

Climate change adaptation and floods: Australia's institutional arrangements

Case Study

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CLIMATE CHANGE ADAPTATION AND FLOODS: Australia's institutional arrangements

The Australian National University

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The role of NCCARF is to lead the research community in a national interdisciplinary effort to generate the information needed by decision-makers in government, business and in vulnerable sectors and communities to manage the risk of climate change impacts.

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Cover images © Eric Wenger, Ginninderra Creek in flood

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PREFACE

Climate change adaptation and floods is a case study that contributed to a broader climate change adaptation project. The case study used project methodology developed by Karen Hussey, Steve Dovers and Richard Price. Details of the umbrella project are:

Hussey, K, Price, R, Pittock, J, Livingstone, J, Dovers, S, Fisher, D & Hatfield-Dodds, S 2013, *Statutory frameworks, institutions and policy processes for climate adaptation: Do Australia's existing statutory frameworks, associated institutions and policy processes support or impede national adaptation planning and practice?*, National Climate Change Adaptation Research Facility, Gold Coast, 193 pp.

The case study also drew upon work undertaken as part of a second NCCARF project under its synthesis and integrative program (referred to in this paper as the SIRP Report):

Wenger, C, Hussey, K & Pittock J 2013, *Living with floods: Key lessons from Australia and abroad*, National Climate Change Adaptation Research Facility, Gold Coast, 267 pp.

The author would like to thank Jamie Pittock, Karen Hussey and Richard Price for valued feedback on the initial draft.

1. EXECUTIVE SUMMARY

1.1 Objectives and Methodology

This case study was conducted as part of the broader project *Statutory frameworks, institutions and policy processes for climate adaptation*, funded by the National Climate Change Adaptation Research Facility (Hussey et al, 2013).

Case studies were prepared using a matrix methodology. Five attributes formed the **x-axis** (jurisdictional scope; sector; threat; nature; basis of power) and seven institutional mechanisms formed the **y-axis** (intergovernmental function; intra-governmental function; regulation by prescription; planning processes; funding function; information and analysis function; supporting market arrangements). Case studies also assessed findings in terms of four adaptive characteristics: clarity of purpose; diversity; connectivity; integration and feedback.

This case study addresses a 'threat' attribute, flood, in terms of each of the seven institutional mechanisms. Flooding is Australia's most expensive natural hazard and the federal government allocated 5.6 billion in recovery funding to Queensland alone, primarily to restore public infrastructure (BITRE, 2008, Gillard, 2011). Climate change scenarios predict an increase in intensity and frequency of floods, potentially exposing Australia to even greater damages in the future. Floods are thus a key area for improving adaptive capacity. Past research identified inadequacies in institutional and regulatory arrangements, development planning and funding mechanisms (Wenger et al 2013). That research overwhelmingly pointed to the need for improvements in non-structural measures, particularly in the preventative phase of emergency management. It also found that adaptive approaches that are proving successful and cost-effective overseas are largely unknown in Australia, and would have difficulty being implemented under current arrangements.

Accordingly, this paper explores flooding from the perspective of government function to determine:

- current policies and institutional arrangements in place to address flooding
- the types of reforms that would be required to reduce Australia's vulnerability to flooding in the future.

1.2 Findings

The current approach of flood management in Australia is 'resilience' and through federal leadership and funding, it has been adopted throughout the country. While partly a rebranding of the emergency management framework "Prevention-Preparation-Response-Recovery", resilience also attempts to promote shared responsibility for disasters. It is yet to be seen whether the community will accept this responsibility (and remember it during periods of prolonged drought). However, given that flooding is expected to worsen, and that response capacity will be stretched in large magnitude floods, greater self-sufficiency would be a sensible adaptation if it can be achieved.

Climate change adaptation is a stated rationale for resilience, though it is not referred in key funding mechanisms, such as the National Partnership Agreement for Natural Disaster

Resilience, or in most annual state implementation plans. However, these funding mechanisms and others have enabled the development of risk assessments and adaptation plans, as well as community awareness raising and development or revision of key flood management tools. At this early stage, it is difficult to determine whether the resilience approach enables effective adaptation to flooding. In view of the paucity of funding of the National Partnership Agreement and its vast scope, it seems doubtful that it will have a greater impact than its predecessor, the Natural Disaster Mitigation Program. Other elements of the National Strategy for Disaster Resilience (NSDR) implementation, such as the *Enhancing Disaster Resilience in the Built Environment Roadmap* are innovative and hold promise. However, major opportunities to incorporate climate change risks into planning controls through the Building Code of Australia have been missed.

Perhaps one of the most significant initiatives to so far come out of the resilience approach is the greater availability of flood risk information through National Flood Risk Information Program (NFRIP). This could prove to be a major step forward in awareness of flood risk and the need to mitigate.

In order to achieve improved flood management, reforms are needed at all three levels of government. Major impediments to achieving improved flood management include conflicting development policy objectives, many of which value short term development gains over long term disaster prevention; the non-mandatory nature of many current provisions relating to flooding; insufficient investment in prevention (as opposed to relief and recovery); disincentives such as badly targeted flood relief and lack of financial consequences for those making risky development decisions; planning that is based on administrative boundaries rather than natural geographic ones; planning tools that are inadequate to address future risks; and inadequate resourcing, particularly for on the ground implementation. Potential financial consequences are a major barrier that inhibit local government from using flood information and applying appropriate land use and development controls, particularly if this means land has to be 'downzoned'.

State / territory planning processes could be improved to facilitate adaptation. Rather than relying on modeling to provide greater certainty about flood risk, improved decision making systems need to be implemented that enable low cost, flexible approaches to flood risks. Local governments also need to be better supported by state governments in terms of technical capacity and financial resources for generation of flood information and risk assessment. Appropriate legal protection or financial capacity to pay compensation when it is necessary to down zone could encourage the actual application of flood information.

In a country with very short term records of past floods, the use of flood mapping that incorporates palaeological information about past flood events, such as the Queensland Reconstruction Authority's (QRA) maps, will enable better assessment of possible worst case scenarios and identification of potential flow paths. As likelihood of flooding is predicted to increase, consideration should also be given by state / territory governments to the use of more conservative planning tools, such as higher floor levels and building material and design, particularly for areas that will suffer largest consequences of flooding, such as urban areas or development in confined catchments.

Local government needs to ensure it has adequate flood risk information on which to base decisions, and to incorporate this into planning schemes. Councils also have a responsibility to make information freely available as it is only when information is available that flood risks can be addressed. Community resilience objectives will not be achieved in the absence of this information.

Local government alliances can greatly facilitate the capacity of local governments to adapt to climate change. They can promote synergies, help leverage funding, advocate adaptive approaches and be a vehicle for locally relevant research and action. Such alliances have good coverage in some states, such as Victoria where they were initially funded by State government, but less coverage in others. More alliances in other states could greatly benefit adaptive capacity of local governments and the development of locally relevant solutions.

Local government also has a large role to play in community education. Flood damage often results in activity by communities and landowners, such as channel straightening, building embankments and vegetation clearance, that actually increase the potential for future flood damages over whole catchments.

Floods should not be seen merely as disasters. Australia's carryover water storage system depends on them. Managed well, flooding can replenish groundwater, restore ecosystems and boost economies. Floods are vital for Australia's water security and this will only become more important during the prolonged droughts anticipated as a result of climate change. To adapt to climate change, Australia needs to ensure it maximizes the benefits of large and small floods, while minimizing the adverse consequences of large floods that result from poor management. This requires an ecosystems approach to flood management, widely used overseas. Administrative systems that support a catchment approach would help to achieve this. Much could be done to enhance catchment based approaches in terms of mapping, assessing cumulative impacts across entire catchments and implementing appropriate measures in the parts of the catchment that would be most beneficial. While having catchment management authorities with a legislated role in the development approval process is an advantage, these activities could also be achieved by well-coordinated state processes. Market mechanisms, such as payment for ecological services, have great potential to improve catchment-wide flood management and innovative Australian proposals demonstrate this could be achieved at low cost.

1.3 Recommendations

Analysis in this paper suggests that aspects of flood management most in need of reform are:

- assessment of the adequacy of current planning instruments to accommodate climate change
- consistent policy, legislation and planning processes to ensure that future flood risks are assessed and addressed
- sufficient resources for local government (both technical and financial) for on the ground flood prevention and mitigation
- significant increase in funds available to flood prevention/mitigation to reduce long term damages, in particular for:

- basic nationwide flood mapping
 - sophisticated flood mapping in urbanised and developing areas that includes worst case scenarios, projected population and development and flood consequences
 - improved development planning
 - relocation of those most at risk and reassignment of land to flood compatible uses
 - recognition and support for ecosystem approaches
- flood recovery strategies that merge with prevention to increase future resilience
 - administrative structures that enable a catchment based approach to flood management
 - integration of ecosystem approaches into training for flood managers, coupled with community education programs.

Proposed reforms are found in Table 2 of this paper.

2. OBJECTIVES OF THE RESEARCH

2010-2011 saw some of the biggest flood events in Australia's history, with approximately 80% of Queensland declared a disaster zone and extensive flooding in other eastern states, notably Victoria. Flooding is Australia's most expensive natural hazard and the federal government allocated 5.6 billion in recovery funding to Queensland alone, primarily to restore public infrastructure (BITRE, 2008, Gillard, 2011). Climate change scenarios predict an increase in intensity and frequency of flooding, potentially exposing Australia to even greater damages in the future. Floods are thus a key area for improving adaptive capacity.

The large scale of events, the number of lives lost and the scale of the damage incurred prompted numerous inquiries and review processes by different governments and organizations. Flood research for a related project by the same author analyzed four Australian flood reviews¹ to determine if they offered any lessons for climate change adaptation (Wenger et al., 2013). The project identified inadequacies in institutional and regulatory arrangements, development planning and funding mechanisms and overwhelmingly pointed to the need for improvements in non-structural measures, particularly in the preventative phase of emergency management. It also found that adaptive approaches that are proving successful and cost effective overseas are largely unknown in Australia, and would have difficulty being implemented under current arrangements.

Accordingly, this paper will explore flooding from the perspective of government function to determine:

- current policies and institutional arrangements in place to address flooding
- the types of reforms that would be required to reduce Australia's vulnerability to flooding in the future.

Floods should not be seen merely as disasters. Australia's carryover water storage system depends on them. Managed well, flooding can replenish groundwater, restore ecosystems and boost economies. How Australia manages floods will be vital for its adaptation to other climate change impacts such as drought.

Prevention, Preparation, Response and Recovery, otherwise known as PPRR, is the standard emergency management framework currently used in Australia (COAG, 2011, EMA, 2004). Its advantage, as well as being widely understood by flood managers, is that it divides disaster management into temporal phases. Research indicates that proactive intervention in the prevention stage, is more effective and cost efficient than interventions at later stages (BTRE, 2002, Wenger et al., 2013). The emphasis of this paper is therefore on flood prevention.

¹ Australian reviews studied for the SIRP report include: the Queensland Floods Commission of Inquiry (referred to in this report as the QFCI); the Victorian Review of the 2010-11 Flood Warnings and Response (referred to in this report as the Comrie Review); the Brisbane Flood January 2011: Independent Review of Brisbane City Council's Response; and the Environment and Natural Resources Committee Inquiry into Flood Mitigation Infrastructure in Victoria (referred to in this report as the ENRC Inquiry). Other reviews were referenced but not studied in depth.

Adaptation to climate change in the context of flooding can encompass many different strategies, including protect, accommodate and retreat options. In terms of protection, structural measures such as constructing flood walls, dams and levees are options often called upon, though in the long run, this approach can be maladaptive, having adverse environmental impacts, transferring problems elsewhere or leading to a false sense of security that increases vulnerability when defences are overcome. Another approach is to ensure land use and/or building design that is compatible with flooding. For this to be effective under climate change conditions, it is important that future risks are assessed and incorporated into planning processes. Where accommodating floods is not feasible, relocation can be used to remove people from hazardous areas, and this can be combined with land use changes so that affected areas can continue to be used.

Other adaptation strategies can include improved preparation and response mechanisms for large scale emergencies that enable joined up capacity across different agencies, coupled with improved community awareness and self-sufficiency. Many of these can be hard to sustain during extended periods between large flood events. Moreover, some note that non-structural methods of prevention, such as land use planning and building standards, are more effective than attempting to modify human response behaviour through public education, warning systems and emergency response (Comrie, 2011:191). The emphasis of this paper is therefore on identifying the drivers and barriers to more proactive prevention approaches to flood management.

3. RESEARCH ACTIVITIES AND METHODS

The case study used methodology used in the umbrella project, *Statutory frameworks, institutions and policy processes for climate adaptation* (Hussey et al., 2013). This entailed assessing institutional arrangements for flooding according to seven institutional mechanisms (covered in the 'results' section of this paper), and assessing their adaptive characteristics according to four criteria (covered in the 'discussion' section of this paper).

The seven institutional mechanisms include:

Intergovernmental functions: These are formal agreements between governments to work towards specified objectives. The Council of Australian Governments, comprising the heads of the federal and all state and territory governments, represents the pinnacle of such frameworks. At the issue level, agreements and frameworks include the Murray Darling Basin Agreement, National Water Initiative, and the National Competition Policy among others. Usually these agreements and frameworks are underpinned by legislation and supporting institutions.

Intra-governmental functions: These are initiatives within a tier of government, either Federal or State, which imposes a common platform of accountability, such as reporting on sustainability or social inclusion, or promotes or requires cross agency cooperation in dealing with a particular issue. The joint administration of the Natural Heritage Trust and Caring for our Country initiatives between SEWPAC and DAFF is an example of this.

Regulation by prescription: These are mandatory (legal) requirements that must be met under specific laws/legislation. They are the primary instrument of government agencies to achieve agency objectives.

Planning processes: These are strategic and administrative procedures and modus operandi by which agencies prescribe and authorize desired action in anticipation that such action will provide public benefit or avoid public dis-benefits.

Funding functions: These are incentive programs or investment initiatives that provide subsidies or co-investment as a means of stimulating the uptake of particular actions.

Information and analysis functions: These are publicly funded initiatives aimed at enhancing the understanding of phenomena (basic research) and how to deal with these (applied research) and at enhancing stakeholder understanding of the consequences of phenomena and the means of responding (education and awareness).

Market arrangements: These are instruments of government that influence the way in which industry actors behave in various markets. Examples include water trading and trade policy.

The four adaptive characteristics assessed include:

Clarity of purpose: Requires clear definition and understanding of problems at a system level so that we can address root causes and not just symptoms.

Diversity: Requires a diversity of ideas, skills and resources, a diversity of views, innovation, flexibility in problem solving, and wide inclusion of stakeholders in a purposeful and structured fashion.

Connectivity: Requires institutional (including community) networks that are not susceptible to collapse due to one part failing; effective use of resources; community ability to organise itself; appropriate leadership; spare capacity; and some duplication of functions and overlapping of institutions.

Integration and feedback: Requires a holistic consideration of issues and realistic consideration of scale, accounting for the full range of interactions between humans and ecosystems. It also requires resources to monitor and to promote debate and learning.

The case study primarily relied upon literature review. Due to the nature of the topic, government documents form a large proportion of source material, including flood reviews, policy documents, agreements and funding reports. Where relevant, this report also draws upon work the author carried out for the NCCARF project, *Living with floods: key lessons from Australia and abroad* (referred to in the body of this work as the 'SIRP report'). The methodology of the SIRP report included literature reviews for both Australia and overseas, and interviews with six end-user groups.

