity, leading to increased rainfall volume, is a key consideration of climate change flood risk.

While the IPCC's Assessment Reports provide detailed predictions for the average annual number of wet days and dry days, these projections do not include information relating to potential changes to intensity-frequency-duration rainfall relationships required for assessment of future flood risk. *Australian Rainfall and Runoff (ARR2019)* (Ball et al., 2019) provides the latest advice for practitioners, designers and decision makers for the estimation of an increase in flood-producing rainfall intensity from climate change, while further research is undertaken.

As an interim approach, ARR2019 presents a relationship for increased rainfall intensity from climate change that is directly related to increase in temperature from climate change. This is because, generally there is more confidence in Global Climate Model simulations of temperature than for rainfall. Given the uncertainty in flood-producing rainfall projections and their considerable regional variability, ARR2019 recommends the following:

- a 5% increase in rainfall intensity or depth per degree Celsius (°C) increase in local temperature

Using this assumption and drawing on increased temperature projections from the Climate Change Futures Tool developed by CSIRO (https://www.climatechangeinaustralia.gov.au/en/projections-tools/climate-futures-tool/projections/) from AR5, the ARR DataHub (https://data.arr-software.org/) provides a calculation tool that calculates the likely increase in rainfall intensity for any location in Australia. Median increases in rainfall intensity are provided every 10 years from 2030 to 2090 for RCP4.5, RCP6.0 and RCP8.5. However, ARR2019 recommends the use of RCP4.5 and RCP8.5 to determine the range of projected increases in rainfall intensity.

It is anticipated that ARR19 will be gradually updated as newer and more detailed research findings on climate change are released. The most up to date version should be used.

The NSW Government's *Floodplain Risk Management Guideline, Incorporating 2016 Australian Rainfall and Runoff in studies* (2019), provides a practical approach that can be used in flood studies in NSW to assess the potential scale of the impacts of increased rainfall from climate

change. In NSW, the rainfall volume for a 1 in 200 (0.5%) AEP is in the order of 15% greater than the 1% AEP flood, while the rainfall volume for a 1 in 500 (0.2%) AEP is in the order of 30% greater. Rather than undertaking additional flood model runs for climate change, the 1 in 200 and 1 in 500 model runs can be used as proxies for a range of future 1% AEP flood events with climate change.

This provides a sensitivity to potential future increases in rainfall. For example, when determining design flood levels or flood planning levels, the freeboard can be adjusted to reflect the level of uncertainty associated with the climate change factors. Testing the sensitivity of modelling parameters adopted aids in the selection of a suitable freeboard to account for uncertainty in climate change projections.

3.5 Tolerability – insurance

Flood insurance has been widely available in Australia under a standardised definition of 'flood' since 2012, with insurers setting premiums based on the underlying flood risk at each policy location under current climate conditions. The standard 'flood' definition does not include coastal inundation, and coverage for coastal flooding therefore varies by provider. Flood insurance is not mandatory, but many mortgage providers require mortgagees to maintain a flood insurance policy.

Climate-induced changes to the frequency and severity of flooding will be reflected in the cost of flood insurance, and insurers have raised concerns for the affordability of flood insurance for the very small proportion of policies in unmitigated high-risk flood zones most sensitive to a changing climate.

Flood insurance is typically provided as an annual contract and its availability, and premiums charged, could change over time for those areas particularly susceptible to climate change flood risks.

The following issues have been identified as key areas for future collaboration between insurers and flood risk management practitioners:

- ***Increase the community's awareness of current and future climate flood risk*** — Flood insurance premiums are a key risk signal for residents and businesses in flood-prone areas, and will be one of the most visible signals to the community of climate-induced changes to the underlying flood risk. To ensure these risk signals closely reflect the community's view of flood risk, floodplain managers can share data with insurers via the Insurance Council of Australia[2].

- ***Understand and quantify future-climate flood risk*** — Floodplain managers can leverage the insurance industry's national view of risk and heavy investment in future-climate scenario modelling to gain an understanding of climate sensitivity and likely risk trajectories. Insurers have highlighted particular areas of concern around estuarine areas subject to both sea level rise and increased rainfall runoff, and areas with historically strong flood planning controls which are particularly sensitive to changes in flood risk due to the build-up of assets at an historical flood planning level. Relevant resources are listed in this document or available via the Insurance Council of Australia.

[2] See FMA "Sharing Flood Risk Information with Insurers Fact Sheet"

- ***Manage existing flood risk through targeted mitigation in high-risk areas*** — Addressing existing flood risk through community- and household-scale flood mitigation measures is the most effective way to reduce flood insurance premiums in high-risk areas and ensure that flood insurance remains affordable in a changing climate. Insurers reflect the reduction in flood risk through reduced premiums, floodplain managers can share data with insurers via the Insurance Council of Australia to ensure the risk reduction associated with mitigation projects is reflected in flood insurance premiums.

