# Limits to Adaptation

## Limits and barriers to climate change adaptation for small inland communities affected by drought

NCCARF
National
Climate Change Adaptation
Research Facility

Synthesis and Integrative Research Program

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## The Limits to Adaptation

# Limits and barriers to climate change adaptation for small inland communities affected by drought

**Authors:**

**Anthony Kiem, University of Newcastle**

**Emma Austin, University of Newcastle**

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**Author contact details**

Enquiries should be addressed to:

Anthony Kiem
Environmental and Climate Change Research Group (ECCRG)
School of Environmental and Life Sciences
Faculty of Science and Information Technology
University of Newcastle, Callaghan NSW 2308 Australia
T: +61 2 4921 8656
Email: Anthony.Kiem@newcastle.edu.au

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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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# Preface

The National Climate Change Research Facility (NCCARF) is undertaking a program of Synthesis and Integrative Research to synthesise existing and emerging national and international research on climate change impacts and adaptation. The purpose of this program is to provide decision-makers with information they need to manage the risks of climate change.

This report on "***Limits and barriers to climate change adaptation for small inland communities affected by drought***" forms part of a series of studies/reports commissioned by NCCARF that look at the limits to adaptation. The notion of 'limits to adaptation' is fundamentally concerned with identifying the thresholds at which actions to adapt cease to reduce vulnerability. Much of the research on adaptation avoids the question of what adaptation cannot achieve. It is therefore implied by omission that adaptation can avoid all climate impacts. Yet this is clearly not going to be the case for many systems, sectors and places at even modest rates of warming, let alone at the more rapid rates of warming that now seem almost inevitable. Understanding the limits to adaptation is an emerging frontier of climate change research. It is important for decision making about adaptation for three reasons.

Firstly, it helps to determine which responses to climate change are both practicable and legitimate, and the time scales over which adaptation may be considered to be effective. Secondly, it helps to understand how people may respond to the damage to, or the loss of, things that are important to them, for which there may, in some cases, be substitutes or ameliorating policy measures. Thirdly, it can help prioritise adaptation strategies, refine their intentions, and identify communities that will be served by them.

This report assesses the social, economic, and environmental costs and benefits of water trading and the implications of using 'market-based' instruments (MBIs) for adaptation, in particular the barriers and limitations to climate change adaptation in small inland communities. MBIs are tools that utilise a range of market-like approaches to positively influence people's behaviour. MBIs achieve outcomes by: altering market prices; setting a cap or altering quantities of a particular good; improving the way a market works; or creating a market where no market presently exists. The project found that water trading has potential to deliver as a beneficial adaptation strategy, although for some peo0ple and industries there can be negative impacts that are not well understood.

Other reports in the series are:

- *Limits to climate change adaptation in the Great Barrier Reef: scoping ecological and social limits;*
- *Climate change adaptation in the Australian Alps: impacts, strategies, limits and management;*
- *Climate change adaptation in the Coorong, Murray Mouth and Lakes Alexandrina and Albert;*
- *Limits to climate change adaptation in floodplain wetlands: the Macquarie Marshes;* and*,*
- *Limits to climate change adaptation for two low-lying communities in the Torres Strait.*

To highlight common learnings from all the case studies, a brief synthesis has been produced which is a summary of responses and lessons learned.

All reports are available from the website at www.nccarf.edu.au.

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# EXECUTIVE SUMMARY

This report provides an extension to the "Drought and the future of small inland towns" historical case study which was recently completed as part of the National Climate Change Adaptation Research Facility (NCCARF) Synthesis and Integrative Research Programme (Phase 1). The previous project investigated adaptation measures being put in place as a result of the knowledge gained from previous drought experiences. This report focuses on the social, economic, and environmental costs and benefits of water trading and insights are gained from this as to the implications of using 'market-based' instruments (MBIs) for climate change adaptation.

On the whole it was found that water trading has potential as a climate change adaptation strategy with many benefits experienced in previous and current versions of water trading. However, there are also some significant limitations and the people and industries that are negatively impacted by water trading are hit hard. These social impacts and limitations of water trading have not been thoroughly investigated and are not well understood.

Similarly, significant uncertainty also exists around the impacts of water trading on the environment (e.g. changed hydrological regimes, underestimation of sustainable environmental flows etc). Proper quantification of these impacts is needed, however, it is a very complex task given the current lack of understanding as to what is sustainable and what is not and how to best balance and optimise the water needs of the environment, agriculture, other non-agricultural industry, and human settlements.

In assessing the limitations of water trading, and MBIs in general, as a climate change adaptation tool it is crucial to note the difficulties of separating the impacts and issues attributable to water trading or water policy and those that are caused by drought or other climate impacts. The highly variable nature of Australia's climate poses a significant barrier to overcome when developing and assessing the performance of any water trading scheme. There is an urgent need for more research into this area in order to differentiate what part of the changes in water use (or limitations or failure of water policy) are due to inadequate water policy and which parts are due to variable (or permanently changed) hydroclimatic conditions. The two are strongly related in that robust water policy (including a robust water trading scheme) should account for and be able to cope with changes in hydroclimatic conditions but to date there has been minimal effort focussed on assessing whether the existing and proposed water trading schemes are robust under the range of historical and projected Australian climate conditions or in fact whether such a 'climatically resilient' water trading scheme is even possible.

Finally, it appears that 'cap and trade' quantity-based MBIs such as water trading will eventually do what they are designed to do (i.e. reallocate a resource to 'high value' users). However, given that the 'low value' users in this case are agriculture and supply of drinking water and the 'high value' users are mining, manufacturing, and electricity production (i.e. industries with high greenhouse gas emissions) the question that must be asked is do we really want the water trading MBI to achieve its objective? And, what would the social and environmental ramifications of such a shift in water use within Australia be? These questions, along with the above-mentioned barriers, limitations and potential implications of using water trading (and MBIs in general) as a climate change adaptation tool, must be carefully considered and rigorously investigated before implementing if past drought and water policy failures are not to be repeated.

# 1. INTRODUCTION

Whilst the magnitude and impacts of anthropogenic climate change remain under debate, the need to address climate variability and change continues to be both necessary and urgent. At the forefront of climate concerns is the vulnerability and adaptive capacity of small inland towns which make up the majority of drought-affected areas and whose economic and social viability is heavily dependent on agriculture. There is widespread acknowledgement that past policy responses to drought have not worked effectively and are unlikely to do so in the future (e.g. Kiem et al. 2010). The National Climate Change Adaptation Research Facility (NCCARF) represents one initiative by the Australian Government to coordinate innovative and holistic research on climate change and variability, to improve understanding of the impacts of climate change and to develop more effective adaptation responses.

