A review of Australian institutions for riparian adaptation to climate change

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ABSTRACT

Australia represents a global proving ground for effective riparian climate change adaptation due to its scale and diversity, extreme variation in runoff and degrees of aridity. An array of autonomous riparian zone (RZ) management adaptations have emerged in Australia that have captivated the international community but have yet to be effectively delivered. This paper reviews government policies, governance structures, the application of market-based instruments and voluntary measures to ask why Australia has not achieved more. We find promise in: the resurgence of application of indigenous knowledge and engagement in management; understanding of the catalytic roles of women, means of better engaging individuals, strengthening of social networks and fostering leadership in rural communities; transferring of urban resources to their rural hinterlands; better engaging communities through campaigns, businesses and political leaders; and strategic research programmes. These findings have application in other difficult hydrologies. We contend that government and market-based programmes are underpinned by voluntary and cultural institutions, and that these require strengthening through fostering of an ethic to conserve RZs as the core element of the biophysical and human landscape. It calls for stakeholders to adopt a common vision for conservation of RZs that can sustain implementation through institutional changes.

Key words | climate change, governance, institutions, market-based instruments, scale, social

INTRODUCTION

The zones of interaction between freshwater and land in river corridors, known as riparian zones (RZs), are critical areas for biodiversity, biogeochemical cycles and water supply, and have provided ecosystem services for people through time (MEA 2005). Early land settlements followed riparian corridors and valley floors which provided water and rich sources of food and fibre thanks to their diverse plant and animal communities. Worldwide, valley floors now boast highly productive agricultural lands and major cities. As a result, despite being at the centre of life for people, they now represent the world’s most altered ecosystems and consequently are highly sensitive to climate change (Vörösmarty et al. 2000; MEA 2005; Bates et al. 2008; Vörösmarty et al. 2010). Paradoxically, as we ourselves are faced with the challenges of a changing climate, we will be increasingly dependent on RZs and the services they provide, making their preservation a high priority (MEA 2005; Vörösmarty et al. 2010).

RZs are among the first systems impacted by climate change. Climate shifts are having dramatic impacts on biodiversity, ecosystem function and human well-being along RZs (Daufresne & Boet 2007; Palmer et al. 2008; Kingsford 2011).
Human behaviour also changes in the face of a changing climate, impacting and changing the stresses on river systems (Pittock 2010). Increasing the resilience and resistance of RZs to a changing climate may help alleviate pressures of climate change on people (Capon et al. 2013). For example, the risk of fire or increased temperatures in streams, and biogeochemical imbalances leading to events like blackwater fish kills which have wider repercussions for water quality and availability (Olden & Naiman 2009; Davies 2010). Institutional arrangements and public policy initiatives across many sectors will impact RZs as hot spots for population and production making them a litmus test for the efficacy of climate change adaptation strategies (Matthews & Wickel 2009; Nelson et al. 2009).

As the driest inhabited continent on Earth, with a landmass stretching across 34 degrees of latitude, Australia has a large diversity of RZs which experience a wide variety of climates and high climate variability, and where colonisation has significantly stressed ecosystems. We consider institutions for adaptation within five broadly differing bioclimatic systems that encompass a range of Australian RZ types and vary in their exposure to projected climate change: two upland bioregions – tropical highlands and southern highlands; and three lowland bioregions – tropical savanna, temperate coastal and drylands (Capon et al. 2013). Examples of autonomous adaptation within Australian RZs provide lessons that may enhance planned initiatives for RZ adaptation to climate change.

The country and its people have had a long history of autonomous adaptation to a highly variable climate system (Pittock & Connell 2010). Traditional inhabitants evolved migratory patterns based on riparian resources. Colonial farmers had boom and bust farming systems, while modern farmers have implemented strategies that optimise yields in the face of variability (Pratley & Robertson 1998). The development of impoundments to store water during wet years allows urban communities to survive during extended droughts (Connell 2007). Riparian systems are susceptible to the tragedy of the commons owing to their longitudinal connectedness within river catchments. Not all of these autonomous adaptations are sustainable and there has been a push to coordinate responses to catchment problems (Robins 2007). At the centre of these is the often unvoiced realisation that RZs are the centre of our own adaptation to many stressors.