The scope of this paper is limited to the institutional arrangements in place at the time of and immediately following the 2010-11 floods, and should be regarded as a 'snapshot in time'. Reforms that take place as a consequence of the floods may be covered in future work.

4. INSTITUTIONAL LANDSCAPE FOR FLOODS IN AUSTRALIA

Under Australia's constitution state governments have primary responsibility for natural resources and flood management is therefore the domain of State and Local Governments. The Federal Government's role is limited unless it is invited by state governments or chooses to legislate using its powers to regulate corporations or to fulfil national obligations under treaties, such as those related to wetlands and climate change. The Federal Government has therefore avoided a coercive approach to activities that relate to land use and development planning. However, as discussed in section 5.5, more coercive tactics have been used overseas by states with similar constitutional limitations.

Table 1 provides an outline of the institutional landscape for floods in Australia. The table is not exhaustive but it shows that Federal Government involvement in flood prevention is primarily confined to exhortative and cooperative styled policy instruments such as intergovernmental agreements, funding arrangements and the provision of information, standards and guidelines (Handmer and Dovers, 2007:110-120). The role of State and Territory governments is to develop policy, strategies, tools and legislation, while Local Governments implement them. States can also directly approve development, for example states can have separate development legislation for projects of regional or statewide significance.

The business sector and individuals also have a role to play in flood management, for example, through private land management practices, insurance, use of flood resilient design and purchase decisions. Some of these aspects are addressed more fully in Case Study 4 on market mechanisms.

Table 1: Key statutory and institutional frameworks that relate to flooding²

Government Level	Responsibility	Legislative/ Policy/ Coordination Mechanisms	Responsible government authority/institution
Federal	Coordination across jurisdictions where there is a national interest Provision of information, standards, best practice guidance Provision of funding to enable national objectives to be met.	National Strategy for Disaster Resilience (adopted by COAG 13.2.11) National Disaster Resilience Framework (endorsed by MCPPEM 20.11.09) National Partnership Agreement on Natural Disaster Resilience (2009/10 - 2012/13) Australian Emergency Management Arrangements (endorsed by MCPPEM 6.11.08) Climate Change Adaptation Program (endorsed by MCPPEM 20.11.09) Enhancing Disaster Resilience in the Built Environment Roadmap National Risk Assessment Framework (endorsed by AEMC in 2007) Australian emergency management manual series Natural Disaster Relief and Recovery Arrangements National Flood Risk Information Program	Council of Australian Governments (COAG) Standing Committee on Police and Emergency Management (SCPEM)³ Australia-New Zealand Emergency Management Committee (ANZEMC)⁴ National Flood Risk Advisory Group (NFRAG) Land Use Planning and Building Codes Taskforce Attorney-General's Department Emergency Management Australia Australian Emergency Management Institute Geoscience Australia

² Note this table focuses on policy and institutional frameworks that relate to the prevention of flooding rather than emergency response.

³ Previously the Ministerial Council for Police and Emergency Management (MCPPEM)

⁴ Previously the National Emergency Management Committee (NEMC), or the Australian Emergency Management Committee (AEMC)

Government Level	Responsibility	Legislative/ Policy/ Coordination Mechanisms	Responsible government authority/institution
Federal (cont.)		Flood Warning Service Program Building Code of Australia Water for a Healthy Country Flagship Floodplain Management in Australia: best practice principles and guidelines (SCARM) National Climate Change Adaptation Framework (agreed by COAG in 2007) Climate Change Adaptation Program Australian Rainfall and Runoff Revision Project (Engineers Australia, funded by DCCEE)	Bureau of Meteorology Australian Building Codes Board CSIRO Department of Climate Change and Energy Efficiency (DCCEE) National Climate Change Research Facility

Government Level	Responsibility	Legislative/ Policy/ Coordination Mechanisms	Responsible government authority/institution
State/ Territory ⁵	Enactment of planning and development legislation and development of planning policies and instruments Development approval for some projects of state significance (e.g. regional development projects) Coordination and funding of regional or catchment based approaches Provision of expertise and resources to local governments to enable them to meet legal obligations and policy objectives	<i>Catchment and Land Protection Act 1994 (Vic)</i> <i>Water Act 1989 (Vic)</i> <i>Planning and Environment Act 1987 (Vic)</i> Victoria Planning Provisions <i>Coastal Management Act 1995 (Vic)</i> <i>Building Act 1993 (Vic)</i> <i>Victoria Building Regulations 1994</i> <i>Local Government Act 1989 (Vic)</i> <i>Emergency Management Act 1986 (Vic)</i> Climate Change White Paper (Vic) Emergency Management Manual Victoria Victoria Flood Management Strategy Victorian River Health Strategy Victoria Flood Database <i>Water Act 2000 (Qld)</i> <i>Coastal Protection and Management Act 1995 (Qld)</i> <i>Building Act 1975 (Qld)</i> <i>Sustainable Planning Act 2009 (Qld)</i> Queensland Planning Provisions State Planning Policy 1/03 (Qld) Queensland Development Code ‘Satellite’ planning legislation (various) <i>Building Regulation 2006 (Qld)</i> <i>Local Government Act 2009 (Qld)</i> <i>Disaster Management Act 2003 (Qld)</i> Climate Change Adaptation for Queensland: issues paper Planning for Stronger, More Resilient Floodplains (Qld) Resilience and Rebuilding Guidelines (Qld, various) Queensland Coastal Plan	Catchment Management Authorities (Vic) Natural Resource Management bodies (Qld) Department of Sustainability and Environment (Vic) Department of Planning and Community Development (Vic) Department of Primary Industries (Vic) Department of Community Safety (Qld) Department of Housing and Public Works (Qld) Department of State Development, Infrastructure and Planning (Qld) Department of Local Government (Qld) Queensland Reconstruction Authority Department of Environment and Heritage Protection (Qld) Department of Natural Resources and Mines (Qld) Queensland Climate Change Centre of Excellence Victorian Centre for Climate Change Adaptation Research

⁵ For state government mechanisms, Victoria and Queensland are provided as examples

Government Level	Responsibility	Legislative/ Policy/ Coordination Mechanisms	Responsible government authority/institution
			Emergency Management bodies (various)
Local	Undertaking flood studies (NB, in Victoria this is a CMA responsibility) Development of planning schemes that align with state legislation and policy to enable appropriate land use and development controls Development application decision-making Emergency management responsibilities at all stages of PPRR	Planning schemes and policies State and Federal Local Government Associations Coastal Councils Adaptation Taskforce (Qld) Regional Organisations of Councils Other local government alliances, for example, the South East Councils Climate Change Alliance Incorporated (Vic) and Sydney Coastal Councils Group (NSW)	Local Councils

5. RESULTS OF FLOOD INSTITUTIONS ANALYSIS

5.1 *Intergovernmental Function*

Disaster management is subject to many intergovernmental agreements and institutional arrangements. In recent times, the focus has been on resilience, a broad term that covers all aspects of disaster management,⁶ and that can be applied to communities, management systems and infrastructure. This moves away from 'mitigation', which became the focus following the 2002 report to COAG on "Natural Disaster Management in Australia: reforming mitigation, relief and recovery arrangements" (DOTARS, 2004).

5.1.1 *National Strategy for Disaster Resilience*

Currently, the most influential intergovernmental mechanism for emergency management is the National Strategy for Disaster Resilience (NSDR), formally adopted by COAG in February 2011. The NSDR attempts to drive a cooperative, national approach to natural disaster management, using 'resilience' as its motivational power, and emphasising shared responsibility for emergency management between governments, communities, businesses and individuals. The aim is to develop partnerships, understanding of risks and long term behavioural change. More practically, the strategy provides seven key actions, each with a number of priority outcomes. The strategy is broad in scope, covering leadership, risk assessment, empowerment, awareness, partnerships, prevention and response capacity. Future drivers such as climate change and development pressure are provided as the rationale for developing the strategy (COAG, 2011).

The Standing Council on Police and Emergency Management (SCPEM), a high level body that reports direct to COAG, has been assigned responsibility for implementing the NSDR (EMA, 2012). The SCPEM is serviced by the Attorney-General's Department and supported by a number of other committees and bodies. To address issues associated with flooding, the National Flood Risk Advisory Group (NFRAG) reports to Australia-New Zealand Emergency Management Committee (ANZEMC), which reports to the SCPEM and thus to COAG (see Table 1).

The SCPEM (and its predecessors or committees) have been responsible for producing many other key documents to guide intergovernmental natural disaster arrangements. These include the National Disaster Resilience Framework, the Australian Emergency Management Arrangements and the Climate Change Adaptation Program. These documents complement each other and should be considered together rather than in isolation.

A number of intergovernmental funding agreements and arrangements are also in place, including the Partnership Agreement on Natural Disaster Resilience and the Natural Disaster Relief and Recovery Arrangements (both discussed in the Funding Mechanisms section). Mechanisms that are more response-oriented, such as the National Catastrophic Natural Disaster Plan, are not the focus of this paper.

⁶ In Schedule A of the National Partnership Agreement on Natural Disaster Resilience (2009), resilience is defined as "the capacity to prevent/mitigate, prepare for, respond to and recover from the impacts of disasters".

5.1.2 Australian Emergency Management Arrangements (AEMA)

Under Australia's constitution, responsibility for emergency management rests with State / Territory governments. However the AEMA makes it clear that this is carried out in partnership with other government levels and community sectors. The arrangements are not limited to natural hazards. The AEMA clarifies the roles and responsibilities of different levels of government, the community and specific sectors, such as insurance, development planning and construction industries, infrastructure providers and the media. The Arrangements specify activities that are expected to be undertaken at all stages of prevention, preparedness, response and recovery. The AEMA does not cover climate change as it focuses on responsibilities rather than strategies (Australian Government, 2009).

5.1.3 The National Disaster Resilience Framework

The National Disaster Resilience Framework appears in some respects to be a precursor of the NSDR and the framework was endorsed by MCPPEM-EM in November 2009, the month before COAG resolved that a national strategy needed to be developed. The framework specifically includes climate change and other future risks as a rationale and covers the whole range of PPRR, integrated nationally across sectors (MCPPEM-EM, 2009^a).

5.1.4 Climate Change Adaptation Action Plan

At the same November 2009 meeting, the Council endorsed a Climate Change Adaptation Action Plan (MCPPEM-EM, 2009^b). This highlighted the need for adaptation to minimise projected impacts of climate change for the emergency management sector. It includes nine key strategies that aim to achieve a national, integrated approach; improved incorporation of climate change information into emergency management; and integration of climate change into settlement, land use planning and development decisions at the local level. To date, not many of these strategies appear to have been implemented. For example, the only reference to the proposed strategy #1, "National Statement on Climate Change Adaptation and Emergency Management" appears to be in the Climate Change Adaptation Action Plan. The proposed strategy #9 "National Guide to Climate Change and Emergency Management in Land Use Planning" is presented as a single webpage on the Australian Emergency Management Institute website that contains eight dot points of links that "lead to information on the impacts of climate change and current guidelines on accounting for these impacts in land use planning policies". Of these eight links, four do not work and some provide only the homepage of relevant organisations. When accessed (22nd October 2012), the page recorded that it had last been updated on 17th October 2011 (AEMI, 2012a). The Climate Change Adaptation Action Plan thus appears highly relevant at first glance but implementation is patchy.

5.1.5 Enhancing Disaster Resilience in the Built Environment Roadmap

The SCPEM is currently developing the 'Enhancing Disaster Resilience in the Built Environment Roadmap', a collaborative attempt across jurisdictions to improve land use planning and building regulation in the context of emergency management. Should this be endorsed it will be notable for being one of the rare high level intergovernmental agreements

to tackle this aspect of disaster prevention. Little can be said about the Roadmap as at the time of writing it had not yet been made publically available. However, it is expected to cover integrated legislation, process enhancement, comprehensive data and mapping, collaborative vendor disclosure, governance partnerships, inter-jurisdictional collaboration and lifelong education and training on natural hazard management (AEMI, 2012b:7-8).

5.1.6 The National Climate Change Adaptation Framework

The federal government's climate change strategy is built on 3 'pillars', including mitigation (reduction of emissions), adaptation (to climate change that cannot be avoided) and contribution to the collective global response (DCC, 2010). The National Climate Change Adaptation Framework was agreed to by COAG in 2007 and it covers natural disaster management (COAG, 2007). The Framework's key strategies in the context of emergency management include the need to improve knowledge of the nature and extent of changes to hazards such as flooding and the incorporation of this knowledge into planning for natural disaster management through programs such as the (then) Natural Disaster Mitigation Program. It also recommends awareness raising among communities and response agencies about the impacts of climate change. Through a national partnership agreement, the Natural Disaster Resilience Program appears to be working towards these objectives by funding risk assessments and community resilience (see funding mechanisms section). It is not clear to what degree preventative measures are likely to be put into place as a consequence of these assessments or how effective awareness raising activities are in achieving long term increased community responsibility or behavioural change.

'Settlements, infrastructure and planning' is another highly relevant strategy in the Framework. In its list of actions it includes, "revision of planning systems including revision and development of codes, standards and guides to increase resilience to climate change". Initiatives that address development planning, as exemplified in this framework, often appear in parallel with emergency management rather than being integrated into them. This is not necessarily an issue if outcomes are achieved but it could have the effect of reducing the emphasis on disaster prevention in intergovernmental mechanisms such as the National Partnership Agreement on Natural Disaster Resilience (see funding mechanisms).

5.1.7 The Australian Building Code Board

The Australian Building Code Board (ABCB) is a joint initiative of all three levels of government in Australia, with the Board's website describing it as "a regulatory reform vehicle for COAG". It was established by an inter-governmental agreement in 1994, which was renewed in April 2012 (ABCB, 2012a). The Board develops (minimum) national standards for building and plumbing, aiming to ensure (in order of priority), safety, health, amenity and sustainability. At the time of the 2010-11 floods, these did not include standards that addressed flooding (Comrie, 2011:193); (QFCI, 2012:212). Apart from the ABCB's National Construction Code, the federal government's involvement in facilitating improved land use and development planning to minimise damage from natural disasters is relatively recent, justified by an anticipated increase in exposure to natural hazards and corresponding escalating costs of recovery. Building codes will be covered in more detail in later sections of this paper.

There are thus a number of different intergovernmental mechanisms applicable to flooding and adaptation to climate change. They are comprehensive in that they seek to address knowledge gaps about climate change related flooding, and to integrate this knowledge into planning, professional training and awareness raising. Measures known to reduce exposure to flooding, such as improved development planning, are receiving high level attention. Whether or not these mechanisms will translate to improved management on the ground, it remains to be seen. Discussion in other sections of this paper suggests that to ensure success, many barriers would need to be overcome, including the non-mandatory nature of many current provisions relating to flooding, disincentives such as badly targeted flood relief, conflicting development policy objectives, planning tools that are inadequate to address future risks and inadequate resourcing.

5.2 Intra-Governmental Function

Intra-governmental mechanisms for flooding operate at all levels. These collaborations are important in ensuring a whole of government approach and are often very efficient in terms of making use of skills and resources from other agencies, pooling financial resources, and providing a focus for common concerns that might otherwise be overlooked due to competing priorities (this seems particularly relevant for the local government example, below). However, to be effective, they require policy leadership to ensure all agencies involved are working together, rather than working to conflicting agendas. This section provides an illustrative example of intra-government interactions for each level of government.