This report, prepared as part of the Limits to Adaptation project within NCCARF's Phase 2 Synthesis and Integrative Research Programme (www.nccarf.edu.au/node/172), provides an extension to the "Drought and the future of small inland towns" historical case study (Kiem et al., 2010) which was completed as part of NCCARF's Phase 1 Synthesis and Integrative Research Programme. The "Drought and the future of small inland towns" project investigated the following questions:

- what are the effects of long-term drought on rural communities?
- what are the critical issues likely to affect the future of rural communities?
- what options do rural communities have in terms of drought adaptation?
- do rural communities have the capacity to implement adaptive strategies and remain viable into the future?

In Kiem et al. (2010) information was gained as to adaptation measures being put in place as a result of the knowledge gained from previous drought experiences (e.g. use of alternate water supplies, water reuse, water savings projects, drought awareness programs, change in town focus from agricultural to tourism or mining etc.) and also areas where future adaptation measures need to be developed following subsequent reflection on ways of better preparing for such events (e.g. additional/alternative water supplies, changes in agricultural practice, changes in industrial water use, water trading etc.). Several barriers and limitations to adaptation were also identified and twenty-four Key Insights were obtained, including:

**Key Insight 1:** The social and economic issues facing inland (rural) communities are not just a product of drought – to understand them as such would underestimate the extent of the problems and inhibit the ability to coordinate the holistic, cross-agency approach needed to address them.

**Key Insight 2:** In areas relying on irrigation, there is an immediate need for a stable and secure water allocation and buy-back system which can be more readily and effectively negotiated, planned for, and managed by farmers. The new Murray-Darling Basin Plan (draft released in October 2010) may provide stability, but there will likely be stakeholders who are negatively affected by this 'stability'.

**Key Insight 6:** Exit Grants can produce negative flow-on economic and social impacts to inland (rural) communities if they are not properly integrated with land use planning and assistance for redevelopment and restructure at the community and individual level. These impacts need to be acknowledged as part of more holistic government assistance schemes, incorporating re-skilling and accreditation programs for exiting farmers. Further provisions are also required for succession and long-term land use planning.

**Key Insight 10:** The multiple uncertainties (e.g. climate impacts, water markets, commodity prices, demographic changes) pervading the farming community is detrimental and exhausting. Government policy and assistance schemes need to provide a strong and consistent response to service delivery and rural support.

**Key Insight 14:** Proactive, long-term and practice-oriented support and funding schemes are the most effective in facilitating adaptation in farming communities. Research and training will be key factors in such an approach but it was stressed that this research should be relevant to the local area and be brokered at the local level (as opposed to the Commonwealth government level).

**Key Insight 15:** Adaptive capacity and the ability to conceive of different futures is apparent – these capabilities can be built on and developed to create effective and locally responsive adaptation and mitigation strategies.

This report focuses on the issues identified in the Key Insights listed above and further investigates social, economic, and environmental costs and benefits of water trading and insights are gained from this as to the implications of using 'market-based' instruments (MBIs) for climate change adaptation. Other barriers and limitations to climate change adaptation in small inland communities that are considered include:

- the dynamic nature of climate (extremes, spatial and temporal variability and change) and the potential for surprises – this is critical for informing realistic 'hydroclimatic baselines' on which to establish water allocation or trading schemes and to put future climate projections into context;
- uncertainty associated with climate change projections;
- uncertainty associated with global economic cycles;
- uncertainty associated with federal, state and local government drought/water policy and who controls the water;
- ineffective communication between climate scientists, policy makers, stakeholders in the agricultural industry;
- declining and aging population of rural communities;
- undervaluation of the farming enterprise and a shift in thinking with respect to the 'best' use of land (e.g. for solar/wind farms, mining etc as opposed to for agriculture).

# 2. DROUGHT AND WATER POLICY IN AUSTRALIA: AN HISTORICAL OVERVIEW

Drought, and water management in general, in Australia has elicited an extensive and long-running response from successive governments. Drought policy existed in various guises throughout the 1900s, largely as a focus of broader agricultural policy frameworks (see James, 1973). Until the late-1980s, drought was thought to be a climatic abnormality and as such was treated with disaster relief policies and Exceptional Circumstances (EC) payments in a similar way to floods, earthquakes and cyclones (Botterill and Wilhite, 2005). During the late-1980s, however, the view of drought as a one-off, unpredictable and unmanageable natural disaster began to be questioned in scientific and policy circles. Drought was subsequently removed from national disaster relief arrangements, and a task force was initiated to shape the most appropriate response to these changing perceptions of drought.

Subsequently, the National Drought Policy (NDP) was established in 1992 through collaboration between State and Commonwealth Governments. The NDP was based on principles of self-reliance, risk management and an understanding that drought is an inherent feature of the Australian environment (Nelson et al., 2010). Despite a focus on the agricultural sector assuming greater responsibility for climate risks, provisions were included for EC whereby applications for assistance could be made in times of severe drought. The primary avenue for government assistance was the Rural Adjustment Scheme (RAS, previously termed 'the Farmers' Debt Adjustment' and also 'the Rural Reconstruction Schemes') and 'the Farm Household Support Scheme' (FHSS). The RAS adopted structural adjustment initiatives to improve farm productivity, profitability and sustainability. These initiatives included interest rate subsidies, commercial borrowings, and small grants, all of which were subject to substantial increases under a provision of EC. The FHSS, however, was aimed at encouraging unviable farmers to exit the industry (Botterill and Wilhite, 2005). Together, the policy framework was viewed as a holistic response to recurrent and extreme drought events.

During the 1990s, drought policy faced considerable challenges and debates resulting both from the accumulated effects of decades of inadequate drought response and from the most recent concerted attempts to address policy shortcomings and establish farming self-management and sustainability. Along with considerable political pressures from welfare, academic and influential industry groups, governments were facing a combination of conditions and challenges, including:

- prolonged, expanding and worsening drought conditions across significant agricultural producing regions;
- widespread inconsistency, abuse and normalisation of EC declarations;
- increasing focus on government intervention rather than self-management and sustainability;
- the situation where EC payments artificially kept unviable and/or poorly managed farm businesses afloat – this view of EC payments as "*money wasted on people that shouldn't be farming anyway"* emerged frequently throughout the Kiem et al. (2010) case study interviews and workshops and is consistent with the current views of Burke (2010);
- evidence of widespread welfare gaps in the farmer support system (Botterill and Wilhite, 2005).