In this review paper we draw lessons from three categories of institutional mechanisms practiced in Australia that have global relevance. We start by assessing lessons that can be drawn from institutions aimed at managing RZ adaptation across scales. We then consider the contributions of three types of institutions: governments, markets and voluntary measures. We finish by focusing on cultural institutions that have been especially influential, leading to conclusions on lessons that may advance climate change adaptation in RZs.

INSTITUTIONS FOR MANAGING ACROSS SCALES

RZs cross ecological, cultural and political borders such that effective climate change adaptation needs to occur through linked and mutually supportive action at difference scales (Adger et al. 2005a, b; Cash et al. 2006). Diversity in conditions means that adaptation measures often need to be designed and implemented at the local scale (Dovers & Hezri 2010). Adaptation is most effective when it is undertaken by enhancing existing institutions, such as catchment management organisations (Naiman 1992; Milliken 1999), rather than establishing new ones (Dovers 2009; Pittock 2009; Dovers & Hezri 2010).

As a large country, Australia has a long history of natural resource management institutions intended to operate at different scales which can inform RZ adaption. Under Australia’s constitution, the Federal Government has a limited but expanding role in governing water and other natural resources based on regulating trading corporations (businesses) and implementing treaties (Connell 2007). In 2007 the Federal Government relied on environmental treaties, such as the Ramsar Convention on Wetlands, to begin to directly regulate water allocation in the Murray-Darling Basin (Pittock et al. 2010). More typically the Federal Government seeks to harmonise state and federal policies, for example, through the National Water Initiative (NWC 2011), and use transfer payments to encourage state implementation. The state (provincial) governments have primary responsibility for natural resources but are frequently criticised for favouring economic development over sustainable management (Connell 2007). Local governments have had limited roles in governing natural resources outside of urban areas.
Enforcement of environmental laws across such a vast country is challenging. In recent decades peak agricultural and mining industry associations, environmental groups and Aboriginal organisations have influenced land and water use institutions of governments, including by challenging decisions by developers or governments in the courts (Connell 2007). One response at the sub-state scale has been the establishment of multi-stakeholder catchment management agencies (also known as natural resource management regional bodies) as co-regulatory structures under state laws, and operating within a national policy framework (Robins 2007; Robins & Kanowski 2011).

From the late 1980s local communities were encouraged by governments to establish landcare groups: voluntary organisations for the conservation and restoration of local biodiversity, waterways and soils. This cultural movement successfully engaged a large portion of farmers in management of the landscape, including RZs (Curtis & Lockwood 2000; Robins 2007). However they were criticised as lacking strategic focus and expertise to maximise the environmental benefits from their investments, and they have waned in the past six years with a reduction in government support (Robins & Kanowski 2011). The landcare movement was underpinned by regional natural resource management bodies formed under state laws, often as catchment management authorities. These bring together government and non-government stakeholders to identify priorities for management of natural resources, including RZs. In part the intention was subsidiarity. The extent to which these bodies have had advisory versus management roles has varied between states and over time. Competition with state government environment and natural resource departments has seen these bodies being built up, changed frequently and torn down. Lessons emerging from this experience are the need for a clear understanding of the roles of local institutions in agreeing on locally appropriate means of instituting policies of state and national governments, a degree of institutional stability, continuity based on having some independent sources of income, and the need to prioritise interventions and assess their effectiveness (Curtis & Lockwood 2000; Pittock 2009; Pannell & Roberts 2010; Robins & Kanowski 2011; Pannell et al. 2012).

At a state (provincial) scale there have been extensive policy efforts to systematically manage RZs, including for adaptation to climate change. Some innovative freshwater protected area laws have been adopted but unsystematically implemented (Nevill 2007). Despite national agreements in 2004, environmental flows have not been well implemented (NWC 2011). In the Australian federation, the lack of monetary and legal penalties for non-compliance or effective financial incentives for implementation at a state level inhibits implementation of national policies (Pittock & Connell 2010). In the case of the Murray–Darling Basin, which covers a seventh of the continent, a management Authority has been formed and a Basin Plan adopted with agreement of six governments but effective riparian adaptation has been limited by poor planning, conflicting policies, contested reallocation of water and an overly narrow mandate (Pittock & Connell 2010).

