CLIMATE CHANGE ADAPTATION AND FLOODING: AUSTRALIA'S STATUTORY AND INSTITUTIONAL ARRANGEMENTS

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Introduction

Flooding is Australia's most expensive natural hazard and 2010-2011 saw some of the biggest flood events in Australia's history. The federal government allocated $5.6 billion in recovery funding to Queensland and almost $1 billion to Victoria, primarily to restore public infrastructure (Gillard, 2011; VAGO, 2013). Climate change scenarios predict increasing intensity and frequency of floods, potentially exposing Australia to even greater damages in the future. Flood management is 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). It pointed overwhelmingly to the need for improvements in non-structural measures, particularly in the preventative phase of emergency management. It also found that successful and cost-effective approaches to flooding 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. Current policies and institutional arrangements are explored and assessed for their ability to address climate change threats. Reforms are also suggested to reduce Australia's future vulnerability to flood.

Methodology

This research was undertaken as part of a broader project, *Statutory frameworks, institutions and policy processes for climate adaptation,* funded by the National Climate Change Adaptation Research Facility (Hussey *et al.*, 2013) and formed one of the project's seven case studies (Wenger, 2013).

Research was based on literature review. Due to the nature of the topic, government documents formed a large proportion of source material, including flood reviews, policy documents, agreements and funding reports. The report also drew on work the author carried out for NCCARF project, *Living with floods: key lessons from Australia and abroad* (Wenger *et al.*, 2013). Flooding was analysed in terms of seven institutional mechanisms, namely intergovernmental function; intra-governmental function; regulation by prescription; planning processes; funding mechanisms; information and analysis; and supporting market arrangements. These were selected by the project team as being instruments that governments can use to stimulate adaptation to climate change (Hussey *et al.*, 2013).

Past research suggests that in terms of avoided damages, prevention is highly cost effective (BTRE, 2002; Healy and Malhotra, 2009). Moreover, 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). The paper therefore focuses on identifying the drivers

and barriers influencing the adoption of proactive prevention and mitigation approaches to flood management.

The scope of the original case study was limited to institutional arrangements in place at the time of the 2010-11 floods. This paper incorporates some recent changes.

Findings

Intergovernmental function

Under Australia's constitution state governments have primary responsibility for natural resources and, by extension, flood management. State and territory governments develop policy, strategies, tools and legislation, and devolve much of the responsibility for implementation to local government. States may also directly approve development, especially where projects have regional or statewide significance. Federal government involvement generally takes the form of exhortative and cooperative styled policy instruments such as intergovernmental agreements, and the provision of funding, information, standards and guidelines.

In recent times, disaster management has focused on resilience, a broad term that covers all aspects of disaster management, including prevention/mitigation, preparation, response and recovery (PPRR). It can be applied to communities, management systems and infrastructure. This moves away from 'mitigation', which became the program focus following a report to COAG on flood mitigation (DOTARS, 2004).

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. 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).

Other intergovernmental mechanisms applicable to flooding and adaptation to climate were studied (Australian Government, 2009; COAG, 2007; MCPEM-EM, 2009; AEMI, 2012; ABCB, 2012). Analysis found that implementation of some of these, including the Climate Change Adaptation Action Plan was patchy, while at the time of the 2010-11 floods, Australian Building Code Board had no standards that addressed flooding (Wenger, 2013).

Nevertheless, mechanisms 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. Strategies incorporate measures known to reduce exposure to flooding, such as improved development planning. Whether or not these mechanisms will translate to improved management on the ground remains doubtful. Other sections of this paper reveal many barriers, including the non-mandatory nature of many 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.

Intra-governmental function

Intra-governmental mechanisms for flood operate at all levels of government. These collaborations are important in ensuring a whole of government approach and are often highly efficient in 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 is particularly the case for many local government alliances such as the Sydney Coastal Councils Group (SCCG, 2012a; SCCG, 2012b). SCCG has effectively advocated the retention of strong climate change planning laws, has information exchange processes, and has formed partnerships with research institutions such as CSIRO to increase information relating to climate change adaptation. Ten such alliances cover most of Victoria (NAGA and SECCCA, 2012).