Successive reviews and amendments of the NDP and RAS occurred throughout the late-1990s and 2000s. Changes included: further clarification and separation of EC declarations and processes; adjustments to interest rate subsidies; Exit Grants; income support; and increasing access to social and economic support services. However, despite these changes, many of the issues surrounding drought and water management policy in the

1990s have continued to plague government approaches to farm management and drought support into the 21st century. Recently, the Australian Government's approach to addressing drought impacts, particularly the NDP, was subjected to another government review across three key areas:

- an economic assessment of drought support measures by the Productivity Commission (2009);
- an assessment by an expert panel of the social impacts of drought on farm families and rural communities (Drought Policy Review Expert Social Panel, 2008);
- a climatic assessment by the CSIRO and the Bureau of Meteorology (BoM) of the likely future climate patterns and the current EC standard of a one-in-20-to-25-year-event (Hennessy et al., 2008).

As a result of these reviews, the government is now faced with a number of recommendations which, in line with strengthening focus on climate change adaptation, recognise more than previous efforts the critical importance of moving beyond crisis management towards supporting long-term, sustainable and coordinated drought policies. Importantly, the three reviews have reinforced the urgent need to rethink the NDP and particularly the EC provisions, which they argue are ineffective and inequitable, perversely encourage poor management practices, create unnecessary stress for families, and provoke resentment between farmers and farming regions based on inclusion criteria in the scheme (Drought Policy Review Expert Social Panel, 2008; Productivity Commission, 2009). The reviews emphasise the urgent need to help farmers improve their self-reliance, preparedness and drought management and/or adaptation practices.

In addition, the three reviews suggest that the government programs used to support an adaptive response need to affirm that prolonged periods of drought are natural and routine, as opposed to an unexpected event. It is also necessary to ensure that decision-making on drought response is undertaken independently of extreme drought events when public emotions and political effects are heightened. Similarly drought adaptation strategies should not be shelved during periods of above average rain. Drought and flood adaptation strategies need to co-exist – one should not replace the other as the climate oscillates between its wet and dry phases. This coexistence of strategies is especially important given the anthropogenic climate change projections for Australia which suggest that increases in the frequency and duration of droughts will be associated with increases in the frequency of short-lived but intense rainfall events (i.e. the type of weather that leads to flooding) (IPCC, 2007a; Tubeillo, 2005).

The government is advised, as part of the reviews, to produce coordinated programs of support that move beyond overlapping and short-term initiatives towards long-term, sustainable, proactive and flexible approaches to drought and equitable distributions of drought support services across regions. Drought policy needs to focus on early intervention by investing in and planning for the well-being of farming families and rural businesses under drought. For example, the Productivity Commission Review (Productivity Commission, 2009) suggests the replacement of the NDP with an extended version of Australia's Farming Future – which focuses on adaptation, research and building the skills of farmers. As another example of a way forward, from July 2010 to June 2012 the Australian Government, in partnership with the Western Australian Government, is conducting a pilot of drought reform measures in part of Western Australia that will test a package of new measures developed in response to the national review of drought policy (www.daff.gov.au/agriculture-food/drought-pilot). The measures are designed to move from a crisis management approach to risk management. The aim is to better support farmers, their families and rural communities in preparing for future challenges, rather than waiting until they are in crisis to offer assistance. The drought reform measures being considered are summarised in Figure 2.1.


**Figure 2.1: The seven drought reform measures being considered in the Western Australian pilot study (www.daff.gov.au/agriculture-food/drought-pilot)**

The recent drought policy reviews also recognised that similar recommendations on the NDP approach have been made previously but are largely yet to be adopted. Intergovernmental agreement across all scales of government will be vital to finally advancing these long-running recommendations for drought policy. In addition, social dimensions of climate change adaptation and resilience will also need to be escalated as part of revised drought policy. Examples such as the *Drought Mental Health Assistance Program* in NSW represent attempts to support communities in responding collectively to their social and emotional needs with respect to the current drought, and also to plan ahead for the next one (see Hart et al., 2010). This program is consistent with the growing emphasis on the social and emotional dimensions of climate change adaptation, the subject of the 'Kenny Report' (Drought Policy Review Expert Social Panel, 2008), which recognises that better understanding of social impacts and outcomes will mutually support improved economic and environmental outcomes.

Policy is one key mechanism for driving mitigation and adaptation to climatic change and extreme climatic events such as drought. Yet for policy to be effective, it needs to be flexible enough to persist through the various scales and sites of government, NGOs, and businesses, and as part of diverse local contexts within which policy aims may become confused and conflict with existing practice. Research on various forms of environmental management and adaptation consistently point to the significance of local governments and communities in achieving policy aims and effectively shaping policy to local contexts (O'Toole, 2001; Brunckhorst and Reeve, 2006; Hayes, 2008; Urwin and Jordan, 2008). It is imperative then that drought policies, such as those to emerge from the above mentioned reviews, set the tone for adaptation yet provide the flexibility and openness to local contexts that will provide the foundations for robust and effective drought adaptation strategies and support programs.

# 3. CURRENT WATER POLICY IN AUSTRALIA: PREPARING TO EXIST WITH LESS

In recent years, existing Commonwealth, State and Local government water policies and adaptation strategies have been revised, with a view towards preparing all sectors of the community to exist in a future with less water. This section outlines the main policy frameworks and programs governing water security and use across the three levels of government (refer to http://www.nwc.gov.au/www/html/7-home-page.asp for further details), with an emphasis on Victoria as per the case studies investigated in Kiem et al. (2010).

## *3.1 Commonwealth government water policy and programs*

The Australian Government's national framework, *Water for the Future*, comprises The Water Act 2007 (DEWHA, 2010a) and advances the previous implementation of the National Water Initiative (NWI, 2004) by the Council of Australian Governments (COAG). The framework recognises the four key priorities of: (i) taking action on climate change; (ii) using water wisely; (iii) securing water supplies and; (iv) supporting healthy rivers (DEWHA, 2009). These priorities will be delivered through a $12.9 billion investment over a ten year (2010-2020) period of strategic programs, improved water management arrangements, and a renewed commitment to deliver a range of water policy reforms in rural and urban areas.