5.2.1 Implementation of the NSDR

The NSDR is a focus for much intra-governmental activity on flooding at the federal level. As an example, the Bureau of Meteorology, Geoscience Australia and Emergency Management Australia are all involved in implementing the National Flood Risk Information Project (NFRIP), which contributes to the NSDR by improving the quality and availability of flood risk information. Geoscience Australia leads the technical and implementation aspects of the project and has developed a database of flood studies as well as national guidelines for flood risk information. The Attorney-General's Department (housing Emergency Management Australia) has the policy lead, while the Bureau of Meteorology also contributes information to flood studies and provides historical data. This collaborative approach appears to make good use of different agency strengths (Geoscience Australia, 2012).

5.2.2 Applying flood controls at the State Government level

The management of flood prevention can involve interactions between multiple state departments. Administered by the Department of Community Safety (DCS), State Planning Policy 1/03 (SPP 1/03) is the most important state planning instrument for considering flood risk in Queensland. However, DCS is not the only department involved in the application of the policy, and the assessment of local planning schemes has not favoured the inclusion of flood provisions.

Queensland's planning schemes are subject to review by a number of state agencies before a decision is made by the Minister for Local Government and Planning about whether to approve them. Investigation into these review processes by the Queensland Floods Commission of Inquiry found interactions between these agencies to be dysfunctional (QFCI, 2012). The Department of Environment and Resource Management (DERM)⁷ is responsible for advising DCS, on request, about the adequacy of any proposed planning scheme. It advises on a scheme's compliance with SPP 1/03, its flood map and on the proposed 'defined flood event' (if an event of greater frequency than a 1:100 year event is proposed). However, the DCS did not routinely seek this advice, even in the case of Brisbane's planning scheme which failed to identify a defined flood event. Recommendations by DCS to ensure compliance with SPP 1/03 for significant flood prone areas such as Brisbane and Emerald

⁷ Note that since the inquiry report was published, Queensland state government departments have been restructured.

appear to have been routinely disregarded by the Department of Local Government and Planning (DLGP), resulting in non-compliant planning schemes. Issues raised by the DCS about a number of planning schemes included lack of or insufficient flood mapping and failure to nominate a defined flood event. In the case of Brisbane's planning scheme, the DCS reiterated its concerns about non-compliance on 16 occasions, 12 of these after the 2010/11 floods. The reasons why DLGP rejected DCS recommendations could not be explored by the Inquiry due to lack of documentation. The QFCI report also noted that prior to the Inquiry, the DCS had not realised the extent to which its advice had been disregarded. This raised serious questions about administrative procedures and accountability measures.

The SIRP report identified *conflicting policy objectives* as contributing to difficulties in applying flood controls. This is likely to be a root cause in the failure of the Queensland approvals process. Some key, interrelated policy conflicts include:

- affordable housing objectives *versus* safety through reduced exposure to floods
- short term economic gains from development *versus* long term cost of exposure to flooding
- population pressure that pushes development into unsuitable areas
- high cost of developing flood free land beyond existing townships
- environmental objectives (e.g. to reduce the urban footprint via infill) which reduces the availability and affordability of flood-free land within urban areas

Portfolios responsible for conflicting objectives in the context of flood risk include community safety, emergency management, development planning, climate change and environment and natural resource management. Adaptation to increased flood risk needs a consistent, whole-of-government approach if it is to be successful.

Many of the policy conflicts identified are directly or indirectly related to upfront development costs and housing affordability. Climate change studies suggest that future flooding risks to disadvantaged groups "would increase by factors of three to 20 – significant sections of the population could be blighted" (Galloway, 2009). The provision of cheap (but risky) residential sites to disadvantaged groups who can't afford to buy premium, flood-free land only increases their long term vulnerability to climate change.

State and local governments have the responsibility for providing affordable housing, and yet it is the federal government that provides the majority of relief and recovery funding. Unless the financial liabilities for bad development decisions rest with those making them, there will be little incentive to change.

If governments determine that affordable housing is needed, they need to weigh up the most cost effective and appropriate ways of achieving this. Subsidising the long-term costs of affordable housing through increased expenditure on disaster relief and recovery may not prove to be the most cost effective solution. It is not consistent with the 'community resilience' approach. Neither is it a just solution in terms of the psychological impacts people will be exposed to.

5.2.3 Local Government Alliances

At the local level, local government alliances have formed in some states that aim to address regional climate change impacts. Initially funded by the Victorian Government, almost the entire state of Victoria is covered by ten such alliances (NAGA and SECCCA, 2012). Similar alliances are also found in NSW.

As an example, Sydney Coastal Councils Group is a Regional Organisation of Councils (ROC) comprising fifteen local governments⁸. Its stated aim is “to promote cooperation between, and coordination of actions by Member Councils on issues of regional significance concerning the sustainable management of the urban coastal environment,” and one of the outcomes it is working to achieve is the sustainable and integrated planning and management of natural and built coastal and estuarine assets (SCCG, 2012a). Information is exchanged between councils at regular fora, workshops, through newsletters and reports. The group is also involved in advocacy, making submissions on policy issues relating to planning and climate change adaptation. These include recent submissions to the State government regarding the *Coastal Protection Amendment Bill 2012* and an anticipated submission to the NSW Government Planning Review Green Paper. Partly due to the SCCG’s position, regressive reforms contained in the Amendment Bill, such as removal of the need for councils to use state-wide sea level rise projections, have been postponed pending further consultation. The SCCG also carries out many climate adaptation projects in partnership with research institutions, such as its Mapping and Responding to Inundation project with CSIRO (SCCG, 2012^b).

Combining forces is not only cost-effective but also gives greater ability to leverage funding. The SCCG example demonstrates that local government alliances can be effective ‘bottom up’ mechanisms that allow local governments to increase their collective knowledge and power, and address climate change impacts such as flooding.

⁸ Note that not all ROCs have climate change, flooding or catchment management as an objective. Some are more focused on regional economic development or other shared goals.

5.3 Regulation By Prescription

Development planning is a key measure for flood prevention. If construction in flood prone areas can be prevented, then the costly damage and social trauma associated with floods can be completely avoided. However, prevention of development in flood prone areas has proved difficult to achieve because floodplain land is attractive for settlement, being highly fertile with easy access to water. Minimising flood impacts through controlling development can be achieved through legislation, construction standards and through planning (the latter will be covered in the following section). Queensland and Victoria, the two states most affected by the 2010-11 floods, will be used as examples of legislative and planning measures currently in place and some of the issues that need to be addressed to enable them to adequately mitigate flood risks.

5.3.1 Inclusion of Climate Change in State Planning Legislation

State legislation relating to land-use planning generally does not contain any requirement to take climate change into account. Some states have legislation specific to climate change or coastal management and this can include a requirement for decision makers, including planners, to consider climate change, particularly increased flood risk due to sea level rise. There appears to be less consideration of inland flooding due to changes in rainfall patterns. An exception to this is the Queensland Inland Flood Review which recommends the use of a climate change factor for incorporation into flood studies⁹ (Queensland Government, 2010). The Queensland Reconstruction Authority includes the factor in its model terms of reference for flood investigations, for state-wide application (QRA, 2012b:44). According to a recent review by the Productivity Commission, planning regulations that accommodate climate change adaptation need to facilitate a risk management approach, and incorporate community risk tolerance, rigorous consultation processes and full cost benefit analysis of land use. A key component of the risk management approach is for development approvals to be time-limited or trigger-bound to enable land to be used in the short term until new adaptation approaches are needed (Productivity Commission, 2012:139-143).

5.3.2 Non-Mandatory Provisions

The Queensland government administers development planning through the *Sustainable Planning Act 2009 (Qld)* (SPA). The Act allows for the development of the Queensland Planning Provisions, which set out a standard structure for planning schemes and drafting instructions. These Provisions include standard zones and overlays and assessment criteria. In terms of flooding, the Provisions include a standard overlay for flood hazard in the 'development constraints' category. However, the use of the overlay in planning schemes is optional, even where flood mapping information is available (QFCI, 2012:106-108).

⁹ The review suggests a climate change factor of 5 per cent per degree of global warming be applied to rainfall depths and that local governments use the following projections in their flood studies, pending update of the Australian Rainfall and Runoff handbook: 2°C by 2050, 3°C by 2070, 4°C by 2100.

Mandatory provisions have conditional application

The Queensland SPA enables the development of State Planning Policies, with which local government planning schemes in Queensland are required to comply. Provisions relating to flood risk are made through State Planning Policy 1/03 (SPP 1/03), administered by the QLD Department of Community Safety (DCS). This policy is the most important state planning instrument for ensuring consideration of flood risk. In practice, there are significant problems with applying SPP 1/03. One problem is that SPP 1/03 cannot be applied to local planning schemes unless they *both* adopt a 'defined flood event' (identify a historical flood, ideally close to a 1 in 100 year event) *and* have a flood map. Councils that don't include these in their planning schemes can essentially opt out of applying SPP 1/03 to their planning schemes (QFCI, 2012:97; 118). In Victoria, the application of the Victoria Planning Provisions that relate to flooding (including standard zones and overlays) only apply if flood mapping has been carried out (Comrie, 2011:192-194).

5.3.3 Exemptions to standard provisions

Application of planning legislation and instruments to address flood can be significantly compromised by exemptions. The QLD Floods Commission of Inquiry examined many examples where development is exempt from applying SPP 1/03.¹⁰ 'Development commitment' such as 'material change of use that is code assessable' and development where there is overriding need in the public interest are exempt. Mining and agricultural activities are not assessable development under the SPA. Activities involving hazardous materials are governed by the *Environment Protection Act 1994 (QLD)* and are assessed according to 'standard criteria' which make no specific reference to flooding (SPP 1/03 only comes into play when hazardous materials are manufactured or stored 'in bulk'). Placement of fill on floodplains to raise soil level to build on can be exempt under certain circumstances, as is placement of fill for infrastructure construction by authorised public sector entities. Some aspects of the electricity supply network are 'exempt development' and in some planning schemes minor levees can be exempt.

Some types of community infrastructure (unless identified in the SPP 1/03 list) are 'exempt development'. Community infrastructure not covered by SPP 1/03 includes childcare, aged care, schools and electricity works, among others. SPP 1/03 requires community infrastructure to function effectively during and after a flood of a specified flood risk level. This is generally set between the 1:200 year and 1:500 year event flood level. However, for categories of community infrastructure not included in the SPP 1/03 definition, these standards do not apply.

As an illustration of problems with exempt community infrastructure development, the Inquiry offers the case of a Goodna childcare facility. Catering for 115 children, it was built on a site that was flooded in 1974, adjacent to an overland flow path and near the 1 in 20 year event flood line. The centre was inundated to a depth of 1.8m and had to be evacuated for 45 days. A Yeronga aged care facility was similarly affected. Built in a waterway corridor, evacuation routes were submerged and the site was submerged to a depth of 1 metre. Some residents were unable to return for two months (QFCI, 2012:150, 174, 201).

¹⁰ QFCI 2012. Exemptions referred to in this section are found on pp 91, 98, 108, 149, 153, 156, 166, 169, 175, 190-3, 197, 242-4.

Most development in Queensland is administered through the *Sustainable Planning Act 2009 (Qld)*. However, there are some other planning systems that operate under different legislation. These satellite planning schemes provide for development such as affordable housing (the aim being to expedite approval of development applications); legislation governing the development of a specified riverside area of Brisbane; State development areas (which can include developments such as hospitals, infrastructure and essential services); and significant projects (including high value mining projects). As satellite planning systems are not subject to the SPA, they are not required to comply with SPP 1/03 (QFCI, 2012:138-143).

5.3.4 The Federal Government Role

Under constitutional arrangements, the federal government has little ability to legislate on planning issues but it has adopted a leadership and coordination role through intergovernmental agreements.

Overseas experience suggests it could be possible for the federal government to expand its influence should it wish to do so. The USA, a country where federal government involvement in land management is similarly restricted, has implemented legislative measures that encourage improved land use and development controls. The USA's *Flood Disaster Protection Act 1973* prohibits federal agencies from providing communities with assistance in floodplain acquisition or construction unless communities participate in the National Flood Insurance Program. This program (as well as requiring mandatory insurance), imposes minimum land use and control requirements for new construction in flood prone areas. The Act's provisions also apply to "financial institutions regulated or insured by the federal government, thereby covering virtually all types of financial assistance" (Wright, 2000:34-5). While national flood insurance is unlikely to be an approach suitable for Australia,¹¹ it demonstrates that there are possibilities for the federal government to apply legislative incentives to reduce future disaster relief and recovery bills.

The federal government has itself been at fault in not applying adequate flood controls. The SIRP report provides examples of development of flood prone areas that were funded through the Commonwealth government's economic stimulus package. At a minimum, the Commonwealth needs to ensure its own development projects are subject to adequate assessment and controls.

5.3.5 Building Codes and Standards

While it is preferable to avoid siting development in areas of flood risk, this is not always possible to achieve (QFCI, 2012:223, 245). Improved materials and design can be used to improve flood resilience and can significantly reduce damages and enable rapid clean up and recovery. This is a useful adaptation measure for climate change, as it can mitigate more frequent small flooding as well as extreme flood events. Prescriptive building requirements are generally easier to apply to new development, but they can also be applied to rebuilds, as in the case of North Wagga (Wagga Wagga City Council, 2010).

¹¹ Wright notes that in the USA, flood insurance represents the largest potential demand on the Federal Treasury after social security (p.41).

National building standards are set through the Building Code of Australia. These are minimum standards only and states may enact more rigorous standards. Currently there are no national standards for building in flood-prone areas, though the Australian Building Codes Board is in the process of developing a standard for residential development (Comrie, 2011:193, QFCI, 2012:212).

The draft *Standard for Construction of Buildings in Flood Hazard Areas* contains the following definitions:

Defined flood event (DFE): the flood event selected for the management of flood hazard for the location of specific development as determined by the *authority having jurisdiction*.

Defined flood level (DFL): the flood level associated with a *defined flood event (DFE)* relative to a specified datum. The *DFL* plus the *freeboard* determines the extent of the *flood hazard area*.

Flood hazard level (FHL): the flood level used to determine the height of floors in a building and represents the *defined flood level (DFL)* plus the *freeboard*.

Freeboard: the height above the *defined flood level (DFL)* as determined by the *authority having jurisdiction*, typically used to compensate for effects such as wave action and localised hydraulic behaviour.

(ABCB, 2012b:11-12)

These definitions are based on historic flood levels and do not incorporate possible future flooding scenarios due to climate change or land use change. Indeed, the draft standard makes no reference to climate change.

The Australian Building Codes Board has also produced a draft *Information Handbook* to accompany the Standard. Reference to climate change is contained in the Handbook's background. It explains its effect on flooding, flood water velocity, depth, and the need to consider this when selecting a Floor Height Level. However, the purpose of the document is only advisory: "this Handbook is not mandatory or regulatory in nature. Rather, it is designed to accompany the ABCB Standard for Construction of Buildings in Flood Hazard Areas and to assist in making information on this topic readily available" (ABCB, 2012c:ii; 3). If the Handbook does no more than provide information it is questionable whether it will have much influence on ensuring climate change is incorporated into key local planning tools. This is disappointing given the rhetoric surrounding the need to improve building codes.

Building construction in Victoria is regulated by the *Building Act 1993 (Vic)* and Building Regulations 2006 (Vic), of which one, regulation 802, relates to flood. However, the only design aspect that can be specified through this regulation is floor height. The regulation does not include flood resilient materials or other design features (Comrie, 2011:193). Some Victorian legislation specifically relates to controlling increased urban run-off due to subdivision. It is thus an important instrument for controlling aspects such as amount and velocity of stormwater, aspects that have a big impact on infrastructure. These provisions are contained in Clause 56.07-4 of the Victoria Planning Provisions, which were amended in 2006. There have been issues regarding compliance with the Clause 56 and it is currently being reviewed (Hussey, *pers. comm.*).