The need for Federal Government involvement in climate change adaptation is contested, with economic rationalists arguing that autonomous adaptation by individuals, business and local governments will largely suffice (Productivity Commission 2013) while other government agencies argue for key leadership and enabling roles (DIICCSRTE 2013). Nationally, Australia’s climate change, adaptation and water policies are not well linked and a number of conflicts are evident. For example, carbon sequestration policies do not adequately consider the resulting consumption of water (Pittock et al. 2013). Federal Government adaptation papers do propose to prioritise adaptation in the water sector (Australian Government 2010; DIICCSRTE 2013). Despite the presence of a range of institutions that could facilitate RZ adaptation across scales, actions are constrained by a number of barriers. These include the paucity of institutions for integration across governments, with other levels of government and stakeholders, frequent restructuring, limited mandates, lack of independent income and limited accountability mechanisms (Ross & Dovers 2008; Pittock 2011). We now consider different RZ adaptation policy measures in Australia in more depth.

**INSTITUTIONAL CONTRIBUTIONS TO ADAPTATION**

Effective adaptation programmes should draw judiciously from a range of policy instruments to include complementary
governance, market-based and voluntary instruments (Rose 2005; IPCC 2007).

**Governance measures**

RZ adaptation requires integration of governance measures (including strong regulatory frameworks) across a number of sectors, not least agriculture, water, biodiversity and climate change. Effective integrative governance requires leadership, mandates, accountability mechanisms and institutions for integration across governments, with other levels of government and stakeholders (Ross & Dovers 2008; Pittock 2011). Adoption of new policies is not usually a linear or logical process, and proponents often need to exploit policy reform windows (Meijerink & Huitema 2009).

RZ governance in Australia has been contested from the time of federation (Connell 2007). A vision of populating and developing the nation through subsidised agricultural development saw extensive conversion of rivers in the two upland and temperate coastal bioregions to supply water in the face of great climatic variability, with governments acting as proponents (Connell 2007). As the limits of these resources have been reached, increasing conflicts between upstream and downstream interests has seen governments try to become umpires of sustainability. Policy entrepreneurs have used extreme droughts, the emergence of economic rationalist policies, international environmental agreements and new political leaders to increase the role of the federal government and reliance on market-based instruments for more sustainable natural resources use (Connell 2007; Meijerink & Huitema 2009). However, the paradigms of subsidised agricultural development (primarily of irrigated agriculture) versus more sustainable management are competing, leading to conflicting policies (Pittock & Connell 2010; Connell 2011a). There have also been efforts to intensify water-based agricultural development in the tropical savanna bioregion.

**Role of market-based instruments in riparian adaptation**

Research and experience with the use of market-based instruments (MBIs) in Australia suggests that there is potential to provide more flexibility in management than traditional regulatory and fixed payment schemes. It has also shown the risks if such instruments are poorly designed. MBIs have been adopted in Australia in two different contexts. The first arose in the 1990s as part of the National Competition Policy designed to increase economic productivity by separating government service provision and regulatory functions, reducing subsidies, increasing competition and reducing transaction costs. For natural resources, capped markets in tradeable rights were established to limit over-exploitation and enable rights to transfer to higher-value producers in sectors such as forestry, fisheries and water (Grafton 2011). A principle of cost recovery by water supply agencies was adopted (Quiggin 2001). Federal and state governments agreed to reduce diversions to sustainable levels, harmonise water entitlements as a share of the available resource and separate water from land titles (McKay 2005). These measures could drive efficiencies in irrigated agricultural production and help sustain adequate environmental flows to RZs in areas where water is limited and scarcity is anticipated to be exacerbated by climate change (Grafton 2011; Grafton et al. 2012), yet implementation remains incomplete (NWC 2011). There have been socio-economic benefits from water trading in enabling permanent crops and high-value agricultural production to be sustained during drought through purchase of water entitlements from other users (Grafton 2011). Design flaws, however, led to a number of perverse impacts on freshwater ecosystems. In the transitional stages of implementation, diversions increased with the financial incentive to fully exploit previously under-utilised water entitlements. Further, many existing and emerging inflow reduction activities were not included within the surface water cap, including groundwater extraction and forest plantation establishment (Young 2010). The establishment of a carbon market that treats water use as an externality, suggest that further perverse impacts are likely without better integration of markets (NWC 2011). From an environmental perspective, it is arguable whether tradeable water rights have made it easier to restore environmental flows through acquisition of water rights and whether the stronger legal rights associated with entitlements-based water will benefit the environment (Young 2010; Connell 2011b).