- ***Plan for future-climate resilience*** — To maintain the affordability of flood insurance, and the livability of communities for future generations, floodplain managers should consider distant planning horizons under future-climate scenarios when planning new or developing areas. Insurers stress the importance of considering the full spectrum of possible events to inform strategic planning and development controls, as traditional controls based on a single design flood event have often resulted in unacceptably high residual risk that ultimately results in high flood insurance premiums.

- ***Build back stronger, more resilient communities following flood events*** — Floodplain managers and insurers should work together to encourage resilient rebuilding following flood events, particularly in areas particularly sensitive to climate change flood risk. increases in flood risk, for example by facilitating land-swap deals or relocation of high-risk communities following major events.

4 Roles and responsibilities of governments

Roles and responsibilities for flood risk management are distributed across different government agencies, a broad range of stakeholders and the private sector. As outlined in the FMA Land Use Planning Position Policy the application of flood risk management within the planning system should be undertaken as a partnership between all levels of government, with State and local governments have a primary role in land use planning while the federal government should contribute by directing financial resources and providing nationally consistent policy direction.

While the implications of climate change flood risks can vary between different areas, core principles for managing these risks can remain constant. Consistency in the application of climate change assumptions within a whole floodplain means all stakeholders and all levels of government use the same climate change information to understand the implications for current and future flood risk.

Table 1 outlines the FMA position on the roles and responsibilities that should be embraced by each level of government.

Table 1: Roles and responsibilities for consideration of climate change flood risk

Planning Activity	Comment on Existing and Possible Future Planning Studies, Strategies and Policies	FMA Policy Position
National Level		
Policy Direction	Climate change is a universal phenomenon. Consequentially, it would be logical for key climate change related flood risk factors such as sea level rise and rainfall variability to be the subject of nationally based research and policy direction. For the same reasons, it is also desirable for key core policy direction to be driven at a national level, which would have the added benefit of avoiding parochial socio-political barriers to undertaking action. Such polices could for example include the adoption of sea level rise benchmarks.	1. The federal government should: • lead research into key variables associated with climate change flood risk, in particular projected rates of sea level rise and rainfall variability • provide direction at a national level on core policies to provide consistent guidance for action taken at a state and local level for managing climate change related flood risks.
Financial Resources	Presently, there is a concentration of financial resources applied to post disaster recovery as opposed to flood risk mitigation in Australia. The FMA have consistently lobbied for increased expenditure in up front flood mitigation to minimise the extent of property and infrastructure damages, and loss of life, associated with flood disasters. As the effects of climate change increase over time, this will become increasingly important.	2. Funding for flood risk mitigation in Australia should be increased to address both existing shortfalls and to progressively address projected rise in climate change related flood costs.
State or Territory Level		
Planning Information	Planning polices typically impose flood related development controls that apply to the property and do not necessarily reflect all flood risks that a property may be exposed to. This can inadvertently misinform the community about actual flood risks. The potential for the community to be misinformed is exacerbated due to a common lack of clarity as to whether flood risks reflected in planning policies or other information sources are current day risks or projected risks which factor in climate change. The community should be fully informed about flood risks to allow an opportunity for individuals to decide what are acceptable risks (particularly where planning policies retain some residual risks) and to provide awareness that aids emergency management and recovery.	3. The form and content of planning policies and certification should be reviewed to: • avoid misleading the public who may believe there are no flood risks when only advising if flood related planning controls apply • ensure that the same and more complete information is communicated to all enquirers • ensure the public is fully informed of known flood risks, including those related to climate change, or if there is insufficient information to know whether a flood risk exists • clearly reflect flood risks that both exist today, and the level of risk projected for the future due to climate change • specify what periods in the future that climate change flood risks are notified (eg, 2050 and 2100).