Queensland's state building standards are regulated by the *Queensland Development Code* and *Building Regulation 2006 (Qld)*. The Code does not include regulation of building

construction in areas at risk of flooding. The government is drafting a new mandatory part to the code, Part 3.5 'Construction of Buildings in Flood Hazard Areas', based on the new draft national standard. This would cover design, but not water resistant materials. The latter may form a non-mandatory provision (QFCI, 2012:211-213).

As per development planning legislation, building codes only apply if flood hazard areas have been designated, although Victoria has better provisions than Queensland in that the local planning scheme is not the only mechanism by which flood-prone land can be identified (Comrie, 2011:193, 196); (QFCI, 2012:213).

5.3.6 Catchment Management Authorities and the Development Approval Process

The Comrie Review investigated development approval processes in Victoria. Under the *Planning and Environment Act 1987 (Vic)*, planning permits in that state have to be referred to the relevant Catchment Management Authority (CMA) if the land is in a flood zone or overlay (flood information and mapping is thus a prerequisite to mandatory referral, though advice may also be sought without it). CMAs have the power to refuse development or impose conditions on development to make it more flood resistant. The assignment of this role to CMAs is appropriate as they have technical expertise in flood management and a long term understanding of flood risk implications. Their value in providing a long term perspective is particularly relevant to adapting to future flood scenarios. The review also points out that, unlike councils, CMAs are not subject to competing pressures from interest groups and short term economic gains such as rates increases.

Current state policy in Victoria aims to remove this power from CMAs, not only removing their power to refuse development, but also removing their ability to impose conditions. Any advice they provide will become non-binding. The review finds this will 'inevitably lead to poor flood planning outcomes' and recommends that CMAs retain their powers (Comrie, 2011:192, 197). The Victorian Government is not planning to make a formal response to the report, however of the 93 recommendations, three have not been accepted. One of those not accepted was the recommendation that CMAs retain their current powers. This has been confirmed by the Victorian Minister for Police and Emergency Services (Ryan, 2012) and is also alluded to in Victoria's ENRC Inquiry (Parliament of Victoria, 2012:21-2).

5.3.7 Conclusion

Development planning was identified in the SIRP report as being one of the most important adaptation measures to address climate change flooding. However, evidence from recent flood inquiry reports suggests that provisions in some states are inadequate to accommodate even existing risks of flood. The flood reviews reveal numerous issues with planning and development legislation in Australia which result in *ad hoc* consideration of flood risk and implementation of mitigation measures. Much of the lack in consistency in the way legislation deals with flood risk is likely to reflect conflicting policy objectives, as discussed in the intra-governmental section above. Many of the legislative exemptions appear to increase the vulnerability of groups that are already vulnerable and compromise the resilience of essential infrastructure.

While State legislation and instruments already exist, they need to be amended to ensure more consistent consideration of flood in the development process. The application of legislation can also be improved through ensuring adequate flood information, improved administrative processes and clear and appropriate responsibilities and accountabilities.

The use of Catchment Management Authorities in the development approval process provides one of Australia's best models for ensuring a more comprehensive approach to development planning, incorporating flood risks and extending beyond narrow administrative and temporal boundaries. It is of concern that this is currently under threat. These issues compromise adaptation to flooding, regardless of any increase in risk that comes with climate change.

5.4 Planning Processes

5.4.1 The Adequacy of Planning Tools to Accommodate Climate Change

Adoption of a Defined Flood Event (DFE) or Flood Level is a key planning tool in both Queensland and Victoria. According to the Queensland Inquiry, state planning instrument SPP 1/03 which addresses flood risk cannot be applied unless planning schemes adopt a DFE. Generally a 1:100 year event is selected, with an additional freeboard of between 300 and 500 millimetres (QFCI, 2012:63, 147); (Comrie, 2011:193). The 1:100 year level is not a compulsory requirement in Queensland but is included in Victoria's *Water Act 1989 (VIC)* as a minimum default that applies to Catchment Management Authorities. The defined flood event is based on an historic flood and it is used to determine the level of flood hazard for a location and any development controls that need to be applied to mitigate risk. For example, it can be used to prevent incompatible development from being sited in an area of flood risk or it can apply controls such as the height of habitable floor levels.

Analysis in the SIRP report found significant barriers to incorporating up-dated information into planning schemes in both Victoria and Queensland, including a ten-year interval before some planning instruments become due for revision, the complexity of approval processes, cost, compensation liabilities and competing pressures. These can all prevent timely incorporation of flood data, including climate change information, into planning schemes. According to a recent report by the Productivity Commission, climate change risks are not consistently managed in land-use planning schemes, with local governments hampered by a lack of guidance from state governments and financial and expertise constraints (Productivity Commission, 2012:151).

Recent studies suggest that the use of the 1:100 year event standard for flood control may be inadequate, particularly in countries with a short term flood records like Australia. As flood frequency is calculated on past flood events, any subsequent severe flood adds to data and can lead to recalculations. Inaccuracies can also occur as a result of out of date techniques and assumptions. Whether due to inaccurate data, climate change or urbanisation, the 1:100 flood line is not static but can move. This can place people at unacceptable risk of flooding (Wenger et al., 2012).

Studies in the US indicate that twenty per cent of repetitive flood losses occur outside the designated 100-year floodplain, suggesting the accuracy of flood mapping is a significant problem (NWF, 1998:58). In Australia there are also indications that the 1:100 year event can be inaccurate.

Uncertainties regarding Brisbane's 1:100 year flood line were identified in the QFCI, with past estimates ranging from 3.16 m to 5.34 m at the city gauge (QFCI, 2012:48-51);(QFCI, 2011:20, 38). In another example, a 2004 flood study of Wagga Wagga determined that the 1974 flood in that city, which had previously been considered a 1:90 year event, was actually a 1:60 year event (Askew, 2009).

Data accuracy, assumptions and collection techniques aside, future changes such as development and climate change are expected to alter catchment hydrological conditions; what was once a 1:100 year event may become a more frequent occurrence. A study by Melbourne Water on the impacts of climate change on flooding found that rainfall intensity

over five urban catchments in Melbourne was likely to increase and that the interval between large scale events would decrease. Using existing tools and models, they found a 30% increase in rainfall intensities was likely by 2030, at which point there would be a period of pseudo-stationarity till 2070.

While results varied from catchment to catchment typical results from this analysis indicated the 2070 1 in 5 year design ARI event was equivalent to the present 1 in 10 year ARI event and the 2070 1 in 100 year ARI event was equivalent to the 1 in 300 year ARI event.

(Pedruco and Watkinson, 2010)

The impact of development on flood frequency has also been studied. In a US example, development caused a seven-year event to become an annual one, and what was once a 1:100 year event now occurs 1 in every 25 years (Freitag et al., 2009:44-5).

Overseas reviews suggest that planning tools based on the 1:100 year event are inadequate to deal with existing and future threats. The USA, which pioneered the use of the 1:100 year standard to administer its National Flood Insurance Program, has been debating a move to the 1:500 year event. This is more in line with safety standards for other hazards and is particularly suitable for urban areas where rapid evacuation is harder to achieve. While the 1:500 year flood event is just as arbitrary as the 1:100 year standard, it provides a greater margin of error of use for adapting to future uncertainties such as climate change and continuing development (Wenger et al., 2012).

Flood risk is not only determined by flood area, but also by velocity and depth. A blanket standard should not be selected simply because it is administratively easy to apply. A 1:100 year flood may be relatively shallow and the difference between it and a 1:500 year flood only a matter of centimetres. If the terrain is flat, a flood may be weeks in coming, giving ample warning time to move valuables and prepare. In steeper, more confined catchments, a 1:100 event may be deep and occur with little warning. According to the Bureau of Transport and Regional Economics, the difference between a 100-year flood level and the probable maximum flood can be measured in centimetres for most NSW floodplains (BTRE, 2002). Thus, adapting to higher flood frequencies may only require minimal adjustments - for example, of floor height requirements - in many areas of Australia.

Recent Australian flood reviews reinforce a need to move away from a single defined flood level for development planning. The Brisbane Flood Review endorses a Flood Taskforce recommendation that flooding up to the most extreme event should be considered. It supports a risk management approach in line with the National Flood Risk Advisory Group (NFRAG) guidelines (Arnison et al., 2011:57). The QFCI similarly finds the focus on a single defined flood event is insufficient:

Restricting development within the extent of the [1:100 year] flood will manage a portion of the risk, but it does not deal with the risk of floods that are less frequent, but more severe, or those that will occur more often, but with less damaging consequences. Instead, the various areas to which planning controls apply should be selected having regard to the likelihood, behaviour and consequences of the full range of possible floods, up to and including the probable maximum flood."

(QFCI, 2012:63)

However, it is concerning that neither the QFCI, the Comrie, nor the Brisbane flood reviews discuss the fact that weather patterns under climate change are unlikely to remain stationary, and that likelihood values may change. A particularly notable omission is in the QFCI discussion on flood mapping, even though the issue is well-recognised by water resource management professionals.

The QFCI found that residential housing needed to be located in low hazard areas as this use was most vulnerable to flood in terms of loss of life, injury and property damage. However, at one point, the QLD Inquiry contemplates accepting lower habitable floor levels for residential areas, for example, at the 1:50 year flood level, depending on the community's willingness to accept risk (QFCI, 2012:147-8). The question of *who bears the cost of that risk*, be it the communities themselves, insurance companies, charities, taxpayers or future generations, is not discussed by the Inquiry. A recent decision by Suncorp to not insure entire towns for flood risk unless mitigation measures are undertaken indicates that insurance companies, at least, are not willing to bear that cost (Jabour, 2012). Accepting lower floor levels seems maladaptive if lesser floods are expected to increase in frequency and if the number of large floods is expected to increase.

Despite the lack of integration of this issue into its report, the QFCI does include reference to climate change in some instances. Its expert panel recommended that climate change risks be included in a new Brisbane flood study. The Inquiry also received evidence from North Burnett Regional Council about a commissioned flood study aiming to incorporate climate change into its flood risk management framework and into its DFE (QFCI, 2012:45, 130). Based on the North Burnett study, a climate change factor that addresses inland flooding is expected to be applied state-wide (QRA, 2012b:45).

A current review of SPP 1/03 is considering when it is appropriate to select a greater or less than 1:100 year flood as DFE. Matters that are being considered in the review include resilience to flooding in a changing climate. In this context, the review will be looking at whether there needs to be standardisation for determining a defined flood event and undertaking flood studies; when it is appropriate to use a defined flood event greater or less than the 1:100 year flood event standard for residential development; and how to improve the integration of land use planning and disaster management (QFCI, 2012:99). Thus there is potential for planning instruments dealing with flooding to be strengthened in line with current understanding of threats. However, the many issues surrounding the application of SPP 1/03 (as discussed in 'intra-governmental function' and 'regulation by prescription' sections) would also need to be addressed for it to be effective.

5.4.2 Ecosystem Approaches to Flood Management

The SIRP report identified floodwater velocity, or energy as a significant aspect of flooding which had little coverage in most reviews (though it was covered by Victoria's ENRC Inquiry). Velocity causes some of the most expensive damage, primarily to infrastructure such as roads, bridges and railways, but also in terms of erosion and loss of farmland, reduced water quality and long term reductions in storage capacity of dams due to siltation.

Improved land management can reduce these problems. In countries such as the Netherlands, China and the USA, 'Room for the River'¹² initiatives allow more land to flood through wetland restoration, relocation, levee removal or setback and flood-compatible land use. By giving water more room to spread, floods are shallower and water velocity is reduced. Often these changes are associated with multiple economic, social, environmental and health benefits. They rely strongly on integrated catchment management approaches that seek optimal outcomes across sectors and communities. Case studies for these countries are provided in the SIRP report.

Australian researchers interviewed for the SIRP report suggest that work needs to be done primarily in the upper catchment to impede water. Thus, rather than clearing and straightening water channels, vegetation actually needs to be encouraged to grow inside them and for water to spill over onto the floodplain. This is a completely revolutionary idea that strongly contrasts with current practices and community views (Wenger et al., 2013); (Parliament of Victoria, 2012:114-118). Upper catchments would be encouraged to flood and hold water temporarily in wetlands or detention basins and then gradually release it back into the system.

This approach has many benefits besides reducing damages. It would delay flooding downstream, and thus increase warning times and potentially reduce damages and casualties from flash flooding. It would also reduce flood peaks, and crucially, decrease the power of floodwaters in the middle and lower catchments. Another benefit is that it could allow aquifer recharge, a significant benefit that could help address increasing severity of climate change drought. By contrast, channel straightening, vegetation removal and floodplain levees to protect rural land can be counter-productive in that they increase velocity and transfer flood problems downstream or across to neighbouring properties.

As the most productive farmland tends to be located in the middle catchments, little can be done there to reduce the power of the flow. Suitable interventions in middle catchments could include bank stabilisation with riparian vegetation. By contrast, land in upper catchments is generally of lower value and there is scope to ensure compatible dryland grazing uses.

A business case that applies ecosystem approaches to sediment reduction in the Moreton Bay area was recently prepared by the Queensland Conservation Council in collaboration with university researchers as part of the Healthy Waterways Partnership. It found that 70% of the sediment is coming from 30% of the region, suggesting that it is possible to target activities to specific localities. This example also suggests that in the Australian context, ecosystem approaches would be cost effective in terms of water quality and supply, as well as having side benefits for fisheries and wildlife. The value of avoided flood damage costs was not included in this study (QCC, 2012).

Ecosystem approaches to flood mitigation are probably the least understood in Australia. Interviews conducted for the SIRP report found that, other than researchers and floodplain managers trained in natural resource management, flood professionals had only limited

¹² This strategy was developed by the Dutch as part of their Delta program following dangerously high water levels in 1993 and 1995.

understanding about ecosystem approaches and many reservations. A reason for lack of understanding about this approach could be the segregation between traditional flood management and natural resource management disciplines. However, ecosystem approaches are widely used overseas as a strategy to adapt to climate change related flooding. They can mitigate the impacts of flooding for existing as well as future development, and thus have a wider reach than development planning.

A further barrier for this approach is lack of community understanding about hydrology. Following the recent floods misperceptions about the causes of flooding resulted in significant activity clearing vegetation and debris from water channels. Such activities increase the efficiency of waterways, resulting in greater water velocity and flood impacts downstream. They are thus maladaptive. Modelling reported in the ENRC Inquiry found that vegetation had a minimal effect on local flooding. For example, at Creswick, clearance would have reduced the water level by 15cm without changing the number of houses that were flooded (Parliament of Victoria, 2012:113).

5.4.3 Achieving an Ecosystems Approach

One of the biggest challenges for implementing an ecosystem approach is that it requires flood studies, modelling, risk assessment, planning and implementation on a catchment scale, rather than on the individual town or locality scale, which is currently the norm. Local council responsibilities stop at their municipal boundaries and achieving a catchment approach to flood management is beyond the financial and skills capacity of most councils. Implementing catchment approaches needs to be led from a State level and must involve all players.

States vary widely in the administrative structures they have in place for whole of catchment management. Victoria has a great advantage in this regard as its historic Public Purpose Reserve system means that 25,000km of riparian land is owned by the Crown rather than privately owned. This greatly facilitates riparian management. Victoria has enacted a catchment approach through its *Catchment and Land Protection Act 1994 (Vic)* and *Water Act 1989 (Vic)*, which together establish ten Catchment Management Authorities and provide them with specific responsibilities and powers, along with resourcing direct through the State Government. These arrangements overcome the limitations of artificial administrative boundaries.