Second, more targeted uses of MBIs are being piloted to redress particular environmental problems, including taxes, subsidies, covenants and revolving funds, cap-and-trade
schemes, offset markets, tradeable rights or quotas, and baseline-and-credit schemes (Stavins 1995; Whitten et al. 2004; Grafton 2005). While there has been extensive experimentation, widespread adoption has not occurred. Reasons for this failure include the lack of an independent source of income for catchment management authorities to pay for such reforms, as well as the varying motivations of communities for implementing reforms (see below; Curtis & Robertson 2003; Seymour et al. 2011). The limitations in government programmes and MBIs outlined here have resulted in a great reliance on voluntary measures for management and adaptation.

Voluntary measures

In landscapes as vast as those within Australia, regulating for uptake of strategies and adherence to market-based instruments is fraught with risk because of the infeasibility of enforcement. Transaction costs can become insurmountable if local communities resist top-down measures (Sumalde 2004), or where regulations are not complied with (Sutinen & Kuperan 1999; Crawford et al. 2004). In situations where regulations are undesirable and market-based instruments are limited, voluntary measures are vital. There is a long history of such measures in all parts of Australia that include movements like the landcare groups and indigenous land and sea rangers. However, landholders are motivated by a range of factors (Marshall et al. 2010). For example, business-oriented landholders may be interested in market-based instruments, whereas lifestyle-oriented landholders may be more motivated by the aims of a strategy and whether it aligns with their personal interests (Moon & Cocklin 2011; Seymour et al. 2011).

Landholders tend to identify strongly with their occupation, and take pride in their own knowledge, skills, judgements and experiences (Cumming & Collier 2005; Frank et al. 2011; Marshall et al. 2011a). Whilst a strong feeling of identity can be a positive driver for people and communities to sustain their livelihoods, it can also erect psychological barriers against behavioural change (Stoll-Kleemann et al. 2001; Hinds & Sparks 2008; Adger et al. 2011). These denial mechanisms cause individuals to heighten the cost of behaviour change, blame others for inaction and reject uncertain science that projects future, not immediate, problems (Moon & Cocklin 2011). In these instances, the strategies that are likely to work best will be those that match the social identities that people have created around themselves. In this context, we now examine lessons from Australian institutions that have successfully engaged with people and social identities in the context of RZ management.

CULTURAL INSTITUTIONS

In our assessment undertaken at an Australian National Climate Change Adaptation Research Facility workshop, ten key cultural initiatives and resulting lessons for enhancing RZ management and adaptation were identified that may aid programmes elsewhere in the world. We begin with those initiatives at more local scales before moving to larger scales.

Indigenous institutions

A key challenge in Australia is to include indigenous people as significant partners in the adaptive management of RZs (Langton 1998; Howitt 2001; Jackson et al. 2005; Finn & Jackson 2011). In the tropical savanna and drylands bioregions in particular, indigenous people constitute a large and growing percentage of the population, are major landholders and are involved in primary industries (Langton & Godden 2009). Moreover, indigenous communities are directly dependent on RZs for their food resources and are consequently more vulnerable to changes in RZs (Peloquin & Berkes 2009; Finn & Jackson 2011). The rights of indigenous groups to be consulted over decisions about natural resource management have received formal and informal recognition through legislation, policies and corporate responsibility initiatives (Langton et al. 2005; Berkes 2009; Langton & Godden 2009).