Planning Activity	Comment on Existing and Possible Future Planning Studies, Strategies and Policies	FMA Policy Position
Directions for deciding on land use zones and planning controls	State or Territory level planning policies sometimes exist that provide high level direction as to how to manage climate change related flood risks. Government policies may also explicitly or implicitly direct the form and content of statutory planning schemes (local environmental plans in NSW) and supplementary planning controls (such as development control plans and codes). These policies should include direction as to the future climate change projected flood risk that should be considered.	4. Each state should have a state policy to provide direction for the management of climate change related flood risks, that: • incorporates direction consistent with that advocated by this FMA policy • specifies that matters identified in this policy be addressed prior to the preparation of a plan that significantly changes development potential in floodplains • ensures that planning addresses climate change related flood risks to private and public property, infrastructure and to life. 5. That the relevant state planning authority be responsible for preparing the policy in consultation with other relevant government agencies in particular those involved with the management of the natural environment, emergency services, local government, utility authorities, FMA and the Bureau of Meteorology. 6. The directions should specify the future climate change projected flood risk that should be considered for different: • land uses (eg vulnerable land uses, critical infrastructure or general residential, commercial and industrial development) and • planning contexts (eg infill development or greenfield development). 7. In States or Territories where no state level climate change FRM planning policy currently exists, this should be prepared as a priority. 8. Related policies, and regional, subregional, and district plans plan and strategies, should also be revised to provide consistency.

Planning Activity	Comment on Existing and Possible Future Planning Studies, Strategies and Policies	FMA Policy Position
Strategic Planning	Regional, subregional, and district plans and strategies are typically prepared at a state or territory government level which establish locations for new areas, encourage redevelopment of older areas and provide broad direction for detailed local planning. It is therefore important to consider the longer term flood risks due to climate change when undertaking such planning.	9. Consider climate change flood risk early in the regional, subregional and district planning processes. 10. Adopt the principles (Chapter 2) and guidance (Chapter 3) provided in this Policy. 11. This should be informed by catchment or regional scale guidance on flood hazard and risk. 12. Consider risks from cumulative impacts and coincident natural hazards 13. Develop 'whole of organisation' responses to provide a consistent and coordinated approach to flood risk management, of which land use planning is an important action.
Local		
Strategic Planning	Local government is typically responsible for more detailed planning of suburbs, neighborhoods and the overall settlement pattern within the LGA. While such planning is often implementing plans prepared at a state level, there remains opportunities for refinement of strategies to address natural hazards including climate change flood risks, and to achieve a flood responsive settlement pattern.	14. Consider climate change flood risks at the strategic planning stage to minimise the long term exposure of the community to unacceptable risks. 15. Adopt the principles (Chapter 2) and guidance (Chapter 3) provided in this Policy. 16. Adopt climate change design flood levels when assessing the suitability of land at the strategic planning stage and assessing potential development outcomes associated with a proposed change in land use.
Local Plans (such as Local Planning Schemes or Local Environmental Plans)	Local plans are typically statutory planning instruments that should have a line of sight back to higher order plans and policies. Local plans identify the preferred settlement pattern for the LGA and provide the basis upon which the majority of development is approved. A local plan will typically contain provisions that contribute to the way flood risks are considered in the assessment of a development proposal. These provisions include land use zonings, definitions, and flood overlay maps. These can be unclear and inconsistent between local government areas in regard to whether climate change is factored in.	17. The provisions of a local plan should: • include a requirement for climate change considerations when assessing development proposals • factor in climate change when specifying the flood risks to be considered • provide clarity as to temporal context of the climate change flood risk that is to be considered (that is, risks at present and risk that are projected into the future due to climate change). 18. The approach to identifying and addressing climate change flood risks should be consistent with direction provided at a state and national level, if available. 19. Avoiding inappropriate zoning and land use and development in areas where the existing flood risk profile will increase or become more severe or intolerable with future climate change.

Planning Activity	Comment on Existing and Possible Future Planning Studies, Strategies and Policies	FMA Policy Position
Development Codes, Guidelines or Control Plans	These provide detail controls that supplement higher order planning instruments (normally planning schemes or local environmental planning schemes).	20. Model controls should be prepared by state agencies to assist Councils in preparing FRM provisions for development codes/plans. 21. These controls should incorporate guidance for the assessment of climate change related flood risks to development. 22. Consider using flood planning levels that incorporate an additional climate change factor allowance and in combination with hazard resilient building design to accommodate the risk to an acceptable level. 23. Consider using greater flood planning levels in parts of the floodplain where peak flood levels are expected to worsen under future climate change scenarios (eg: for some uses it may be appropriate to scale up the 1 in 100 AEP to a 1 in 200 AEP or 1 in 500 AEP to a 1 in 1000 AEP). 24. Apply a sensitivity analysis to determine the practical implications of increases in design flood levels in current planning controls that apply to development to take into account long term predicted climate change effects (eg amenity impacts due to height of buildings, streetscape changes, ability to construct driveways, etc). Variable flood planning for different land uses and scale of development could be considered where this would allow for a more practical planning outcome. 25. Consider introducing controls that impose time-limited consents to provide the potential to remove, replace or adapt development in the future. Such policies should apply an expiration date that is event triggered (e.g. the reaching of a certain mean sea level) as opposed to calendar date triggered.

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