CMAs involve local stakeholders through Floodplain Management Advisory Committees. Their roles include overseeing floodplain management strategies, involvement in planning schemes, flood warning support, conservation of natural assets, managing flood infrastructure and provision of monitoring and advice (Parliament of Victoria, 2012:20-22). They currently have a strong role in the development approval process as 'designated referral authorities for local government in implementing statutory planning provisions and for proposed construction of infrastructure assets on floodplains' under the *Planning and Environment Act 1987* and the *Water Act 1989*.

CMAs would appear to be well placed to implement ecosystem approaches to flood control, and indeed have been doing so for many years through their management of riparian

vegetation. However they would need adequate resourcing if they were to undertake programs of similar scope and complexity to those overseas.

By contrast, Queensland's 14 catchment organisations are not public entities. Some are community based, not-for-profit organisations that rely on a variety of government and non-government sources for funding, such as South East Queensland Catchments Inc and Desert Channels Queensland Inc. Others, such as Reef Catchments Ltd operate on a business model and generate income through consultancies as well as accepting government grants. While they are 'regional' organisations they are structured around catchments (for example, South East Queensland Catchments encompasses 14 catchments). The websites of many of these bodies state that they were first established using federal funding, rather than by the State Government. For example, the Burnett Mary Regional Group for Natural Resource Management Ltd (BMRG) states that it was formed under the National Action Plan for Salinity and Water Quality and the Natural Heritage Trust programs (BMRG, 2012). A scan of these organisations' activities indicates that many of them are involved in climate change adaptation, for example, Desert Channels Queensland organised a Climate Change Adaptation Forum through its Landholder Support Service Project (DCQ, 2012).

A crucial difference between the Victorian system and the Queensland system is that in Victoria, catchment based management has been embedded in legislation, with defined roles, responsibilities and powers, while Queensland's NRM bodies are only in the position to facilitate improved land management.

When a catchment approach is enforced in Queensland, it requires intervention at the state level. Recently the Queensland state government implemented a Reef Protection Package "ReefWise Farming" aiming to protect the Great Barrier Reef and sea grass beds. Part of the rationale for the program is that climate change is expected to result in larger floods and longer droughts, leading to increased erosion and nutrient run-off. The package includes a new planning instrument that regulates land use, State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments, which came into effect in November 2011. It is designed to regulate earthworks by maintaining a buffer of 50-200m around wetlands in the Great Barrier Reef catchments. Protection does not extend to river channels, however, and the connectivity between rivers and wetlands is not addressed (QLD Government, 2011).

There are examples of robust catchment management mechanisms in Australia that are well placed to implement ecosystem approaches to flood management. However, catchment mechanisms in Queensland, the state most prone to severe flooding, lack authority and state government backing is confined to special instances. More needs to be done to enable a consistent whole of catchment approach to planning and land management in all states and territories of Australia. This would not only help to mitigate flooding but could lead to other benefits such as improved water quality, protection of natural assets, farmland and fisheries, resilience to drought, and enhancements for tourism, amenity and recreation.

5.5 Funding Function

5.5.1 National Partnership Agreement on Natural Disaster Resilience

The Natural Disaster Resilience Grants Scheme, administered under the National Partnership Agreement on Natural Disaster Resilience, is the primary funding mechanism that supports disaster prevention in Australia. While the Agreement pre-dates the National Strategy for Disaster Resilience, it is viewed as being a funding mechanism that supports it (AGD, 2011:122-3). The amount allocated by the federal government to this agreement is approximately \$100 million over four years (2009-10 to 2012-13), to be divided between all the States and Territories (COAG, 2009). Under the terms of the agreement, recipients are required to match Commonwealth funding and state/territory annual implementation plans indicate that matching funds are also commonly required from local government or other agency beneficiaries, thus providing leverage opportunities (e.g. see NSW Implementation Plan 2010/11). A survey of NSW projects approved since 2009 indicates that funding was awarded to local councils, state government agencies and organisations responsible for emergency response. Project descriptions are not detailed enough to assess whether climate change adaptation is incorporated. However, a number of grants were awarded to the NSW Department of Environment, Climate Change and Water (NSW Government, 2012).

The federal government allocates an additional \$3.6 million towards natural disaster resilience each year through National Emergency Management Projects, approved directly by the federal Minister of Emergency Management (AGD, nd). Combined, these funding mechanisms provide approximately \$28.7 million per annum of federal money to natural disaster resilience.

The Natural Disaster Resilience Program replaces the earlier Natural Disaster Mitigation Program which paid \$24.5 million per year in grants (average calculated as from July 2007, when the Regional Flood Mitigation Program was incorporated into it); the Bushfire Mitigation Program (an average of \$4.8 million per year) and the National Emergency Volunteer Support Fund (average of \$3.5 million per year). The total amount is roughly the same as provided by current funding programs.

The National Partnership Agreement is extremely broad. The agreement objective is stated as being "Australian Communities that are resilient to natural disasters". Funding is divided between all states and territories, and between all natural hazards. The Agreement defines resilience as "the capacity to prevent/mitigate, prepare for, respond to and recover from the impacts of disasters". Thus the funding may also be divided between all phases of PPRR. A survey of annual implementation plans indicates that the emphasis is on prevention, preparation and response (in the form of support for emergency volunteers), though some plans explicitly include recovery as well (e.g. the South Australian Implementation Plan for 2010/11). A disadvantage of this breadth of coverage is that limited funds are thinly spread. The paucity of the budget was illustrated by an interviewee of the SIRP report, who commented that the entire annual budget was barely sufficient to construct a flood levee for a single country town (Wenger et al., 2013).

Australia's average annual disaster damage bill, not incorporating recent flood costs, is approximately \$1.233 billion. Flood damages make up the largest proportion of this amount,

averaging \$377 million per year (BITRE, 2008).¹³ The cost effectiveness of investment in disaster mitigation is well recognised. A report to COAG on disaster mitigation reform noted, “recent analysis shows that over some 67 projects, every dollar invested in flood mitigation saved more than \$2.10” (Australian Government, 2004:24). Some USA sources suggest the benefit of investing in mitigation is considerably higher (Wenger et al., 2013). In this context, the annual allocation of \$30 million by the federal government towards disaster resilience appears grossly insufficient.

The Partnership Agreement cover page describes the Agreement as “mitigation” and this is also how it is promoted on Attorney-General Department webpages and annual reports. However, the Partnership Agreement definition of mitigation, “measures taken in advance of, *or after*, a disaster aimed at decreasing or eliminating the impact of disaster on society and the environment,”¹⁴ is at odds with standard definitions found elsewhere. Most definitions state that mitigation involves activities that are undertaken *before* a flood, while response is primarily *during* a flood and recovery *after* (EMA p.76, 88, 92, 94; ENRC p.26). While the agreement is commonly described as the Commonwealth’s contribution to mitigation funding, deviation from the standard definition of ‘mitigation’ is misleading and compromises this description. Moreover, lack of detail provided by most states about projects funded under the agreement makes analysis of the relative proportion of funding allocated to prevention (and to floods as opposed to other types of hazard) difficult.

The Partnership Agreement is touted as addressing climate change adaptation on websites and in annual reports¹⁵. The Attorney-General’s website states, “A key aim of the NPA is to enhance Australia’s resilience to natural disasters through mitigation works, measures and related activities that contribute to safer, sustainable communities better able to withstand the effects of disasters, particularly those arising from the impact of climate change.” However, the Partnership Agreement itself makes no mention of climate change. Wording relating to climate change is included in some of the Agreement’s State/Territory annual implementation plans. Generally this is in the form of acknowledgement of climate change rather than specific strategies to address it. A study of the eight implementation plans for 2011-12 found that six made no reference to climate change, one included climate change in its preamble¹⁶ and the remaining one included climate change in its performance measures¹⁷. The fact that climate change rates little mention does not mean that it has been

¹³ Figures are given in 2005 prices for the period 1967-2005, and do not include recent floods (p.44).

¹⁴ My italics. Quoted from Schedule A of the National Partnership Agreement on Natural Disaster Resilience. According to the Emergency Management Manual Series’ *Australian Emergency Management Glossary*, mitigation is defined as “Measures taken in advance of a disaster aimed at decreasing or eliminating its impact on society and environment”. The partnership agreement definition has added the words ‘or after’ to this standard definition. *Emergency Management in Australia Concepts and Principles* (2004), in the same series, expressly separates ‘prevention/mitigation activities’ from preparedness, response and recovery activities. Activities such as relocation or rebuilding to a higher standard that are carried out *following* a flood are mitigation, but such activities are undertaken in anticipation of (ie, before) the next disaster.

¹⁵ For example, the Attorney-General’s Department Annual Report 2009/10, p.102; the Attorney-General’s Department website <http://www.em.gov.au/npa> (accessed 22.10.12).

¹⁶ “Climate change is expected to further increase natural disaster risk particularly in the coastal zone” in New South Wales Implementation Plan – 2011-12 http://www.federalfinancialrelations.gov.au/content/npa/environment/natural_disaster_resilience/NSW_11-12.pdf (accessed 30.10.12)

¹⁷ “proportion of projects that consider possible climate change impacts” in Australian Capital Territory Implementation Plan – 2011-12

neglected in the implementation of the Partnership Agreement, as the implementation plans are not particularly detailed. However, it makes it hard to gauge the level to which it is integrated. All of the State / Territory plans for 2009/10 include natural disaster risk assessment (this being a partnership agreement requirement for determining implementation priorities). Climate change is likely to have been considered when undertaking these risk assessments.

5.5.2 Climate Change Adaptation Program

The federal Department of Climate Change and Energy Efficiency funds a number of climate change adaptation initiatives through its Climate Change Adaptation Program. In recent years this has included grants schemes such as the Local Adaptation Pathways Program (LAPP) and its Integrated Assessment of Human Settlements sub-program. LAPP (which operated from 2008-2010) provided around \$2 million to local governments to carry out climate change risk assessments and adaptation action plans. At least some of these projects considered flood risk¹⁸. A related funding scheme, the Coastal Adaptation Decision Pathways Program, received applause from the Queensland Government in a recent submission to the Productivity Commission (Queensland Government, 2012b). The Climate Change Adaptation Program also funds national vulnerability assessments, including the National Coastal Risk Assessment that investigated threats of coastal flooding due to rising sea levels.

5.5.3 Natural Disaster Relief and Recovery Arrangements

Disaster recovery is primarily funded through the Natural Disaster Relief and Recovery Arrangements (NDRRA) grants process. This is activated if financial thresholds for disaster costs are exceeded. When this is the case, the Commonwealth Government will share disaster costs with state governments. The proportion of assistance depends on the amount of damages. For the Victoria 2010-11 floods, the Commonwealth's share became 75% when the cost of replacement in "Category B" (including replacement of essential public assets) reached \$155 million (Comrie, 2011:207).

According to the Attorney-General's Department Annual Report for 2010-11, the cost of public infrastructure reconstruction following the 2010-11 floods was estimated to be around \$6.6 billion, (representing three quarters of the total expense funded through the NDRRA, the balance to be funded by State governments). In addition to this, \$823 million was provided to individuals through the Australian Government Disaster Recovery Payment, and a further \$73 million in Disaster Income Recovery Subsidy (AGD, 2011:122). For a country with a relatively small population, this is a significant cost.

In order to fund this enormous recovery bill, the Commonwealth government implemented an additional tax levy on Australian income earners (not applicable to anyone living in a flood

http://www.federalfinancialrelations.gov.au/content/npa/environment/natural_disaster_resilience/ACT_11-12.pdf (accessed 30.10.12)

¹⁸ For example, see the "Climate change in Western Port, Victoria: An integrated assessment of impacts on regional settlements and adaptation response" project, <http://www.climatechange.gov.au/government/initiatives/climate-change-adaptation-program/lapp-ia.aspx> (accessed 30.10.12)

affected area or to low income earners). It also reduced or discontinued spending to numerous Commonwealth government programs. The vast majority of these programs were 'Clean Energy' programs: the Cleaner Car Rebate Scheme, the Green Car Innovation Fund, the Carbon Capture and Storage Flagships program, the Solar Flagships program, the Renewable Energy Bonus Scheme, the Green Start Program, the Solar Homes and Communities Plan, the Global Carbon Capture and Storage Institute. Other programs that were cancelled or reduced included the National Rental Affordability Scheme, the Australian Learning and Teaching Fund, the LPG Vehicle Scheme and a number of regional and local infrastructure programs (Gillard, 2011). It can be concluded from this that Australians, both individually via increased tax and as a nation, have sacrificed much to subsidise the flood relief effort. It is also ironic that many of the programs sacrificed are the ones designed to mitigate climate change, a phenomenon likely to increase our exposure to flooding.

While recovery is generally not viewed as being 'prevention', it can become so. The SIRP report compared disaster relief policies and funding in Australia with those of the United States. In 1993, floods in the upper Mississippi caused a major shift in disaster relief and there was a "consensus that rebuilding or restoring to pre-flood conditions was not an acceptable policy position". During the 1990s, recovery and mitigation became increasingly integrated in the United States and for some disasters they completely merged. Recovery funding took the form of purchase of damaged or destroyed property; rebuilding away from flood hazards; and reducing exposure of rebuilds through measures such as elevation of structures. With the *Hazard Mitigation and Relocation Assistance Act (1993)*, mitigation funding increased, and 15% of all federal disaster costs were required to be spent on mitigation. In some cases this meant whole communities could be relocated (Wright, 2000:69, 78-9). Analyses of avoided flood damages indicate that US investment in preventative measures following a flood, such as relocation, have saved considerable amounts of money. In the upper Mississippi, the 1993 flood caused \$20 billion in damages. Following this, \$150 million was spent on relocation. In 2008, a similar-sized flood occurred in the same area but as a consequence of preventative measures undertaken as part of the earlier recovery efforts, the later flood had a much lower damages bill of \$2 billion (Freitag et al., 2009:5-6); (NWF, 1998:60-61).

Australia has yet to realise the financial benefits of integrating disaster prevention into recovery funding. Attempts have been made to incorporate 'betterment' into recovery funding but these efforts have so far failed. While 'betterment', or rebuilding to improved standards, is technically allowed by the NDRRA, at the time of writing, Comrie reported that no betterment projects had ever yet been approved by the Commonwealth (Comrie, 2011:210-11). Since his report was published, one betterment project has been approved, in Tumut Shire NSW, to relocate a public pool that had suffered repetitive damage (AGD, pers. comm.)¹⁹

There are many difficulties in achieving betterment. The most significant impediment is that when infrastructure is damaged, it needs to be rebuilt as soon as possible, and yet betterment applications, involving both an application and cost benefit analysis, take time to prepare and approve. Early attempts in the United States to integrate mitigation into

¹⁹ National Disaster Recovery Programs Branch, Emergency Management Australia, Attorney-General's Department

recovery were similarly limited due to the speed with which recovery measures need to be implemented following a disaster and the time required to assess options (Wright, 2000:78). Other issues implementing betterment were also presented during SIRP interviews. One related to identifying potential problems in advance. If infrastructure is identified as being a potential candidate for betterment prior to a disaster, duty of care requires it to be included in a schedule of works. Once it is part of a normal works program, it may no longer be eligible for betterment. This suggests that an agreed process is needed that enables *identification* of infrastructure subject to betterment prior to a disaster and *pre-approval* of a resilient rebuild standard. However, it would be important to design the process to ensure it did not encourage construction of sub-standard infrastructure in the hope that a major disaster would result in a free upgrade.