Many indigenous institutions, such as representative bodies, local councils and natural resource management units, are already actively engaged in the management of RZs through both traditional and more modern strategies. Indigenous belief systems already have a well-established ‘environmental ethic’ that positions the health of the environment (typically called ‘caring for country’) as fundamental to the health and wellbeing of Aboriginal people (Rose 2004; Salik & Ross 2009). This is based in part on each individual
tribal group’s traditional ecological knowledge (TEK) of their local environments (Rose 1996; Berkes 1999; Walsh 2008). Collaborative partnerships between scientists and indigenous groups, which draw on both TEK and western science, have heralded increased knowledge about RZs as well as improved environmental management techniques (Howitt 2001; Yibarbuk et al. 2001; Berkes 2009; Russell-Smith et al. 2009). By investing in and empowering indigenous institutions about RZ issues there is an opportunity to contribute to a broader riparian conservation ethic.

Rural women

Investing in women who are well embedded within the catchment’s formal and informal social network is a key pathway to encourage the development of an environmental ethic in all parts of Australia. Men working on the land are often too busy to invest in developing social capital within their lives because of labour-shortages and the costs of labour that require them to personally undertake labouring roles on their land. Women are often better linked with broader society through family duties and off-farm work, and can be better informed as to what societal norms and attitudes towards environmental practices are (Campbell 1997; Davidson & Black 2001; Fincher & Panelli 2001). Women may be more likely to switch their personal identities towards ‘land stewardship’, as women tend to create more identities than men, and appear to be better able to switch between and take on new identities (Lankester 2013). By contrast, men become particularly attached to a relatively small number of identities, and when these identities are threatened, psychological impacts or mental health issues can be observed. For example, during drought periods in rural Australia, men are more likely to suicide than women (Berry et al. 2011). Empowering women within a social network to develop and deliver ‘messages’ about catchment health and conservation successfully promotes a riparian ethic (Alston & Mason 2008; Alston 2011).

Individuals and capacity to change

In formulating new strategies for the management of RZs, institutions need to take into account the capacity of landholders in RZs to adopt the new practices or social norms (Curtis & de Lacy 1998; Marshall 2011). Those landholders more likely to adopt sustainable practices are more likely to have strategic skill sets, transferrable skills, strong informal and formal networks, high local environmental knowledge, high awareness of societal environmental values, as well as a high financial and psychological capacity to absorb change (Adger et al. 2010; Marshall et al. 2012b). Landholders with higher adaptive capacity include those that: positively perceive the risks associated with the change and can manage the opportunities associated with positive environmental outcomes; have the skills to plan for the change, reorganise, experiment, refine and adopt new strategies; have financial and emotional flexibility; and have a willingness to learn about the future (Marshall & Marshall 2007; Adger et al. 2009; Marshall 2010). Investing in the development of strategic skills, networks and environmental awareness of landholders within a catchment can enhance capacity for the preservation of riparian areas (Curtis & Lockwood 2000).

Social networks and capital

The adaptive capacity of societies is partly determined by their ability to act collectively (Adger 1999; Osbahr et al. 2008). This ability is often embedded within the concept of social capital, reflecting the level of social interaction and networks that exist within a community (Armitage unpublished manuscript; Pelling & High 2005; Howden et al. 2007). Communities with increased stocks of social capital typically have reciprocal networks of community interactions and increased social trust that are directed towards mutual benefit. Individuals with higher stocks of adaptive capacity also tend to have stronger formal and informal networks (Marshall 2010). We suggest that social networks should be developed and facilitated within a catchment by: (1) creating forums for building relationships between stakeholders that can demonstrate the value of a cooperative ethic; and (2) educating stakeholders about new riparian policies and the benefits of engaging other stakeholders (Brunckhorst 2002; McAllister et al. 2005).