At the Federal government level, collaborative efforts have been established to implement the NSDR. The national flood risk information project (NFRIP), aiming to increase the availability of flood information, involves the Bureau of Meteorology, Geoscience Australia and Emergency Management Australia (Geoscience Australia, 2012).

Intra-government mechanisms are not always effective, however and significant issues were identified by the Queensland Floods Commission of Inquiry (QFCI) surrounding the application of flood controls in that state.

Arrangements to manage development in floodprone areas can involve interactions between multiple state departments. At the time of the 2010-11 floods, State Planning Policy 1/03 (SPP1/03) was the most important state planning instrument for considering flood risk in Queensland and was administered by the Department of Community Safety (DCS). The Department of Environment and Resource Management had an advisory role and the Minister for Local Government and Planning was responsible for approving planning schemes. The Inquiry found that recommendations by DCS to ensure compliance with SPP1/03, including sufficient flood mapping and nomination of a defined flood event, were routinely disregarded by the Department of Local Government and Planning, resulting in floodprone communities, including Brisbane and Emerald, having non-compliant planning schemes. This raised serious questions about administrative procedures and accountability measures. Queensland state government departments have since been restructured and the Department of State Development, Infrastructure and Planning is responsible for both SPP administration and planning schemes.

Conflicting policy objectives that pit short term economic gains against long term damage costs are likely to be a root cause in the failure of the Queensland approvals process. Many policy conflicts are directly or indirectly related to upfront development costs and housing affordability. The provision of cheap (but risky) residential sites to disadvantaged groups who can't afford premium, flood-free land only increases their long term vulnerability to climate change. This is not consistent with the 'community resilience' approach. Neither is it a just solution in terms of the impacts people will be exposed to.

State and local governments are responsible 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.

Regulation by prescription

State planning legislation

Development planning is a key measure for flood prevention. However, prevention of development in floodprone areas has proved difficult to achieve.

The Queensland Planning Provisions (revised October 2013) are developed under the *Sustainable Planning Act 2009 (Qld)* and flood hazard is included in its standard suite of overlays. At the time of the 2010-11 floods, the overlay was *optional*, even where flood mapping information was available (QFCI, 2012). Section 8.1 of the current version lists specific circumstances where application of an overlay is now a minimum requirement (Queensland Government, 2013).

Where provisions are mandatory, they may have conditional application, for example, they depend on the existence of flood mapping to identify floodprone areas and may also require the adoption of a defined flood event. This was a serious issue for the application of Queensland's recently expired SPP1/03 and Victoria's Planning Provisions (QFCI, 2012; Comrie, 2011).

Queensland replaced SPP1/03 and other state planning policies with a single state planning policy in December 2013 (DSDIP, 2013b). Provisions in the policy are general, but are supported by guidelines (in draft) (DSDIP, 2013a). *Sustainable Planning Act 2009* (s117(1); s119; s130) requires that local governments follow guideline processes.

Application of planning legislation and instruments to address flood can be significantly compromised by exemptions. The QFCI examined many examples where development was exempt from applying SPP1/03 (QFCI, 2012, pp. 91, 98, 108, 149, 153, 156, 166, 169, 175, 190-193, 197, 242-244). Another concern was that satellite planning schemes did not have to comply with SPP1/03, among them, a scheme designed to expedite approval of development applications for affordable housing (QFCI, 2012).

State legislation relating to land-use planning sometimes requires sea level rise to be taken into account (Gibbs and Hill, 2011) but most states give little consideration to the effect changes in rainfall patterns will have on inland flooding. In Queensland, draft state planning policy guidelines require 'climate variability' to be incorporated into flood studies using the Australian Rainfall and Runoff Guidelines (currently under revision) and climate change factors developed by its inland flood review (State of Queensland, 2010; DSDIP, 2013a).