Several policies and programs within this national framework (DEWHA, 2010b) focus specifically on the Murray-Darling Basin (MDB) or have direct application to the MDB (which is relevant to both case studies but in particular Mildura):

- the 'Driving Reform in the Basin' program supports contributions from the Australian Government to the operation and water reform functions of the Murray-Darling Basin Authority (MDBA);
- $5.8 billion has been committed to the Sustainable Rural Water Use and Infrastructure program to assist irrigation communities to upgrade irrigation systems, increase water use efficiency and make early adjustments in anticipation of caps to water extraction;
- 'Restoring the Balance in the Basin' has been allocated $3.1 billion to purchase water entitlements to return to the environment to protect or restore environmental assets;
- the Commonwealth Environmental Water Holder (CEWH) manages the water entitlements acquired by the Commonwealth to be used for environmental watering;
- managed by the MDBA, the 'Living Murray Initiative' focuses on six icon sites of international significance in the improvement of the health of the Murray River;
- $200 million has also been committed to the 'Strengthening Basin Communities' program to assist local governments in the MDB to conduct community-wide planning for a future with less water and to deliver water saving initiatives;
- the 'MDB Sustainable Yields' project, conducted by the CSIRO, provides estimates of current and future water availability in the MDB;
- the development and uptake of smart technologies and practices in water use across Australia has been accelerated through 'Water Smart Australia' projects, including the Wimmera Mallee Pipeline project (completed April 2010);
- the efficiency of water registers, transaction and market information functions will be improved by the development of a National Water Market System (NWMS) as part of the NWI (NWI, 2004);
- the draft (or proposed) Murray-Darling Basin Plan (released in October 2010), and associated Sustainable Diversion Limits are projected to significantly shift water allocation towards the environment at the expense of irrigation. This has potentially profound effects on the viability of irrigation enterprises and other industries that rely on water from the Murray-Darling system. The draft Murray-Darling Basin Plan was widely criticised and major revisions were undertaken in 2011 (see www.mdba.gov.au/basin_plan and Connell and Grafton (2011) for further details).

## *3.2 State government water policy: Victorian context*

Enacted by the Victorian Government in 2004, *Our Water Our Future* is a long-term plan detailing 110 actions for sustainable water management, securing water supplies and sustaining growth over the next fifty years. In 2007, the *Our Water Our Future* plan provided for a new desalination plant in Melbourne, modernisation of the irrigation system in the 'food bowl' (i.e. the Northern Region of Victoria, discussed further in Section 3.3), expansion of Victoria's water grid and increased recycling and conservation of water (DSE, 2007). The Victorian Government's *Growing Victoria Together* prioritises the need to cease the degradation and increase the restoration of Victoria's natural resources.

Figure 3.1 illustrates the four regions encompassed by the Victorian Government's *Our Water Our Future* regional Sustainable Water Strategies (SWS, www.ourwater.vic.gov.au/programs/sws). The SWS are run by the State government, but with considerable regional stakeholder engagement. The Northern Region of Victoria and the Western Region contribute significantly to national agricultural production. Based on the gross value of agricultural production, the Northern Region is mostly irrigated agriculture with some dryland farming while the Western Region relies almost totally on rain fed surface water (45% of total water supplied) and groundwater (52%), with the balance made up from alternative sources such as recycled water (DSE, 2010).


**Figure 3.1: The four regions encompassed by the Victorian Government's Our Water Our Future regional Sustainable Water Strategies (www.ourwater.vic.gov.au/programs/sws)**

The SWS were developed via partnerships between the Victorian Department of Sustainability and Environment (DSE), water corporations, Catchment Management Authorities (Figure 3.2), key regional stakeholders and community and interest groups. The strategies outline the enhancement of policies and the delivery of programs as mechanisms for more efficiently managing the available water supply whilst protecting and reducing risks to agriculture, the environment and communities in preparations for a future with less water (DSE, 2010).


**Figure 3.2: Victorian Catchment Management Authorities (CMAs)**

The Future Farming Strategy, launched by the Victorian Government's Department of Primary Industries (DPI) in April 2008, while not specifically focused on water policy, is another State led policy initiative aimed at improving the productivity, competitiveness and sustainability of farm businesses (http://new.dpi.vic.gov.au/about-us/publications/future-farming). Future Farming outlines new support and services for farm businesses and rural communities – to help them make decisions about their future and meet the challenges of uncertain prices and demand, climate change and competitive global markets. The Future Farming strategy will invest $205 million over four years across seven broad Action Areas to build a strong and secure future for the farming sector. The Action areas are:

- Action 1: Boosting productivity through technology and changes in farming practices;
- Action 2: Building skills and attracting young people to farming;
- Action 3: Understanding and managing climate change;
- Action 4: Strengthening land and water management;
- Action 5: Helping farming families to secure their futures;
- Action 6: Developing new products and securing new markets;
- Action 7: Transporting products to market.

## *3.3 Regional government water policy: Northern and Western Regions of Victoria*

Given the significance of their contribution to national agricultural production, several strategies have been developed to address water supply security in the Northern and Western Regions of Victoria, including:

- Sustainable Water Strategies: as discussed these are State lead strategies but with significant regional/local stakeholder engagement.
- Loddon Mallee Regional Strategic Plan (RMCG, 2009a, 2009b): As part of Phase 2[1] of the Loddon Mallee Regional Strategic Planning project, the challenges faced by the Northern Loddon Mallee region (Figure 3.3) are defined as a result of the reliance on industries dependent on rainfall and/or water allocations (RMCG, 2009a). At the time of writing the Loddon Mallee Regional Strategic Plan the recent drought (known as the Big Dry (e.g. Verdon-Kidd and Kiem, 2009)) was identified as the major and continuing driver of change in the Northern Loddon Mallee region. However, the Murray-Darling Basin Plan (draft released in October 2010), and the associated Sustainable Diversion Limits (discussed in Section 1), are probably as (or more) influential now as the drying climate, especially for areas such as Mildura that are heavily reliant on irrigation. The region has been affected by drought conditions since 1994, with no recharge to groundwater since 1993. Farmers have faced increasing financial, physical and mental pressures as a result of lower rainfall and decreasing water allocations. These challenges have resulted in farmers spreading their risk through: diversification of their enterprises; locations and times of sale; drawing down equity; delaying retirement plans; and reducing spending, which has resulted in a reduction of access to services and social activities. Three of the ten aspirations identified during the Loddon Mallee Regional Strategic Planning project relate directly to water security and the irrigated and dryland agricultural and horticultural sectors in the region. In order to face the challenges of a drier climate, it was determined that the region must develop a more diverse economic base to reduce the reliance on agricultural and horticultural sectors. In response to concerns raised during community workshops as part of the Loddon Mallee Regional Strategic Planning project, the following four regional priorities were identified: (i) establish a social contract (i.e. transitioning away from funding models) with inland rural communities to increase access to services and social opportunities; (ii) develop a robust and diverse economic base so as to reduce the reliance on rainfall and water allocations; (iii) connect people and services through improvements to transport and telecommunications; (iv) support diversity through coordination and the sharing of experiences.
- Wimmera Southern Mallee Drought Report (RMCG, 2007): In response to the Big Dry (mid-1990s to 2010) the Wimmera Development Association (WDA), on behalf of several local municipalities, commissioned a report to assess impacts associated with the Big Dry and to make recommendations for the future of the region. Recommendations were classified into three categories: immediate response to drought, medium to long term response to drought and overall regional growth (RMCG, 2007). Several of the objectives set by the steering committee mirror those for this project and the Key Insights from Kiem et al. (2010), resulting in common themes, focuses and recommendations.
- Regional Catchment Strategies developed by the State's ten statutory CMAs (Figure 3.2) as 'regional sustainability blueprints' are also emerging. This network governance approach has transformative potential but there are significant challenges ahead: the complex task of aligning of national, state, catchment and local government strategies through an outcomes focus; the scarcity of mechanisms and tools to assist in translation of strategies into integrated investment priorities; gaps in knowledge and understanding of natural resource management problems; limitations in the capacity of regional and local bodies; and getting the policy tools right within the framework (Whittaker et al., 2004).