Leadership, praise and peer pressure

To navigate through transitions from production-oriented value-systems to conservation-based ones, landholders and
their networks will also need good leadership (Olsson & Folke 2003). We argue for investment in leadership within catchments and rewarding outstanding examples of individuals as ‘community champions’ (Olsson et al. 2004; Knight et al. 2006; Plummer & Armitage 2007), consistent with global calls to support ‘water policy entrepreneurs’ (Meijerink & Huitema 2009). It is also important to make use of social and peer pressure to change the behaviour of those who are unwilling to cooperate and deliver on catchment goals (Ostrom et al. 1999). For example, in south east Queensland during a recent drought, each person’s individual water use was compared to their local and city average. Achieving across-the-board adoption is vital within a catchment because mismanagement upstream has downstream impacts.

Interaction between rural and urban institutions

A very high degree of public support in Australia – 69% in one poll – is expressed for increased action to conserve water bodies (McAllister 2008). Disproportionate investments have occurred in highly populated, degraded, urban RZs (primarily in the temperate coastal bioregion) versus under-investment in more biologically significant rural riverine corridors (Robins & Dovers 2007). This is reflected in many investments in restoration of small riparian areas in cities. For instance, over AUD$13.9 million was invested in a project in Canberra to replace just two short concreted sections of creek with artificial wetlands for wildlife, water quality improvement and stormwater harvesting (Corbell 2009). Establishing strong links between urban and rural RZ management and adaptation programmes could help to better direct available financial resources, for example, through payment for ecosystem service schemes. Larger local government areas, such as the Southeast Queensland Regional Council, are facilitating such resource transfers with their greater funding base and institutional capacities (Healthy Waterways 2007).

Businesses

Increasing water scarcity and pollution, and the resulting degradation of RZs, is increasing risks to water consuming businesses and in some cases is threatening their social licence to operate (WBCSD 2004). For instance, in Australia, growers of cotton, sugar and timber are often criticised for their water consumption and impacts on rivers. One response from government and industry in Australia has been the establishment of a national water accounting standard (BoM & ABS 2011). This provides consistent data on water use but does not directly allow qualitative assessments of outcomes. A number of stakeholders have now formed Water Stewardship Australia, part of the global Alliance for Water Stewardship, to develop an independent third party certification system for water users. The draft standard requires water using organisations to contribute to sustainable river basin management (WSA undated). This will assist water users to manage their risks by: benchmarking their water use against other users; adopting better practices and reducing consumption; outperforming competitors; going beyond compliance and demonstrating their water stewardship to regulators and the community. While potentially applicable across Australia, these business models are more likely to be applied in the more intensively populated and developed temperate coastal and uplands bioregions. Such non-government social and environmental labelling schemes may provide incentives for industry groups to contribute more to RZ adaptation.

Political leaders and governments

A key challenge for better RZ management and adaptation is support from political leaders in the form of well thought out programmes and funding (Ross & Dovers 2008). Key opportunities for ensuring that decision makers are aware of RZ management and adaptation include engaging with junior politicians (since one in four Australian members of the federal parliament eventually become a minister), engaging them in site visits and pilot projects. Appropriate decision making requires strong leadership and commitment in the face of those seeking less sustainable but perhaps more profitable gains (Meijerink & Huitema 2009). Policies and funding for water resource management should transcend political cycles in order to secure water resources and catchment health. The National Water Initiative is such an initiative that has been partly successful (NWC 2011).
Integrated research

Currently, different Australian Government departments have research funding schemes to address aspects of adaptation or sectors affected by climate change. The present arrangements are sub-optimal for delivering science in the time required (Robertson 2000). The development of the National Climate Change Adaptation Research Facility that runs programmes to integrate the Australian research effort within and across sectors and disciplines has been positive. This could go further, using the Council of Australian Governments meetings of federal and state leaders to negotiate a country-wide, integrated RZ research effort where scale, priority focus areas and cross-discipline questions from the climate, land and water domains could be developed. Examples of better country-wide collaborative research institutional arrangements in Australia include the National Collaborative Research Infrastructure Scheme and the successful Cooperative Research Centre Program. Improved riparian management has benefitted from past national land and water management collaborative research programmes (Lovett 2006). Renewed priority needs to be given to funding public good rather than purely commercial-oriented research programmes.