The federal government role

Under constitutional arrangements, the federal government has little ability to legislate on planning issues and 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 federal government is similarly constrained but 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 floodprone 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). While national flood insurance is unlikely to be

an approach suitable for Australia, it demonstrates that there are options for the federal government to apply legislative and financial incentives to reduce future disaster relief and recovery bills.

Building codes and standards

National building standards are set through the Building Code of Australia. These are *minimum* standards and states may enact more rigorous standards. At the time of the 2010-11 floods there were no national standards for building in floodprone areas. The Australian Building Codes Board has since developed a standard for residential development (ABCB, 2012). The standard uses definitions such as 'defined flood event' that rely on *historic* flood levels. The standard makes no reference to climate change.

The accompanying *Information Handbook* references climate change in its introduction but the purpose of the document is 'not mandatory or regulatory in nature' and it is questionable whether it will have much influence ensuring climate change is incorporated into key local planning tools.

Catchment management authorities (CMAs) and the development approval process

Under Victoria's *Planning and Environment Act 1987,* if land is within a flood zone or overlay, planning permits have to be referred to the relevant CMA. In 2013, state government substantially weakened CMA powers, changing them from designated *determining* referral authorities to designated *recommending* referral authorities (DTPLI, 2013). Prior to this, CMAs had the power to veto or impose conditions on inappropriate development. The Comrie Review recommended that CMAs retain their powers in the development approvals process as they have technical expertise in flood management and a long term understanding of flood risk implications (Comrie 2011). In NSW, CMA legislation has also been weakened. The *Catchment Management Authorities Act (2003)* was repealed in January 2014 and CMAs were amalgamated with other agencies into new Local Land Services agencies. Catchment boundaries were redrawn to reflect production areas and local government boundaries (NSW Government, 2013). This is unfortunate as CMAs have a long term perspective that is particularly relevant to adapting to future flood scenarios.

Planning processes

The adequacy of planning tools to accommodate climate change

There are 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. This is likely to be a serious impediment to the incorporation of climate change information into planning schemes (Wenger, 2013).

Adoption of a Defined Flood Event (DFE) or Flood Level is a key planning tool in both Queensland and Victoria. Generally a 1:100 year event is selected for residential areas (QFCI, 2012, 147; Comrie, 2011).

The accuracy of flood mapping is a significant problem. Uncertainties regarding Brisbane's 1:100 year floodline were identified by the QFCI, with past estimates ranging from 3.16 m to 5.34 m at the city gauge (QFCI, 2012; QFCI, 2011). Recent studies suggest that the use of the 1:100 year event standard for flood control may be inadequate. Whether due to inaccurate data, climate change or urbanisation, the 1:100 floodline is not static but can move. What was once a 1:100 year event is likely to become a more frequent occurrence. This can place people at unacceptable risk of flooding (Wenger *et al.*, 2012; Hirabayashi *et al.*, 2013; Pedruco and Watkinson, 2010; Freitag *et al.*, 2009).

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.

There has been debate about the acceptability of 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). Queensland's new state planning policy guidelines allow this option (DSDIP, 2013a). This raises the question of *who will bear the cost of that risk*: the communities themselves, insurance companies, charities, taxpayers or future generations. 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 the cost (Milliard, 2012). As flood hazard is likely to increase, accepting lower control standards appears maladaptive.

Ecosystem approaches to flood management

Some of the most expensive flood damage is caused by water velocity. This affects infrastructure such as roads, bridges and railways, erodes farmland, reduces water quality and decreases the storage capacity of dams due to siltation (Parliament of Victoria, 2012; Rutherfurd *et al.*, 2007; Wenger *et al.*, 2013).

In countries such as the Netherlands and China this is addressed through improved land management. 'Room for the river' initiatives, involving wetland restoration, relocation, levee removal or setback and flood-compatible land use increase the floodable area, reducing flood depth and velocity. Often these changes are associated with multiple economic, social, environmental and health benefits (Wenger *et al.*, 2013).