[1] As of May 2011, there exists a Phase 3 to the Loddon Mallee Regional Strategic Plan (developed by Sinclair Knight Merz), however, at the time of writing the contents were not publicly available and so have not been discussed in this report.

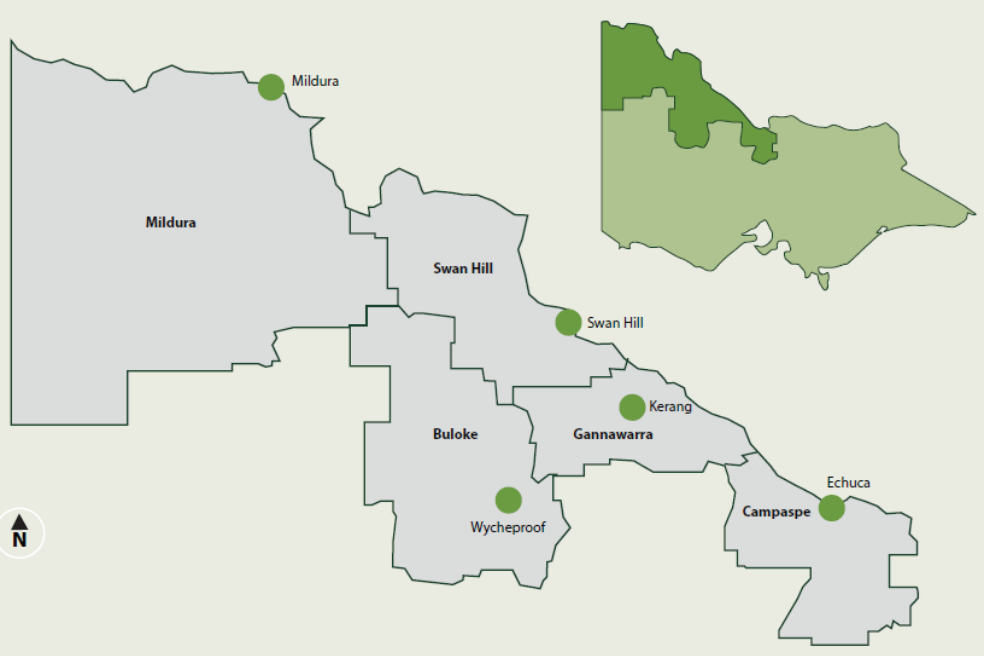



**Figure 3.3: The Northern Loddon Mallee region (www.gannawarra.vic.gov.au/council/policy-and-strategy-documents/loddon-mallee-strategic-regional-plans/)**

Despite these, and many other, drought adaptation strategies and sources of information, SKM (2009) identified that a major constraint preventing incorporation of climate change adaptation into water resource management and planning was not access to available and relevant climate change information, but rather, a lack of understanding of potential adaptive responses and their effectiveness. This limitation was exacerbated by minimal specialist skills and a limited number of resources (supporting the earlier findings of Whittaker et al., 2004). Clearly, the agricultural, economic and social impacts of drought are highlighting and accelerating changes in the agricultural sector and demographic make-up of regional and agricultural areas. This creates a complex and challenging environment and highlights the fact that there are other factors besides climate variability and/or change that make water resource management and drought adaptation difficult (see Kiem et al. (2010) for further details).

Kiem et al. (2010), using interviews and workshops, identified three of the key challenges facing rural communities as: water trade, allocations and security; commodity prices; and a changing farming sector. In this study we focus on water trading and the fact that even though it is an attempt at a holistic climate change adaptation and water management strategy, the current reality of water trading is that the commercial side of trading is complex and it is difficult for most farmers to manage. This is largely because allocations are made subject to the availability of water and are expressed as probabilities meaning that the availability of water becomes uncertain (in some cases even more uncertain than it was). The Big Dry highlighted that in areas relying on irrigation, there is an immediate need for a stable and secure water allocation and a buy-back system which can be more readily and effectively negotiated, planned for, and managed by farmers. The Murray-Darling Basin Plan (draft released in October 2010) may provide stability, but the participants in the Kiem et al. (2010) case studies suspected, and it has subsequently been confirmed, that there will likely be stakeholders who are negatively affected by this ‘stability’. These issues and limits associated with MBIs, in particular water trading, are discussed in the following Sections 4 and 5.

# 4. LIMITS TO MARKET-BASED INSTRUMENTS (MBIS) AS A CLIMATE CHANGE ADAPTATION RESPONSE

MBIs are tools that utilise a range of market-like approaches to positively influence people's behaviour (NMBIPP, 2004). MBIs achieve outcomes by: altering market prices; setting a cap or altering quantities of a particular good; improving the way a market works; or creating a market where no market presently exists (NMBIPP, 2004). MBIs can be applied to natural resource management (NRM) and environmental problems as well as climate change mitigation and adaptation. Figure 4.1 illustrates the three types of MBIs: price-based; quantity-based; and market friction. Water trading in the MDB is an example of a 'cap and trade' quantity-based MBI. Exceptional Circumstances Exit Grants (available in all Exceptional Circumstances declared areas), Small Block Irrigators Exit Grant (available only in the MDB), and deregulation of industry are all examples of price-based MBIs (although the Exit Grants are also related to Market Friction).