Disaster relief and recovery funding can have another effect on disaster prevention, and that is the perverse effect of removing the incentive to invest in prevention. Interviews with different stakeholder groups undertaken as part of the SIRP report found widespread dissatisfaction over the lack of mitigation and betterment funding and of overgenerous disaster relief and recovery funding. Interviewees felt that the billions spent on repairing infrastructure would not increase resilience but would be incurred again after the next large flood event. Many were highly concerned that the Commonwealth, by investing so much in recovery funding, was also creating disincentives for States and local governments to apply adequate preventative measures, such as improved development planning. Disapproval was also expressed about the untargeted nature of individual payments that did little to help those most severely affected and that could have been used to assist rebuilds. Individual cash payments have been similarly criticised in America. Another significant concern was the lack of balance between federal disaster mitigation funding and relief and recovery funding, with some interviewees noting the relative cost effectiveness of spending on mitigation, in terms of reducing response and recovery costs (Wenger et al., 2013).

The SIRP Report study of disaster relief in the US found that generous federal disaster subsidies can increase state and local government dependency and reduce the imperative for them to invest in disaster prevention and preparedness. While accepting the benefits of occupying floodplains, the costs of occupying that land are externalised to federal governments and taxpayers. Similar to Australia, State and local governments are responsible for land use in the United States and the implementation of development controls is widely held to be the most effective flood prevention tool. There is a fundamental disconnect if those responsible for implementing development controls are different to those who pay for the consequences of failing to implement them (Wenger et al., 2013).

The COAG National Strategy for Disaster Resilience lists as a priority outcome:

Following a disaster, the appropriateness of rebuilding in the same location, or rebuilding to a more resilient standard to reduce future risks, is adequately considered by authorities and individuals

(COAG, 2011:12)

However, disaster mitigation is not currently integrated into Australia's disaster relief. While there were isolated examples of relocation following the 2010-11 floods at Grantham, QLD and in the Lower Loddon, VIC, relocation is not a consistent policy and the lack of functional

betterment provisions makes it clear that COAG's aspirational objective is far from being realised.

5.6 Information and Analysis Function

Information on climate change related flooding is abundant, albeit with an emphasis on coastal flooding due to sea level rise. All levels of government, as well as research and training institutions, industry bodies and NGOs are involved in the production and analysis of information related to flooding. This includes impacts of climate change on flooding, guidance material in the form of best practice manuals, tools, information networks, courses and workshops. Governments also have a role in developing guidance to improve the quality and consistency of information. Production of information is often collaborative with a number of different organisations involved and funding opportunities from many different sources. The organisations and the resources they produce are too numerous to detail but some are listed in Table 1. Many recent initiatives by led different organisations are also outlined in “Australia’s fifth national communication on climate change” (Australian Government, 2010).²⁰

While information abounds, the SIRP report found that local flood information is often lacking, is not publically available or is not used. This section explores the needs and barriers to obtaining and using basic flood information.

5.6.1 Flood Information

Accurate flood information is a prerequisite for the application of planning legislation and instruments that address flood. It also enables risk assessment and implementation of mitigation measures. However, it has proved challenging to gather and incorporate flood information into planning schemes in most municipalities, even without factoring in the added threats of climate change.

In Victoria, 80% of floodplains are reportedly mapped for a 1:100 year event but only 70% of these mapped areas are incorporated in planning schemes (Comrie, 2011:194-5). In Queensland, most towns and cities are built on floodplains. However, a recent review of planning schemes found that only 37% of schemes contained any flood related mapping. Of these, only 23.6% were completed in accordance with the SPP 1/03 Guideline. The QFCI concludes this is “a wholly inadequate level of flood mapping” (QFCI 2012: 62).

5.6.2 Barriers to collecting flood information

Possibly the most significant barriers to undertaking flood studies and flood mapping is cost. In Victoria, Catchment Management Authorities have a statutory obligation to provide flood information for councils to incorporate into their planning schemes. However, one CMA that was badly affected by flooding reported that no towns within its catchment had adequate flood mapping, the reason being a lack of a dedicated funding stream (Comrie, 2011:194).

Local Government has the primary responsibility for producing flood studies in Queensland as councils generally hold detailed local information and are the primary users. However, there too, local governments generally do not have sufficient funds or technical resources to undertake flood studies or assess technical information (QFCI, 2012:54-5, 62, 198-200).

²⁰ Initiatives relating to flood can be found on pp.116, 119, 124, 158

Since the 2010/11 floods, the Queensland Reconstruction Authority (QRA) has produced maps for floodplains across the whole of Queensland, which councils can use as interim maps for planning schemes. The maps are intended to provide a basic level of mapping that can be refined by cross-referencing local information (QFCI, 2012:66).

Municipal boundaries do not coincide with catchment boundaries, resulting in flood studies that are done on an individual town or locality scale (QFCI, 2012:55). Yet flood management is most effective on a catchment scale, which raises the issue of whether systems for mapping are fit for purpose (see planning section). Better management outcomes could be achieved if local flood studies were designed to 'nest' within an overall catchment study.

SIRP report interviews indicate that the QRA maps have been beneficial in this regard as they have provided catchment-scale maps to local councils that previously hadn't been able to afford flood mapping. Furthermore, this preliminary work has provided evidence with which local governments can build a business case to obtain funding to undertake more detailed studies. Initial outlays to undertake preliminary flood studies had been a barrier for some local governments. QRA maps have had immediate effect with an example given by one interviewee where a community chose to re-site proposed development to a location that was less flood prone (Wenger et al., 2013).

5.6.3 Adequacy of flood information

There can be issues with the accuracy, completeness and currency of flood information (Comrie, 2011:194); (QFCI, 2012:56, 193). Flood maps can become out-dated if there are landscape changes, such as new floodplain development, road or levee construction, farming system changes or major floods. These can all change future flood behaviour and cause existing flood information to become unreliable. However, in some states, such as Victoria, there is no requirement for periodic updating of flood information.

Recent flood reviews argue that mapping for 1:100 year events is not sufficient from a development planning point of view and events of both greater and lower likelihood need to be included as well, up to probable maximum flood (QFCI, 2012:63); (Comrie, 2011:62-3, 197). In Victoria this is already happening and recent flood mapping funded by the Victorian government includes multiple flood levels (Comrie, 2011:62). These recommendations are relevant to the incorporation of climate change scenarios.

When discussing likelihood mapping, the QFCI does not acknowledge that stationarity is likely to cease with climate change and that historical likelihood will no longer be accurate (QFCI, 2012:63-8). This is a notable omission that suggests a lack of comprehension about how climate change is expected to influence future flooding (see also 'The Adequacy of Planning Tools to Accommodate Climate Change' in the Planning Processes section). The Inquiry rates the QRA maps low in its flood mapping hierarchy and questions their usefulness in a development planning context (QFCI, 2012:67, 213-4). The main reason seems to be that the maps identify too large an area of flood-prone land, with no information on likelihood. The Inquiry argues that the large area identified imposes a burden on development applicants. It does not acknowledge that current likelihood values may cease to be valid as a result of climate change.

The QRA maps are based on satellite images, with towns, gauging stations, contours, drainage data and the 2010/11 flood line superimposed. They also include soil (e.g.alluvium) and pre-clearance vegetation information to identify areas that have inundated at some unknown point in history, adjusted using current contour information (QFCI, 2012:66). Arguably, the use of this geological information means that these maps provide a good representation of probable maximum flood levels. The QFCI's reservations about the use of the Authority maps somewhat contradict its enthusiasm elsewhere in the report to identify probable maximum flood levels (QFCI, 2012:63).

In his book on extreme events, Jonathan Nott looks at the application of the geological record for predicting floods, noting that particularly in countries like Australia, "short historical records may give a false impression of the nature of the flood hazard for a region". This impacts on community vulnerability as it affects individual and community perceptions of risk and their attitudes towards mitigating against it (Nott, 2006:1-16, 75). While the QRA maps are conservative, understanding past extreme flooding events and watercourses could reduce vulnerability to 'unprecedented' floods that are more likely under climate change. Using the Authority's maps in the absence of more detailed information would enable a precautionary approach to development that would assist climate change adaptation, loosening controls as more information comes to light rather than increasingly tightening them. Moreover, restricting development to conservative levels may provide an incentive to improve the knowledge base through funding flood studies.

5.6.4 Incorporation of future threats into flood information

Adaptation measures to non-stationarity have been suggested by some authors. Milly et al propose higher resolution (more localised) modelling incorporating a wide range of information, coupled with improved information transfer, in both directions, between water managers and climate scientists (Milly et al., 2008). This measure would make information more locally relevant and decrease uncertainty. The need to downscale climate change flood information to catchment level has also been identified as a key issue by the Productivity Commission's report on barriers to effective climate change adaptation (Productivity Commission, 2012).

Supported by catchment-level information, adaptation to climate change needs to be sensitive to consequence and not just likelihood. The consequence of different climate change scenarios will vary according to catchment due to their different characteristics. More comprehensive flood mapping that incorporates consequence rather than just flood extent²¹ could help to understand future risks but its production would be more costly.

Attempts are being made to make climate change information locally relevant. As discussed elsewhere in this paper, a recent joint project undertaken by the Queensland Local Government Association and State Government agencies has provided a climate change factor for increased rainfall intensity that can be incorporated into flood studies. However,

²¹ Galloway G E, A California Challenge - Flooding in the Central Valley: A Report from an Independent Review Panel to the Department of Water Resources, State of California, 2007, p.23-4 suggests it is important to map the distribution of risk, including flood depths, existing and future development, including populations, structures, infrastructure and future consequences of flooding.

Hallegatte suggests that improved modelling is unlikely to yield the degree of certainty that planners require, partly due to difficulties distinguishing between natural multi-decadal variability and anthropogenic climate change. Models cannot be validated in the short term, by which time a maladaptive decision may have been made. Moreover, projection ranges continue to be large despite improved information and uncertainty will remain no matter how good the modelling. Hallegatte argues that it is current decision making frameworks that need to be changed to accommodate this uncertainty rather than delaying action until information provides certainty. He ranks adaptation options according to a number of characteristics, including no-regrets strategies, reversibility, ease of incorporating low-cost safety margins, soft strategies (which by their nature are generally reversible), avoiding long term commitment (uncertainties increase further into the future) and synergies, which consider externalities to other sectors. 'Institutionalisation of a long-term planning horizon' is an example of a soft management measure that forces planners to look several decades ahead. Other high priority measures relevant to flood management include climate proofing of new building and infrastructure, restrictive land use planning, insurance and the development of early warning systems and evacuation systems. Structural solutions and options such as relocation and retreat were less favoured, as they were not reversible or flexible (Hallegatte, 2009).

Other adaptation measures to address non-stationarity have been suggested by Lee Godden and Anthony Kung. Their paper on regulatory and planning law suggests reforms in these areas could do much to encourage autonomous and private adaptation. They recommend use of incentives and community engagement (Godden and Kung, 2011). An example of the use of incentives is given in the final QFCI report, where transition of existing residential areas to lower impact uses is facilitated by a lower level of development assessment (QFCI, 2012:146-7).

5.6.5 Application of Flood Information

Mapping enables risk assessment and the application of planning measures such as minimum floor levels and zoning to ensure land use is compatible with the level of flood risk. Risks are assessed in the context of a floodplain management plan which considers environmental, social and economic costs and benefits of different measures and acceptability of flood risk (QFCI, 2012:40, 60). Both the QFCI and the Comrie Review found lack of financial and technical resourcing for local governments compromised their ability to undertake risk assessment. They concluded greater state government support was needed. State governments also needed to be more active in developing standards and providing coordination (QFCI, 2012:60); (Comrie, 2011:39). Victoria's mobile technical support unit is a creative approach to addressing local government capacity issues. Victoria's mobile development planning support unit is a creative approach to addressing local government capacity issues (Productivity Commission, 2012:131-132).

5.6.6 Availability of Flood Information

Awareness of flood risk is often seen as a key factor to increase community resilience. If communities and individuals are aware of flood risk in areas they wish to develop or purchase, they will be able to assess their own risks. Problems associated with the provision of information include impacts on land values and insurance prices, intellectual

property and liability for incorrect information. Geoscience Australia is currently implementing a National Flood Risk Information Project, which includes a national database for flood studies. Thus increased availability of information on flood risk seems to be the direction Australia is headed regardless of current barriers.

While public awareness of flood risk is important to support community resilience, it has its limitations. It is significant that the QFCI found that “purchasers of property, in making the decision to purchase, did not turn their minds to the property’s vulnerability to flood” (QFCI, 2012:70). There are also socio-economic implications in that even if risks are widely known, poorer people may not be able to afford the higher purchase price of living in areas with low flood risk. They also have less financial capacity to retrofit or build using flood resistant design. Neither would risk awareness benefit vulnerable people accommodated in aged care facilities, hospitals and childcare facilities, which are also often sited without adequate consideration of flood risk (QFCI, 2012:150). Thus risk awareness is no substitute for good planning and development controls.

5.6.7 Liability issues

Perception of liability can be a significant barrier to the provision of flood risk information and its incorporation into planning schemes by local government. This is particularly the case for climate change information given the uncertainties involved at the local scale (Comrie, 2011:196); (QFCI, 2012:128-132); (Trowbridge et al., 2011:70). Councils can be exposed to compensation claims if land is ‘down-zoned’, subjecting it to flood controls and reducing land value. In the SIRP report, one interviewee related a case where almost the entire council budget was spent defending development decisions to prevent coastal development applications from going ahead (in this instance State Government was obliged to step in). Councils are also liable for losses if they provide flood advice, act or fail to act in respect to flood-prone land (QFCI, 2012:128). This issue is also identified by Gibbs and Hill, who note that some states such as Queensland have greater legal provision for compensation than others for councils wishing to apply development controls (Gibbs and Hill, 2011).

Some sources suggest a potential liability for the quality and accuracy of flood information (Trowbridge et al., 2011:70). In one case reported by the QFCI, a council decided not to provide any information on historic or current flooding unless an application was made under freedom of information legislation (QFCI, 2012:130). A recent paper by Eburn & Handmer finds that the liability risk of providing flood risk information is vastly overstated and there are “no cases where anyone has successfully sued a council for releasing up to date, accurate hazard information”. Rather, councils face liability for not supplying information about known risks (Eburn and Handmer, 2012).

The QFCI finds it is important that councils not be inhibited by statutory liability to compensation from adopting appropriate regulations and providing information. It makes no formal recommendation on these issues but discusses NSW legislation as a possible solution. Statutory immunity is provided by section 733 of the *Local Government Act 1993* (NSW), (recently amended to include climate change information). The application of this legislation is currently being investigated by the Queensland Government. Granting indemnities for information provided in good faith is similarly recommended by the National Disaster Insurance Review.

Water authorities in Victoria are liable to compensate people who incur a loss due to the performance of water authority functions under the terms of the *Water Act 1989 (Vic)*. This could potentially include failure to take climate change risks into account. The authors view this as positive as it could encourage re-assessment of the adequacy of existing planning controls (Godden and Kung, 2011).

5.6.8 Conclusion

There are many barriers to the collection and use of locally based flood information. They relate to insufficient local government resources (both technical and financial) to fund flood studies and to defend and compensate development decisions that are made as a result of using that information. Other issues include municipal boundaries that inhibit the production of catchment-scale flood studies, community cost in terms of lower land values and higher insurance costs and difficulties downscaling climate change information. The QRA maps provide a positive example of how some of these difficulties can be overcome.

5.7 Market Mechanisms

There are several market based mechanisms that can be useful in achieving improved flood mitigation, including provision of flood risk information to potential property purchasers, insurance incentives and payment for services.

Market mechanisms can be activated by making flood information available. In NSW, information regarding a property's flood risk can be included on its S149 certificate (e.g. Wagga Wagga). These certificates contain information on any development restrictions and conveyance legislation requires them to be attached to contracts for the sale of land.