Ecosystems approaches rely strongly on a catchment-wide management. Improving flood retention in *upper* catchments (where land value is generally lower) delays downstream flooding, increases warning times, potentially reduces damage and casualties from flash flooding. It also reduces flood peaks, and crucially, decreases the power of floodwaters in the middle and lower catchments. Another benefit is that water retention allows aquifer recharge, a significant benefit that could help address increasing severity of climate change drought. Suitable interventions in productive middle catchments include bank stabilisation with riparian vegetation.

Ecosystem approaches to flood mitigation are probably the least understood in Australia. One of the biggest challenges is that they require implementation on a catchment scale. Local council responsibilities stop at municipal boundaries and achieving a catchment approach to flood management is beyond the capacity of most councils. Segregation between traditional flood management and natural resource management disciplines and

lack of community understanding about hydrology also constitute significant barriers (Parliament of Victoria, 2012; see also interviews, Wenger *et al.*, 2013).

CMAs appear well placed to implement ecosystem approaches to flood control, and in some states such as Victoria have been doing so for many years through their management of riparian vegetation. However programs of similar scope and complexity to those overseas would require adequate resourcing and authority.

Promisingly, Queensland's new SPP recognises the role of natural assets in flood regulation and requires planning schemes to include provisions for development to 'maintain and enhance natural processes and the protective function of landforms and vegetation that can mitigate the risks associated with the natural hazard' (DSDIP, 2013b). However, the same document supports the use of mitigation infrastructure, which commonly undermines natural flood mitigation (Freitag *et al.*, 2009; Tockner *et al.*, 2008).

Funding mechanisms

National partnership agreement on natural disaster resilience

The Natural Disaster Resilience Grants Scheme, administered under the National Partnership Agreement on Natural Disaster Resilience, currently under revision, is the primary funding mechanism that supports disaster prevention in Australia. The amount allocated by the federal government to this agreement (2009-10 to 2012-13) was approximately $100 million, to be divided between all the States and Territories (COAG, 2009). An additional $3.6 million per year is allocated through National Emergency Management Projects (AGD, nd). Combined, these funding mechanisms provide approximately $28.7 million per annum of federal money to natural disaster resilience.

The National Partnership Agreement is extremely broad. 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 disadvantage of this breadth of coverage is that limited funds are thinly spread. Australia's flood damages (1967-2005) averaged $377 million per year (BITRE, 2008) and state and federal reconstruction costs following the 2010-11 floods were close to $10 billion (Wenger, 2013). In this context, annual allocation of $30 million by the federal government towards disaster resilience appears grossly insufficient.

The Partnership Agreement is touted as addressing climate change adaptation on websites and in annual reports (AGD, 2010; AGD, 2013). However, the Partnership Agreement itself makes no mention of climate change and a study of the eight implementation plans for 2011-12 found that six made no reference to climate change. Lack of detail makes it hard to gauge the level to which climate change is integrated.

Natural disaster relief and recovery arrangements (NDRRA)

Disaster recovery is primarily funded through the NDRRA grants process, activated when financial thresholds for disaster costs are exceeded. For large disasters, the federal government shares disaster costs with state governments.

Commonwealth expenditure on public infrastructure reconstruction following the 2010-11 floods was around $6.6 billion. This represents three quarters of the total expense funded through the NDRRA, with the balance funded by State governments (AGD, 2011). 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 those living in flood affected areas). It also reduced or discontinued spending to numerous Commonwealth government programs. Ironically, most of the programs sacrificed were designed to mitigate climate change (Gillard, 2011).

Many have noted that disaster relief and recovery funding can have the perverse effect of removing the incentive to invest in prevention. While accepting the benefits of occupying floodplains, the costs of occupying that land are externalised to federal governments and taxpayers (ASFPM, 2007; Larson, 2009; Wright, 2000).

While recovery is generally not viewed as being 'prevention', it can become so. The 1993 floods in the upper Mississippi caused a major shift in disaster relief in the United States resulting in a "consensus that rebuilding or restoring to pre-flood conditions was not an acceptable policy position". Recovery and mitigation became increasingly integrated in the United States and for some disasters they completely merged (Wright, 2000). Analyses of avoided flood damages indicate that US investment in preventative recovery, particularly relocation, have saved billions of dollars in avoided damages (Freitag *et al.*, 2009; NWF, 1998). Similarly, avoided damage at Grantham, Queensland, in 2013 more than covered the cost of its relocation (LVRC, 2013).