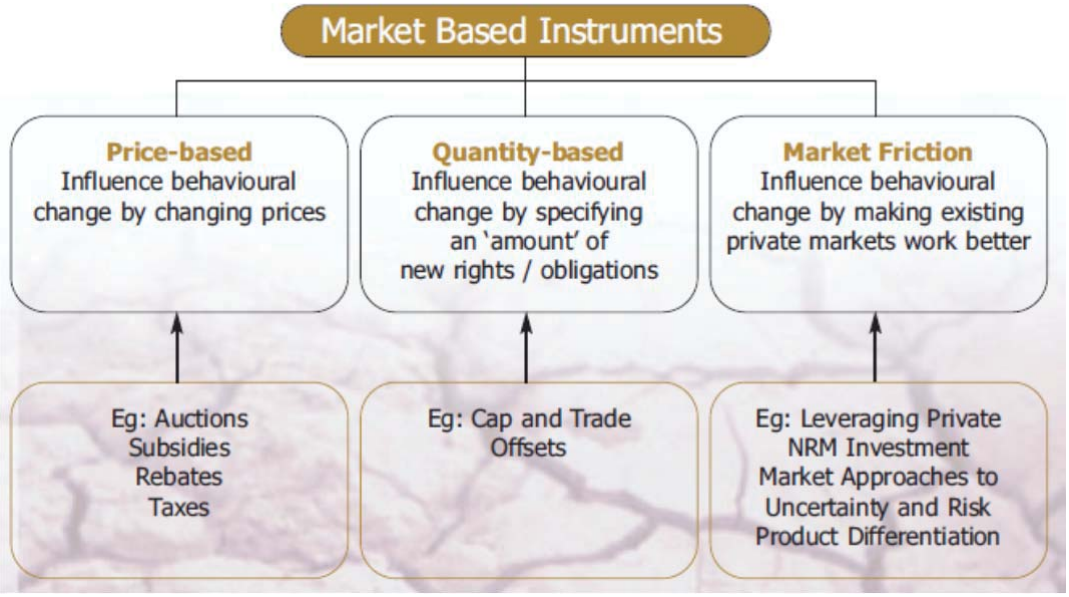



**Figure 4.1: Types of Market Based Instruments (NMBIPP, 2004)**

A search for "climate change market-based" on the internet reveals an abundance of literature on the topic of MBIs aimed at the *mitigation* of climate change (i.e. the reduction of greenhouse gas emissions). Garnaut (2011) identifies MBIs as one of the two approaches available when attempting to reduce emissions, the other being regulatory responses. Mitigation MBIs are based on putting a price on, for example, carbon, which can be achieved in two ways: fixed- or floating-price schemes. A major strength of mitigation MBIs is the amount of revenue raised. This revenue could be directed into the renewable energy sector to help alleviate flow-on costs to consumers, as outlined in the recent Australian Labor Government's carbon tax proposal (www.alp.org.au/agenda/environment/carbon-price-mechanism/) which initially is a fixed-price scheme, will transition to a floating-price and is then intended to move towards a 'cap and trade' scheme (see Figure 4.1). However, there is no guarantee that revenue raised from MBIs will be applied as described. For example, if enough political and/or economical (e.g. the need for jobs) pressure exists the revenue raised from MBIs could be used to increase development which potentially could lead to an

*increase* in greenhouse gas emissions (i.e. a perverse outcome if the aim of the MBI was to mitigate climate change).

Although there has been, and continues to be, significant international research in the area of mitigation MBIs, little research exists on the use of MBIs for *adaptation* to climate change. This is partly due to the fact that adaptation has only recently been accepted as a suitable approach to managing the impacts of climate change. Adaptation differs from mitigation, as it focuses on *coping with the impacts* of climate change rather than aiming to *reduce the causes*.

The following sections outline the strengths and weakness of MBIs for climate change adaptation, focusing on water trading as one potential instrument. This report does not consider the strengths and weaknesses of MBIs for mitigation, such as the proposed carbon tax or the Carbon Farming Initiative (CFI), as the focus here is limits and barriers to climate change *adaptation*.

## *4.1 Strengths and weaknesses of MBIs for climate change adaptation*

Whitten et al. (2007) provide a comprehensive overview of the strengths and weakness of MBIs in the ecological or natural resources sector and many of their conclusions are relevant here. In particular, this statement: *"MBI benefits result from harnessing the 'gains from trade'. Gains are derived from differences, or heterogeneities, between market participants' preferences, resources or production opportunities. Future gains are captured by creating positive incentives to improve management rather than to avoid regulation, and encourage innovation. Where these gains cannot be harnessed an MBI will perform no better, and may perform worse than other measures"* (Whitten et al., 2007).

In general the strengths of MBIs include:

- flexible adoption of targeted behavioural change;
- encouraging innovation to achieve objective of MBI and often facilitate longer term change;
- contributing to long-term and self-sustaining solutions. For example, water trading increases participants' capacity to react to changes in circumstances and allows more flexible risk management and decision making (RIRDC, 2007);
- addressing market failures (NMBIPP, 2004).

In general the weaknesses of MBIs include:

- companies that can afford the burden of a market-based penalty will continue to engage in activities at a higher cost and without the behavioural change targeted by the MBI;
- companies that are not able (or do not choose) to cover the penalty price, will transfer the burden to consumers.

The two weaknesses of MBIs that are mentioned are particularly relevant to drought adaptation and water resource management as it highlights the fact that MBIs do not ensure behavioural change, but instead have the potential to pass on extra costs to members of society who are already vulnerable. This reflects the opinion of many in the small inland communities investigated by Kiem et al. (2010) where the costs of staying on the farm are increasing but vulnerability to drought is seen to be still much the same (or worse due to other factors such as the financial crisis, changing demographics, etc.).

## *4.2 Strengths and weaknesses of water trading as an MBI for climate change adaptation*

'Cap and trade' quantity-based MBIs (Figure 4.1) create a market to facilitate the trade of a good or pollutant. The three components needed for a 'cap and trade' MBI are (NMBIPP, 2004):

- a monitorable and enforceable quantity cap that is placed on the market that limits the quantity of resource used in a defined area;
- entitlements are defined and distributed among the users;
- a market is created to enable trading of entitlements.

### *4.2.1 Case Study: the Murray-Darling Basin (MDB)*

To assess and understand the strengths and weaknesses of water trading as a MBI for climate change adaptation we use the Murray-Darling Basin (MDB) as a case study. The MDB covers 14% of mainland Australia and includes four states (New South Wales (NSW), Queensland (QLD), Victoria (VIC) and South Australia (SA) and the Australia Capital Territory (ACT)) as shown in Figure 4.2. Agriculture in the MDB produces $15 billion worth of produce annually, which is 39% of Australia's total agricultural production. The MDB contains 65 percent of Australia's irrigated land area, 40% of Australia's farms and is the most agriculturally productive area in Australia. The recent Big Dry (Verdon-Kidd and Kiem, 2009) had devastating effects on the environmental, social and economic systems in the MDB. These impacts highlight the need for improved adaptation strategies, and as part of that a water trading scheme has been proposed as part of the draft Murray-Darling Basin Plan.