Insurance pricing can increase awareness of flood risks attached to a property. Insurers are also able to offer incentives to property owners, and even whole communities, to mitigate flood risks through offering lower premiums. However, the industry will need to be careful about what kinds of measures it advocates. Structural approaches to flood mitigation, for example, are not always the best solution and can exacerbate flooding elsewhere or decrease the resilience of those protected by structural works.

Another way in which insurance could help Australia to adapt to flooding would be through new products. For example, in return for a minimal additional premium, some flood insurance schemes overseas offer supplementary payouts to enable more resilient repairs. These issues are covered more fully in the SIRP report.

Payment for services can be used as a means of reducing flood impacts through improved land management. Such schemes compensate property owners such as farmers who allow their property to flood to reduce the impacts of flood for downstream users. This means land use needs to be flood compatible, (e.g. dryland grazing), and land management needs to retain water on the land, through measures such as wetland restoration, use of temporary detention basins and strategic revegetation to slow run-off and assist water infiltration. Such 'flood mitigation' businesses could diversify farm income sources as well as providing a public benefit. In particular, it would be a valuable tool for implementing ecosystem approaches to flood management (see planning section). However, a catchment approach to flood management would be required as flood management measures generally need to be implemented in the upper catchment, while the benefits are found in the middle and lower catchments, and payments would need to be transferred accordingly. Identification of priority areas for improved management would need to be identified within catchments, as well as assessment of the value of that benefit for service users. Pricing would need to be adequate to provide incentives for property owners.

As discussed in the SIRP report, payment for ecological services is an approach used overseas for flood mitigation but it is less well known in Australia. A recent Australian example aims to reduce impacts of flooding including catchment erosion and sedimentation in Moreton Bay, QLD (see planning section). Priority areas for improved land management have been identified and a cost benefit analysis has been done (QCC, 2012). According to the proposal's business case, approximately \$80 million would be needed over the next three years (\$500 million over 20 years). As sedimentation affects water quality and water supply, the scheme would raise the money through household water bills. The catchment levy would cost households \$3-\$8 per year. Analysis of the area's water dependent

industries by Marsden Jacob Associates indicates the economic benefits of this initiative could be considerable. The proposal has been submitted to the state cabinet.

A further example is Victoria's 'Trust for Nature', a not-for-profit organization that has been involved in developing conservation covenants to protect wildlife on private land. It also facilitates payment for ecological services through Native Vegetation Offset agreements, whereby landowners are paid to protect and improve the quality of native vegetation on their land (Trust for Nature, 2012). Thus there are examples of PES in Australia that could help to provide incentives for flood mitigation through improved land management.

6. DISCUSSION: THE EXTENT TO WHICH ADAPTIVE CHARACTERISTICS ARE EVIDENT

Using evidence from the results section, this section assesses the extent to which adaptation characteristics are evident in Australian flood management. Characteristics addressed include:

Clarity of purpose: Requires clear definition and understanding of problems at a system level so that we can address root causes and not just symptoms.

Diversity: Requires a diversity of ideas, skills and resources, a diversity of views, innovation, flexibility in problem solving, and wide inclusion of stakeholders in a purposeful and structured fashion.

Connectivity: Requires institutional (including community) networks that are not susceptible to collapse due to one part failing; effective use of resources; community ability to organise itself; appropriate leadership; spare capacity; and some duplication of functions and overlapping of institutions.

Integration and feedback: Requires a holistic consideration of issues and realistic consideration of scale, accounting for the full range of interactions between humans and ecosystems. It also requires resources to monitor and to promote debate and learning.

6.1 *Clarity of purpose*

Information about climate change impacts on flooding is not lacking and much work has been done at all levels of government to identify these impacts and assess risks. These are used liberally to justify proposed adaptation activities.

Numerous intergovernmental initiatives, including national strategies, arrangements, agreements, frameworks, action plans and roadmaps provide an agreed national approach to flood problems, including exacerbated risk from climate change. The approach in terms of disaster management is 'resilience', which encompasses both root causes and symptoms. As resilience is such a broad term, it is sometimes hard to distinguish the specific aspect of the problem that some measures are intended to address. Some, such as the National Partnership Agreement for Natural Disaster Resilience, while 'sold' as the federal government's contribution to disaster mitigation, actually address symptoms as well. Contradictory definitions of the word 'mitigation' obscure the Agreement's true purpose. However, some recognized methods of flood prevention are understood and are included in initiatives aiming to adapt to climate change. The prevention focus is on improved development controls. Measures such as relocation appear to be less systematically supported, while ecosystem approaches to flood management (that can help mitigate existing as well as future development) are not yet widely understood.

Inconsistent legislation and processes for addressing flood risk at the state level reflect conflicting development policies. This makes it difficult for different institutions to have a good understanding about what is expected of them in terms of flood prevention and management. This lack of clarity about policy priority in different situations results in a lack of shared responsibility and institutions that work at cross purposes.

6.2 Diversity

Flood management is all inclusive. Evidence from all mechanisms indicates wide stakeholder engagement across different levels of government and portfolios, research institutions, industries and communities, even to the individual level. 'Shared responsibility', promoted by intergovernmental arrangements fosters this involvement.

At the federal level, the strengths of different agencies are combined to implement the National Flood Risk Information Program, which works with state governments and local governments to make information about flood available to all. In turn, guidelines produced by the federal government aim to improve quality, consistency and comparability of flood information commissioned across the country by other entities. The aim is for everyone to have access to the flood risk information they need to make development, mitigation or purchase decisions.

Examples from local government include climate change alliances. These not only build synergies across other municipalities within a region but also enable better access to federal government grant schemes. Many of them have wide stakeholder involvement including with industry and research institutions to fund adaptation projects tailored to the local level. Federal government has actively supported such partnerships through grants schemes such as LAPP.

Issues arise at the local level due to resourcing constraints. Many do not have the means, either financial or technical, to undertake flood studies or assess flood information. The Productivity Commission suggests that this could lead to shortcuts in decision making processes that are otherwise costly in time and effort (Productivity Commission, 2012:109-110). For adaptation to actually be implemented there needs to be a wide skills base and financial resources on the ground, coupled with strong policy leadership and guidance from state government.

6.3 Connectivity

Networks related to flooding are of varying robustness. The 'bottom up' networks studied in this paper, such as local government alliances and natural resource management bodies appear very strong and effective. They involve large numbers of stakeholders and have a diverse funding base; the loss of one will not make a large difference. While their objectives continue to remain relevant and they continue to deliver results, they are unlikely to fail.

Not all networks are as successful. The vast majority of recommendations in recent flood reviews pointed to a need for better governance, coordination, integration, accountability, oversight, communication, and other socio-institutional issues. Administrative systems, operating as networks across portfolios, do not always function effectively. As demonstrated in the section on intra-governmental function, network failure resulted in non-compliant planning schemes that did not incorporate flood controls. This is likely to be a consequence of conflicting portfolio agendas and a lack of policy leadership.

While duplication and overlap seem to have occurred in some areas, this is not always useful. The strategies, plans and arrangements in place for emergency management are

profuse and somewhat confusing to negotiate. It seems likely that some, such as the National Framework for Disaster Resilience might be redundant now that the more detailed NSDR is in place. The complexity may have led to some strategies being overlooked or given only cursory attention. Implementation of the MCPEM Climate Change Adaptation Plan, for example, appears to be less than thorough.

Information and analysis is of great importance as a prerequisite to implementation of climate change adaptation. The production of this information is from diverse sources, with multiple sources of funding that address the needs of different stakeholders. In this instance, overlap is positive, in that a broad range of strategies can be explored and all sections of society can be reached. However, there are problems associated with the vast number of tools, approaches and methodologies available to managers, in that it causes confusion about which to use (Productivity Commission, 2012:129).

6.4 Integration and feedback

Floods are not only disasters. Australia's carryover water storage system depends on them. Managed well, flooding can replenish groundwater, restore ecosystems and boost economies. How Australia manages floods will be vital for its adaptation to other climate change impacts such as drought.

Currently Australia does not capitalise on its flood opportunities. Highly regulated water management in Australia eliminates smaller high-frequency floods, which might otherwise replenish watertables and restore natural assets. Not only does this reduce Australia's preparedness to deal with large magnitude events but it can also increase the negative impacts of large scale events, for example, resulting in blackwater events²² and degraded, unconnected wetlands that are less able to mitigate flooding.

Another issue hampering the management of floods is that humans and ecosystems function with different geographic and temporal boundaries. Flood management needs to consider whole catchments and cumulative impacts when assessing development and flood mitigation alternatives. Unless planning and management can be carried out on a catchment scale by organisations with sufficient technical expertise and a long term perspective, the interaction between floods and humans will continue to be harmful.

Legislation and development planning systems currently have an inconsistent approach to flood risk. Opposing policy objectives, such as affordable housing and short term financial concerns conflict with concerns about flood safety and long term damage costs. This reflects a lack of policy leadership about approaches to flood risk by state governments. The situation is not assisted by current arrangements for payment of damage costs, which are largely paid for by the federal government, thus externalising the consequences of this lack of leadership. If policy conflicts are not resolved, flood costs will continue to grow under

²² Blackwater events occur during floods as a result of rapid breakdown of organic matter. This depletes dissolved oxygen levels in the water (also causing water discoloration) and commonly results in fish kills. Blackwater events are worsened by higher temperatures that accelerate the decay of matter. Blackwater events are believed to have worsened due to water regulation which eliminates small floods thus allowing longer accumulation of large amounts of organic matter. This is expected to be exacerbated by prolonged droughts associated with climate change.

climate change scenarios, compromising Australia's economy and the wealth of its citizens. The money that could have been spent on mitigating climate change and developing adaptive strategies will be wasted on avoidable damage costs.

As discussed earlier in this paper, policy conflict is not confined to state governments. Recent development projects located in flood prone areas have also been funded through the federal government's economic stimulus package. Leadership is required at all levels to resolve policy conflicts and to develop consistent legislation and planning processes accordingly.

The federal government has been making increasing efforts to address prevention through coordination and leadership of initiatives such as the *Enhancing Disaster Resilience in the Built Environment Roadmap*. However, some of the government's stated objectives, such as the integration of climate change impacts into the Building Code of Australia, have so far failed (Australian Government, 2010:119); (Productivity Commission, 2012:155). The federal government's current focus on resilience, which covers all aspects of flood management, obscures a desirable emphasis on prevention. Moreover, prevention needs to be better integrated into the federal government's disaster recovery efforts. Simply rebuilding is 'reinvesting in disaster'²³.

Activity on all levels contributes to information about flooding and key aspects, such as weather patterns and projected climate change impacts continue to be monitored and reported by organisations such as the Bureau of Meteorology and CSIRO. This information is used as a basis for research, debate and action. Ecosystem researchers and state government natural resource management agencies are investigating the potential for ecosystem approaches to flood management (Queensland Government, 2012, State Government Victoria, 2012). However, there is a current divide between floodplain managers with a natural resource management background and flood managers with an engineering background. Professional training needs to be better integrated so that there is consideration of all options on a case by case basis. Methods of cost benefit analysis have been developed overseas to compare the merits of flood mitigation options and these could be applicable for use in Australia.

Flood reviews are a major feedback mechanism and these were studied comprehensively in the SIRP report. The report found that none of the reviews studied by the project included climate change in their terms of reference and only ad hoc mention was made of climate change in the body of the reports. Consideration of the adequacy of arrangements in place to address flooding was retrospective rather than considering future conditions (Wenger et al., 2013). This narrow analysis of events will be of limited value in helping Australia to adapt to future threats. Review of the performance of the QRA as a model for flood recovery would be beneficial as initial indications are that it has focused efforts and achieved several successful outcomes, including basic flood mapping for all Queensland floodplains, and amending planning provisions to facilitate the relocation of the town of Grantham.

²³ Charles L. Hardt, Tulsa Public Works Director, 1993. In NWF, 1998: p.144.

7. CONCLUSION AND RECOMMENDATIONS

The current approach of flood management in Australia is 'resilience' and through federal leadership and funding, it has been adopted throughout the country. While partly a rebranding of PPRR, resilience also attempts to promote shared responsibility for disasters. It is yet to be seen whether the community will accept this responsibility (and remember it during periods of prolonged drought). However, given that flooding is expected to worsen, and that response capacity will be stretched in large magnitude floods, greater self-sufficiency would be a sensible adaptation if it can be achieved.

Climate change adaptation is a stated rationale for resilience, though it is not referred in key funding mechanisms, such as the National Partnership Agreement for Natural Disaster Resilience, or in most annual state implementation plans. However, these funding mechanisms and others have enabled the development of risk assessments and adaptation plans, as well as community awareness raising and development or revision of key flood management tools. At this early stage, it is difficult to determine whether the resilience approach enables effective adaptation to flooding. In view of the paucity of funding of the National Partnership Agreement and its vast scope, it seems doubtful that it will have a greater impact than its predecessor, the Natural Disaster Mitigation Program. Other elements of NSDR implementation, such as the *Enhancing Disaster Resilience in the Built Environment Roadmap* are innovative and hold promise. However, major opportunities to incorporate climate change risks into planning controls through the Building Code of Australia have been missed.

Perhaps one of the most significant initiatives to so far come out of the resilience approach is the greater availability of flood risk information through NFRIP. This could prove to be a major step forward in awareness of flood risk and the need to mitigate.

To adapt to climate change, Australia needs to ensure it maximizes the benefits of large and small floods, while minimizing the adverse consequences of large floods that result from poor management. Floods are vital for Australia's water security and this will only become more important during the prolonged droughts anticipated as a result of climate change. Analysis in this paper suggests that aspects of flood management most in need of attention are:

- assessment of the adequacy of current planning instruments to accommodate climate change
- consistent policy, legislation and planning processes to ensure that future flood risks are assessed and addressed
- sufficient resources for local government (both technical and financial) for on the ground flood prevention and mitigation
- significant increase in funds available to flood prevention/mitigation to reduce long term damages, in particular for:
 - basic nationwide flood mapping

- sophisticated flood mapping in urbanised and developing areas that includes worst case scenarios, projected population and development and flood consequences
 - improved development planning
 - relocation of those most at risk and reassignment of land to flood compatible uses
 - recognition and support for ecosystem approaches
- flood recovery strategies that merge with prevention to increase future resilience
 - administrative structures that enable a catchment based approach to flood management
 - integration of ecosystem approaches into training for flood managers, coupled with community education programs.

Major impediments to achieving these objectives include conflicting development policy objectives, many of which value short term development gains over long term disaster prevention; the non-mandatory nature of many current provisions relating to flooding; insufficient investment in prevention (as opposed to relief and recovery); disincentives such as badly targeted flood relief and lack of financial consequences for those making risky development decisions; planning that is based on administrative boundaries rather than natural geographic ones; planning tools that are inadequate to address future risks; and inadequate resourcing, particularly for on the ground implementation. Potential financial consequences are a major barrier that inhibit local government from using flood information and applying appropriate land use and development controls, particularly if this means land has to be 'downzoned'.

In order to achieve improved flood management, reforms will be needed at all three levels of government. At the Federal level, funding needs to be targeted at preventative measures that will reduce future damage bills, such as the better integration of disaster recovery programs with mitigation of future risks. The current focus on risk assessment that addresses consequences is sound. However, the amount of money available to mitigate flood risk needs to be vastly increased. Stronger options to encourage improved land use and development planning, such as reduced federal investment in regions with inadequate controls could be explored if current cooperative approaches prove insufficient.