Campaigns for RZ management and adaptation

Finally, lessons can be drawn from the public health sector where campaigns to educate and induce behavioural change have been used since the early 20th century. The anti-smoking campaign, for instance, has resulted in widespread social change over the last three decades in Australia and elsewhere, now making it socially unacceptable to smoke cigarettes in many settings (Wakefield et al. 2008). By contrast, campaigns for climate change mitigation and water management have been largely ineffectual in inducing transformational social or legislative reforms in Australia. The question is, how do we translate our scientific knowledge of riparian systems into a public campaign that encourages individuals, communities, industries and governments to adopt the necessary reforms needed to ensure resilient RZs? Our proposition is that a new form of social contract, a riparian conservation ethic, needs to be established whereby individuals and institutions are bound together with both rights and responsibilities in the management of RZs.

INSTITUTIONS AND CREATING AN RZ CONSERVATION ETHIC

Our assessment shows that there is rich experience in Australia of success and failure in institutions for RZ management that could be applied to enhance adaptation, both nationally and internationally. But are our societies willing to undertake sufficient adaptation to ensure that our RZs have a sufficiently sustainable future? We are aware of a number of adaptation measures which, if applied now, could prevent key ecological thresholds being exceeded under moderate, mid-century climate change scenarios. These include, for example, environmental flow allocations (Robertson et al. 2001; MDBA 2010; Pittock et al. 2010), strategic riparian forest restoration to provide shade to reduce water temperature below lethal levels for wildlife (Davies 2010), and adoption of appropriate stock management practices to minimise damage to riparian areas (Jansen & Robertson 2001; Jansen & Robertson 2005). We consider that changes of environmental state are likely but with this strategic adaptation it is likely that the emerging, novel ecosystems will continue to provide services and have values that warrant conservation (Pittock et al. 2010; Catford et al. 2012).

We have argued that climate change impacts freshwater ecosystems and people. People have severely impacted on freshwater ecosystems but also need them to be healthy to best adapt to climate change. Thus, a conservation ethic needs to be instilled in our societies that fosters a desire to work together to sustain RZs that are essential to conserving biodiversity, sustaining water resources and generating other benefits for people in a changing world.

For riparian areas to be successful in sustaining human populations, good ecological health of the whole catchment is vital and thus whole-of-catchment adoption of an RZ ethic is necessary. It is important that all landholders within a catchment agree on a common view of the conservation ethic and what it means for their catchment. The National Riparian Program that ran in Australia between 1999 and 2006 made an excellent start in the development of an RZ
that sustain cities, the better engagement of communities
ring urban resources to rural areas to conserve catchments
rapid uptake of better RZ management practices. Transfer-
ger social networks and fostered leadership may aid more
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tion ethic is a commitment to adaptive management to
conserve RZs as the core element of the biophysical and
human landscape. It calls for stakeholders to adopt a
common vision for conservation of RZs that can sustain
implementation through institutional changes.
In this paper we have looked deeper at the legacy of con-
flicting government policies, promising governance
structures that have waxed and waned, and the incomplete
application of market-based instruments to ask why our
nation has not achieved more. We consider that voluntary
and cultural institutions require strengthening through fos-
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government and market-based programmes. This conserva-
tion ethic is a commitment to adaptive management to
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human landscape. It calls for stakeholders to adopt a
common vision for conservation of RZs that can sustain
implementation through institutional changes.
We find much potential in recent research and cultural
innovation in Australia that is also applicable in other
countries. The resurgence of the application of indigenous
knowledge and engagement in RZ management has seen
key landscapes restored. A deeper understanding in rural
communities of the key contributions that women can
make, methods for better engagement of individuals, stron-
ger social networks and fostered leadership may aid more
rapid uptake of better RZ management practices. Transferr-
ing urban resources to rural areas to conserve catchments
that sustain cities, the better engagement of communities
through campaigns, businesses and political leaders, and
strategic research programmes all show promise for better
RZ management. We contend more effective climate
change adaptation requires an RZ conservation ethic to be
fostered based on these cultural attributes for change, work-
ing initially at a catchment scale, then gaining momentum
across catchments.

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