**Figure 4.2: The regions of the MDB (MDBA, 2010)**

The draft Murray-Darling Basin Plan (released in October 2010), and the ensuing controversy and criticism, represents a salient case study into the complexity and limitations associated with implementing water trading in Australia. The first problem is the highly variable climate which means that for any given timeframe (e.g. season, year, decade) it is highly uncertain as to how much rainfall and streamflow will actually be received. This then has implications in defining what is sustainable and what is not, what amounts of water should be allocated for industry, environment, and socio-economic purposes and what happens if people do not receive their entitlements? Of the three components mentioned above that are needed for a successful 'cap and trade' MBI at least the first two are extremely difficult to meet due to the variable nature of Australia's climate, and the possibility that the past may not be a good indicator of the future (e.g. due to anthropogenic climate change, land-use changes, and any other issues that could impact the amount of water available). An added complication in the case of the MDB is the cross-border interactions and the need to involve multiple State and Territory governments, each with different water policies, in the decision making and policy development process.

Nevertheless, water trading is still seen as a viable climate change adaptation option (e.g. Frederick et al., 1997; Luo et al., 2003; RIRDC, 2007; NWC, 2010) and has existed in various forms in the MDB since the late 1980s, with reforms necessary in the mid-1990s and again in mid-2000s which were at least partially due to prolonged drought conditions (i.e. the Big Dry) that were not anticipated when the original water trading rules were developed (RIRDC, 2007; NWC, 2010). Refer to Table 1 in Wei et al. (2011) for a comprehensive summary of the various initiatives on water resources management and policy in the MDB since the 1990s. The introduction and expansion of water markets was based on the premise that *"trading provides economic benefits to buyers and sellers, and to society as a whole, by reallocating scarce water resources to higher valued uses"* (NWC, 2010). RIRDC (2007) put it slightly differently and explain that water trading was intended to facilitate the efficient use of water by moving the scarce resource to 'more productive uses'. However, the issue highlighted by these statements is how do you determine who is a 'high value user' or what is a 'more productive use' and who makes that decision? Quantifying value and productivity is relatively simple from an economic perspective (e.g. tonnes of wheat produced per litre of water) but the social and environmental benefits of water (or just as importantly the negative social and environmental impacts of insufficient water) are much harder to assess. As such, there have always been, and continue to be, concerns that water trading might have adverse economic, social and/or environmental impacts if the needs of all three are not properly understood, quantified and addressed (RIRDC, 2007; NWC, 2010). Figure 4.3, based on data from the Australian Bureau of Statistics (ABS), www.abs.gov.au, illustrates this dilemma.

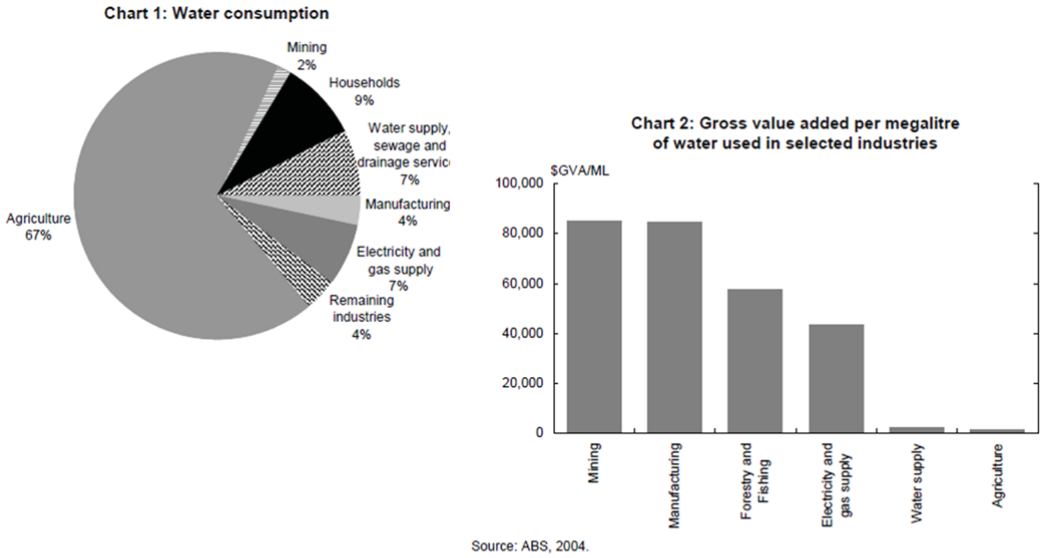



**Table 3**
Gross value per ML water used in Australia during 1996/97–2005/06.

| Crops | Vegetable | Fruits and nuts | Grapes | Dairy | Cotton | Rice | Cereals (other than rice) | Pasture for meat & wool |
|---|---|---|---|---|---|---|---|---|
| % (value) | 12 | 20 | 16 | 20 | 17 | 6 | 2 | 3 |
| % (water) | 2 | 5 | 7 | 17 | 20 | 16 | 10 | 17 |
| Standardization Value/ per unit water | 30 | 20 | 11.4 | 5.9 | 4.3 | 1.9 | 1.0 | 1.0 |

(Data source: ABS, 2008).

**Figure 4.3: The economic value of water in Australia (based on data from the Australian Bureau of Statistics (ABS), www.abs.gov.au)**

It can clearly be seen in Figure 4.3 that agriculture uses a large proportion of Australia's water but, based on an economic assessment, there is no way you could define agriculture as a 'high value user' or one of the 'more productive users'. Hence, unless social and/or environmental value is also considered and accounted for an MBI such as water trading (as it currently stands in Australia) will inevitably shift water away from sectors like agriculture and supply of drinking water towards 'high value' users such as mining and manufacturing. The questions that then emerge as to what we eat and drink once an MBI such as water trading has done what it is designed to do clearly highlight a fundamental weakness of using MBIs as a climate change adaptation tool for sectors with comparatively low economical value but critically high value in terms of social and/or environmental sustainability.