All three levels of government need processes to resolve policy conflicts that compromise the consistent application of flood prevention measures both within and between levels of government. Intergovernmental agreement on policy precedence could buffer shifts in priority as a result of short term changes of government. At the time of writing, the ANZEMC Roadmap is not yet publically available but it is expected to include 'integrated legislation'. It could be the first step in this process and needs to be given high profile support. If a consistent national approach to resolve these issues cannot be achieved, dialogue about policy conflicts and which should take precedence in different situations needs to take place, and this needs to be clear to decision makers on the ground. When considering which policy should take precedence in a given instance, the full costs of policies need to be considered, including intangible and future costs. These policy priorities also need to be reflected consistently in state planning legislation and investment decisions. Crucially, it is important

that state and local governments are not financially penalised or disadvantaged for good decision making. For example, regional development funds could be offered by federal or state governments where appropriate controls are in place and enforced.

State / territory planning processes could be improved to enable facilitate adaptation. Rather than relying on modeling to provide greater certainty about flood risk, improved decision making systems need to be implemented that enable low cost, flexible approaches to flood risks. Local governments also need to be better supported by state governments in terms of technical capacity and financial resources for generation of flood information and risk assessment. Appropriate legal protection or financial capacity to pay compensation when it is necessary to down zone could encourage the actual application of flood information.

Catchment-based approaches to flood mitigation could potentially be achieved cooperatively between councils. However, a council's responsibility stops at its administrative boundary and so catchment management is better implemented at the state level. In Victoria, CMAs have a formal role in the development approval process. However, not all states have administrative structures that support an integrated catchment based approach to development planning and flood mitigation. Nevertheless, much could be done to enhance catchment based approaches in other states, in terms of mapping, assessing cumulative impacts across entire catchments and implementing appropriate measures in the parts of the catchment that would be most beneficial. This could be paid for by market mechanisms, that also need to be coordinated on a catchment scale. This is most appropriately done at state level.

In a country with very short term records of past floods, the use of flood mapping that incorporates palaeological information about past flood events, such as the QRA maps, will enable better assessment of possible worst case scenarios and identification of potential flow paths. QRA flood maps are low resolution but have already resulted in proposed development being relocated to less risky areas. This exercise could well be duplicated across the country to provide basic, cost effective flood mapping to communities that have never been able to afford it. This would need to be coordinated by state / territory governments, and would probably require Commonwealth funding assistance. As likelihood of flooding is predicted to increase, consideration should also be given by state / territory governments to the use of more conservative planning tools, such as higher floor levels and building material and design, particularly for areas that will suffer largest consequences of flooding, such as urban areas or development in confined catchments.

A review of the QRA and its effectiveness in facilitating recovery options that mitigate against future risks would be beneficial to inform future recovery efforts. This could be done by either the federal government (which provided funding to QRA) or by the state government.

Local government needs to ensure it has adequate flood risk information on which to base decisions, and to incorporate this into planning schemes. Councils also have a responsibility to make information freely available as it is only when information is available that flood risks can be addressed. Community resilience objectives will not be achieved in the absence of this information.

Local government alliances can greatly facilitate the capacity of local governments to adapt to climate change. They can promote synergies, help leverage funding, advocate adaptive

approaches and be a vehicle for locally relevant research and action. Such alliances have good coverage in some states, such as Victoria where they were initially funded by State government, but less coverage in others. More alliances in other states could greatly benefit adaptive capacity of local governments and the development of locally relevant solutions.

Local government also has a large role to play in community education. Flood damage often results in activity by communities and landowners, such as channel straightening, building embankments and vegetation clearance, that actually increase the potential for future flood damages. Local governments have a role in communicating optimal strategies for minimising flood damage and for ensuring that local activities do not worsen flooding downstream. This could be supported by NRM bodies in each state. These conclusions are summarised in Table 2, below.

Table 2: Reforms to improve adaptive capacity for flood risk

Problem	Barriers	Reform Needed	Responsibility
Rebuilding to pre-existing standards does not increase resilience to future flooding	Additional upfront recovery costs versus lower long term damage costs Need for immediate restoration of infrastructure that precludes lengthy cost-benefit analysis processes	Flood recovery strategies that merge with prevention Need for agreed processes with local governments to pre-approve infrastructure suitable for betterment.	Federal
Insufficient funds for flood prevention / mitigation versus generous funding of relief and recovery	Lack of understanding about the long term cost effectiveness of preventative approaches, coupled with short parliamentary terms of office: responsible spending is unlikely to receive due credit Political gains in the short term from a well-coordinated emergency response; negative media coverage if efforts are insufficient	Increased funding of prevention, particularly for: • flood information • risk assessment • improved development planning • relocation of those most at risk and reassignment of land to flood compatible uses • ecosystem approaches Strong promotion to the public about the benefits of prevention and action governments are undertaking. Establish relevance to all Australians, not just those in flood prone areas (ie higher tax and insurance premiums for all)	All levels of government, particularly the federal level through the NSDR
Non-mandatory consideration of flood risk in development legislation and processes	Conflicting policy objectives Short term versus long term gains Lack of flood mapping Length of time before key instruments are due for revision	Consistent policy, legislation and planning processes to ensure that future flood risks are assessed and addressed Mandatory inclusion of flood controls in local planning schemes Nationwide investment in cost-effective, basic flood mapping, such as QRA maps	State government is responsible for policy, legislation, processes. Investment in large scale mapping exercises may need federal funding support.

Problem	Barriers	Reform Needed	Responsibility
	and complex processes for regular update and inclusion of flood information	Processes to facilitate prompt inclusion of new flood information into local planning schemes	Local government responsible for inclusion of flood risk in planning schemes. Federal government needs to ensure its own development projects consider flood risk
Inadequate incorporation of climate change into planning tools ²⁴	Flood modeling does not provide adequate certainty for local decision making	Better incorporation of climate change into building codes, at both national and state levels Assessment of adequacy of de facto standards, such as the 1:100 year flood event for climate change. Incorporation of palaeological information in mapping to increase awareness of potential flood area and to compensate for short flood records (e.g.QRA maps) Use of decision making systems that do not rely on information certainty. E.g. adaptive approaches can be identified that are low cost, 'soft', no-regrets, reversible, etc Alliances that pool local government resources to improve adaptive capacity	Primarily State government Local government can improve on low resolution mapping where required, and implement adaptive decision making systems Climate change alliances could be formed independently by local government but initial funding support by state government would facilitate this.

²⁴ Note attempts are currently underway to incorporate climate change into planning tools, such as the Queensland Government's climate change factor and the AR&R Revision Project (undertaken by Engineers Australia and funded by the Federal Government).

Problem	Barriers	Reform Needed	Responsibility
Inadequate on-the-ground application of land use and development controls	Lack of clarity about policy priorities from State government Insufficient resources for local government (both technical and financial) for on the ground flood risk assessment, prevention and mitigation Negative financial consequences of responsible decision making when land is down-zoned (e.g. reduced rates, legal action and compensation liabilities) Lack of financial consequence for those who make risky decisions	Improved clarity and guidance about policy priorities within and between governments Improved resourcing and technical support for local governments Incentives and better financial or legal support for responsible decision making and implementation of measures Reduced investment in communities that do not implement adequate controls²⁵	Primarily State Government, though Commonwealth also has a role in provision of financial resources
Flood risk information is not freely available	Financial consequences for landowners (e.g.drop in land values, rise in insurance premiums) Financial consequences for local governments if they apply the information – see above (if information is public they will be expected to use it)	Being addressed through the National Flood Risk Information Program ANZEMC Roadmap is expected to look at issues such as vendor disclosure	Local government

²⁵ Higher standards should apply to well-resourced urban communities than to rural communities which have fewer resources, and where consequences of flooding are lower

Problem	Barriers	Reform Needed	Responsibility
Implementation of maladaptive approaches to flooding	Localised implementation of flood control where those undertaking activities are unaware of or unconcerned about negative off-site effects Effective flood mitigation measures are sometimes counter-intuitive (e.g. vegetated, meandering waterways containing debris reduce flood damage but the temptation is to clear and straighten)	Administrative systems that support a catchment based approach to: • collection of flood information, • assessment and implementation of flood mitigation measures (considering cumulative impacts and positive and negative externalities) • development planning and application of market mechanisms such as PES Raising community awareness about most effective flood mitigation measures Broad stakeholder engagement is needed for optimal outcomes across sectors.	Catchment approaches need to be championed and empowered by State government. Can also be achieved through local government cooperation. Enforcement of regulations by local government and awareness raising activities NRM bodies are ideally placed to support awareness and implementation Community and industry stakeholder need to be involved

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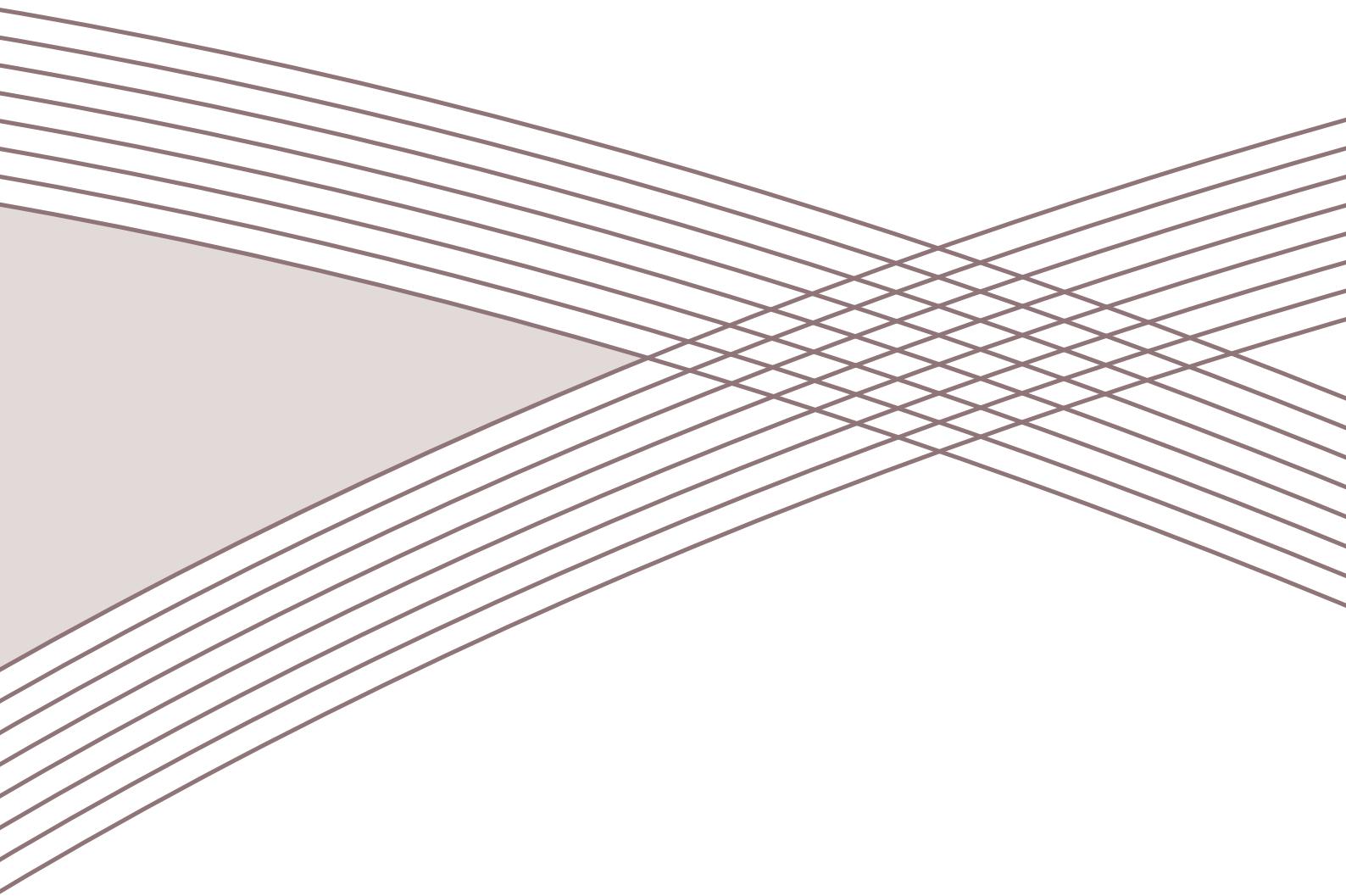
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ACRONYMS AND GLOSSARY

ACRONYM	IN FULL	COMMENT
ABCB	Australian Building Code Board	Develops minimum national building and plumbing standards.
AEMA	Australian Emergency Management Arrangements	Articulates emergency management responsibilities.
AEMC	Australian Emergency Management Committee	Former name of ANZEMC.
ANZEMC	Australia-New Zealand Emergency Management Committee	Reports to SCPEM.
COAG	Council of Australian Governments	Peak government body.
CMA	Catchment Management Authority	State agencies with boundaries defined by natural catchments. Only some states have CMAs and they have varying powers.
DCS	Department of Community Safety (QLD)	An agency with a role in flood approvals at the time of the 2010-11 floods.
DERM	Department of Environment and Resource Management (QLD)	An agency with a role in flood approvals at the time of the 2010-11 floods.
DFE	Defined Flood Event	A development planning tool based on a past flood event, generally close to the 1:100 year event.
DLGP	Department of Local Government and Planning (QLD)	An agency with a role in flood approvals at the time of the 2010-11 floods.
ENRC	Environment and Natural Resources Committee	Responsible for the Inquiry into Flood Mitigation Infrastructure in Victoria.
LAPP	Local Adaptation Pathways Program	A federal grants program to assist local communities adapt to climate change.
MCPEM	Ministerial Council for Police and Emergency Management	Former name of SCPEM.
NCCARF	National Climate Change Adaptation Research Facility	An agency that funds research into climate change adaptation to assist policy makers, business and the community.
NEMC	National Emergency Management Committee	Former name of ANZEMC.
NFRAG	National Flood Risk Advisory Group	Reports to ANZEMC.

ACRONYM	IN FULL	COMMENT
NFRIP	National Flood Risk Information Program	A federal program aiming to increase availability of flood risk information.
NDRRA	Natural Disaster Relief and Recovery Arrangements	Cost share arrangements between Commonwealth and State governments in the event of a natural disaster.
NSDR	National Strategy for Disaster Resilience	Guides Australian natural disaster policy.
PPRR	Prevention-Preparation-Response-Recovery	A commonly used emergency management framework. 'Prevention' includes mitigation and refers to eliminating or reducing the hazard or increasing the ability to withstand it. Flood information and risk assessment are prerequisites to the implementation of prevention measures. 'Preparation' reduces impacts by ensuring hazard awareness and appropriate human response.
QFCI	Queensland Floods Commission of Inquiry	An inquiry body established following the 2010-11 floods.
QRA	Queensland Reconstruction Authority	Established for a limited term to lead reconstruction efforts in Queensland following the 2010-11 floods and Cyclone Yasi.
ROC	Regional Organisation of Councils	An alliance of local governments to address specific regional issues.
SCCG	Sydney Coastal Councils Group	A ROC studied for this report.
SCPEM	Standing Committee on Police and Emergency Management	Reports to COAG.
SIRP	Synthesis and Integrative Research Program	The NCCARF program that funded the 'Living with Floods' report. This paper, also funded by NCCARF, draws on that report.
SPA	Sustainable Planning Act 2009 (QLD)	The primary legislation regulating development planning in Queensland, under which the Queensland Planning Provisions were drafted.
SPP 1/03	State Planning Policy 1/03	The most important Queensland planning instrument to ensure consideration of flood risks in development applications. Due for revision 2013.



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