The NSDR includes among its priority outcomes:

> 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)

However, disaster mitigation is not currently integrated into Australia's disaster relief other than for public assets. While there were isolated examples of relocation following the 2010-11 floods at Grantham, and the Lower Loddon, Victoria, relocation is not a consistent policy. COAG's objective seems far from being realised.

In Australia, prevention is integrated into recovery (for public assets) through 'betterment' provisions, or rebuilding to improved standards. While technically allowed by the NDRRA, no betterment projects had ever been approved by the Commonwealth at the time of the 2010-11 floods (Comrie, 2011). A once-off betterment fund has since been created for Queensland, and eighteen infrastructure projects have received approval (Gillard, 2013; QRA, 2014). However, the Victorian Auditor-General's Office reported none of Victoria's 23 proposed betterment projects had been approved as at the end of the 2012-13 financial year (VAGO, 2013).

Difficulties in achieving betterment include the speed with which recovery measures need to be implemented following a disaster and the time required to assess options (Wright, 2000; Wenger *et al.*, 2013). In the United States, this is overcome by a statutory provision that 15% of federal disaster costs be available for preventative recovery. Assessment is based on cumulative damages as a proportion of property value (FEMA, 2010).

Information and analysis

Information on climate change related flooding is abundant, albeit with an emphasis on coastal flooding due to sea level rise. 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, reviews following the 2010-11 floods found that local flood information is often lacking, is not publically available or is not used. In Victoria, 80% of floodplains were mapped for a 1:100 year event but only 70% of these mapped areas were incorporated in planning schemes (Comrie, 2011). 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 SPP1/03 Guideline (QFCI 2012). Since this time, both states have invested in flood mapping, including large scale mapping for all Queensland floodplains (QRA, 2011; Walsh, 2011).

Lack of financial and/or technical resources are a significant barrier to undertaking flood studies, flood mapping and risk assessment and there are also issues with the accuracy, completeness and currency of flood information where there is no requirement for periodic update. Flood studies are often limited to mapping the 1:100 year events. Recent flood reviews suggest this is not sufficient and events of both greater and lower likelihood need to be included, up to probable maximum flood (Comrie, 2011; QFCI, 2012). These recommendations are relevant to the consideration of climate change scenarios and emergency response. Recent flood mapping funded by the Victorian government includes multiple flood levels and Queensland's new SPP Guidelines also recommend identification of a range of flood events (Comrie, 2011; DSDIP, 2013a).

A further issue is that municipal boundaries do not coincide with catchment boundaries, resulting in local-scale flood studies. Better management outcomes can be achieved where local flood studies 'nest' within an overall catchment study and large-scale Queensland Reconstruction Authority (QRA) maps may help to address this (Wenger *et al*., 2013).

The QRA maps draw on multiple sources, including soil type, to identify areas that have inundated at some point in the past, adjusted using current contour information (QFCI, 2012; QRA, 2011). The use of geological record to provide insight into flood behaviour is useful for countries like Australia, where "short historical records may give a false impression of the nature of the flood hazard for a region" (Nott, 2006). Understanding past extreme flooding events and locations of ancient watercourses could improve perceptions of potential risks and reduce vulnerability to 'unprecedented' floods likely under climate change.

Awareness of flood risk is often seen as a key factor to increase community resilience, enabling shared responsibility. 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 flood risk information is the direction Australia is headed regardless of current barriers. While public awareness of flood risk is important to support community resilience, it has limitations. There are socio-economic implications in that even if risks are widely known, disadvantaged 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. Risk awareness is no substitute for good planning and development controls.

Incorporation of future threats into flood information

The need to downscale climate change flood information to catchment level has been identified as a key issue to make information locally relevant and decrease uncertainty (Milly *et al*., 2008; Productivity Commission, 2012). National and state initiatives aim to address this (State of Queensland, 2010; Wong, 2008). However, some suggest that improved modelling is unlikely to yield the degree of certainty that planners require. For example, perception of liability can be a significant barrier to the provision of flood risk information and its incorporation into planning schemes. This is particularly the case for climate change information due to difficulty justifying decisions in the absence of certainty (Comrie, 2011; QFCI, 2012; Trowbridge *et al*., 2011). Hallegatte (2009) argues that decision making frameworks need to be changed to *accommodate* this uncertainty and he proposes a ranking system to assess adaptation options.

Councils may be liable for losses if they provide flood advice, act or fail to act in respect to flood-prone land (QFCI, 2012). Potentially, councils could also be liable for failure to take climate change risks into account (Gibbs and Hill, 2011; Godden and Kung, 2011). Queensland's *Sustainable Planning Act 2009*, s706(1)(i) allows compensation exempt changes to planning schemes due to flood risk but wording has been criticised as open to interpretation (Queensland Government, 2014; PIA, 2013). Statutory immunity is provided by section 733 of the *Local Government Act 1993 (NSW)*, recently amended to include climate change information.

Market mechanisms

Market based mechanisms can help to achieve improved flood mitigation, including provision of flood risk information to potential property purchasers, insurance incentives and payment for services. For example, in NSW S149 certificates contain information on development restrictions and conveyance legislation requires them to be attached to land sale contracts.

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. New products could also facilitate adaption to flooding. In the USA for example, flood insurance offers supplementary payouts to enable an improved standard of repair in return for an additional premium (Wright, 2000; IFMRC, 1994).

Payment for ecological services has great potential to fund catchment-scale approaches, providing compensation for property owners who allow their land to flood, reducing impacts for people downstream. Such 'flood mitigation' businesses could diversify farm income sources as well as providing public benefits. This requires a catchment approach to flood management as measures generally need to be implemented in upper catchments, while benefits are found in middle and lower catchments, and payments would need to be transferred accordingly. Pricing would need to be adequate to provide incentive for participation. Examples of such schemes in Australia include a Moreton Bay catchment proposal to reduce erosion and sediment and Victoria's 'Trust for Nature' that funds landholders to restore and protect land through biodiversity offset agreements (QCC, 2012; Trust for Nature, 2012).

Conclusion

The current approach to flood management in Australia is 'resilience' and through federal leadership and funding, it 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, greater self-sufficiency is a sensible adaptation if it can be achieved.

Perhaps the most significant aspect of Australia's resilience approach is the greater availability of flood risk information. While funding is limited, it has enabled the development of risk assessments and adaptation plans, as well as community awareness raising and development or revision of key flood management tools. This could prove to be a major step forward in awareness of flood risk and the need to mitigate. Other NSDR initiatives, 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.

Drawbacks of the resilience approach include the lack of clarity about what 'resilience' means in terms of implementing the most sustainable and adaptive on-the-ground measures. Socio-economic aspects are also problematic in that many who live in floodprone areas are disadvantaged and less able to afford measures that would reduce their susceptibility.

There are significant impediments to achieving improved flood management. These 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; disincentives such as lack of financial consequences for those making risky development decisions; and planning that is based on administrative boundaries rather than natural geographic ones.

In order to achieve improved flood management, reforms are needed at all three levels of government. Analysis suggests that areas most in need of reform include consistent policy, legislation and planning processes to ensure that future flood risks are assessed and addressed; adequate resourcing of local governments; improved support for flood mitigation/prevention; improved public and private betterment mechanisms; administrative structures enabling a catchment based approach to flood management; training and education programs to support ecosystems approaches; and better incorporation of climate change scenarios into planning tools. With regards prevention measures, basic flood mapping is needed nation-wide, as well as improved incorporation of flood risk into development planning, relocation of those most at risk and support for ecosystems approaches. Better incorporation of climate change threats can be achieved where floodprone land (up to probable maximum flood) is identified; where decision-making relies less on information certainty and where planning tools incorporate climate threats (including building codes and processes to facilitate planning scheme updates).

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