In RIRDC (2007) the objective was to 'ground truth' the experience of water trading. In particular, the aim was to quantify and report on the actual impacts of water trading on individual water entitlement holders, industries and communities. Case studies were used to test the assumed benefits and perceived concerns resulting from water trading in the MDB. The RIRDC (2007) study concluded that permanent and temporary trades must be considered together in order to understand water trading. Both types of trade affect water use in a region, and there is often an offsetting direction in observed temporary and permanent trading. It was also evident that water trading increases the parties' capacity to react to changes in circumstances and that water trading is a catalyst for change, thus satisfying the objective of MBIs (as indicated in Figure 4.1). RIRDC (2007) also found that it is difficult to untangle effects of water trading from the background of drought and that any approach implying that all impacts associated with changes in water use are attributable to or caused by water trading would be misleading and unhelpful for policy development. This is consistent with the point raised above relating to the highly variable nature of Australia's

climate and the difficulties that poses in developing and assessing the performance of any water trading scheme. There is an urgent need for more research into this area in order to differentiate what part of the changes in water use (or limitations or failure of water policy) are due to inadequate water policy and which parts are due to variable (or permanently changing) hydroclimatic conditions (Kiem and Verdon-Kidd, 2011). The two are strongly related in that robust water policy (including a robust water trading scheme) should account for and be able to cope with changes in hydroclimatic conditions but to date there has been minimal effort focussed on assessing whether the existing and proposed water trading schemes are robust under the range of historical and projected Australian climate conditions or in fact whether such a 'climatically resilient' water trading scheme is even possible.

RIRDC (2007) found that trade in permanent entitlements has assisted existing industries and prompted development of new horticultural ventures in Sunraysia (northwest Victoria and southwest NSW) and that water trading allows more flexible risk management and farm decision making – including the decision to leave agricultural production if that is the most appropriate (e.g. Exit Grants). Water trading in an agricultural system that has both annual and perennial crops gives farmers greater flexibility in making decisions about their priorities for water use, offers a means of managing risk and cash flow (particularly in dry times) and facilitates business growth and development. However, water trading can also have both positive and negative social and economic effects for local communities with strong fear in the community associated with people "selling up" their water entitlements and exiting the community. Many people are opposed to water trading for this reason alone – that is, they fear it will exaggerate the already decreasing populations of small rural communities and the reduction of services and sense of community that is associated with that (Kiem et al., 2010). The social impacts in the regions studied by RIRDC (2007) are not merely a temporary phenomenon associated with the introduction of water trading. Rather, they will probably be a permanent feature of regional economies exposed to rapid shifts in investment between different types (and locations) of irrigated agriculture that is facilitated by water trading. Under existing and proposed water trading schemes the communities in the case study regions of RIRDC (2007) and Kiem et al. (2010) are either net exporters of water ('negative' change) or net importers of water ('positive' change). Communities exporting water experienced reduced populations and less local spending while communities importing water experienced increased populations but did not necessarily have the infrastructure and services to accommodate the new arrivals. Either way, water trading ultimately means change and rural communities can find change and adjustment difficult (RIRDC, 2007; Kiem et al., 2010 and the references therein) whether that change be 'negative' or 'positive'. There is a lot of work that needs to be done to properly understand the social implications of water trading that have been touched on above. For example, how will water trading change the demographics of rural communities? What are the social impacts on people in rural communities that reduce (or disappear) as a result of water trading? What are the impacts on people and local governments in rural communities that rapidly grow as a result of water trading?

The subsequent NWC (2010) report paints a more positive picture of water trading in the MDB, crediting the continued economic viability of the region to the successes of the water market. The NWC (2010) study covers the period 1998-99 to 2008-09, which incorporates the Big Dry and demonstrates unequivocally that water markets and trading are making a major contribution to the achievement of the National Water Initiative (NWI) objective of optimising the economic, social and environmental value of water. The overwhelming conclusion of the study is that water trading has significantly benefited individuals and communities across the southern MDB with aggregate economic benefits for the southern MDB estimated to have increased Australia's GDP by $220 million in 2008-09 through reallocations of water to agriculture. However, this estimate was based on economic

modelling which includes a number of assumptions about water availability, market conditions and individual behaviours. Consultation with irrigators suggests that:

- Conclusions from previous studies are correct when stating that water trading has helped individual irrigators (buyers and sellers) manage and respond to external drivers by allowing more flexible production decisions. This flexibility improved cash flow, debt management and risk management;
- Individual irrigators have become aware of the benefits of water trading and are more sophisticated in their use of markets;
- Restrictions on interregional water access entitlement trading are limiting the benefits of trading for individuals and creating uncertainty for potential buyers and sellers;
- Further improvements to market performance, for example improving trade transaction times, could increase benefits to market participants;
- The benefits to individuals translated to benefits for associated industries, regions and communities, in most cases. Water trading prevented the loss of long-lived agricultural assets. Urban water users also benefited from the purchase of entitlements and allocations;
- Adverse economic and social impacts of water trading are usually linked to cases where trade reduces local water use, irrigated agricultural production and economic activity in associated regions and industries. Reductions in economic activity are linked to concerns about community viability;
- It has been observed in the southern MDB that water trading allows some high-value industries to maintain production while other low-value industries reduce production;
- There was no correlation between trade patterns and key socio-economic indicators. For example, employment in agriculture fell in all regions regardless of whether the region was a net purchaser or seller of water. It is suggested that other factors had a greater impact on influencing social and economic change in the region from 1996 to 2006, for example, commodity prices as discussed in Kiem et al. (2010).

The more recent work by Wei et al. (2011) gives a wide-ranging overview of irrigated agriculture in the MDB and develops insights into the interactions between water policy, agricultural policy, irrigation practices and drought management in Australia since 1990. Figure 4.4, extracted from Wei et al. (2011) but based on work by Mallawaarachchi and Foster (2009) which used farmer interviews and discussions with water authorities to explore factors influencing water trading behaviour, illustrates some further weaknesses of water trading as a MBI for climate change adaptation. As outlined above (Section 4.2, dot point 3), a ‘cap and trade’ quantity-based MBI such as water trading can only be successful if a market is created. From Figure 4.4 it is clear that a large percentage of irrigators/farmers are not engaging in the water trading market – and the reasons for this or numerous and not easily overcome.

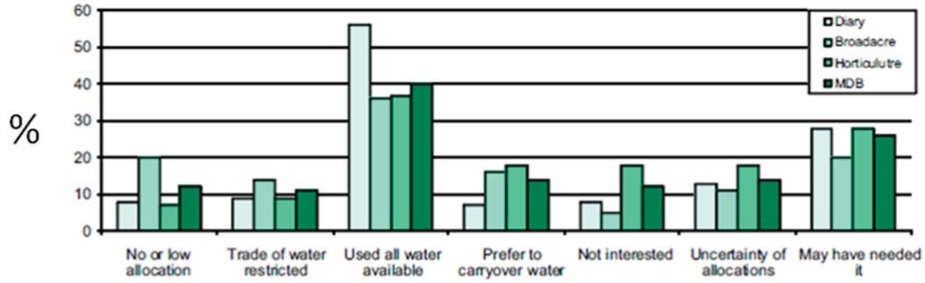



**Fig. 8.** Reasons for not selling water in the MDB in 2006–2007.
(Data source: Mallawaarachchi and Foster (2009)).

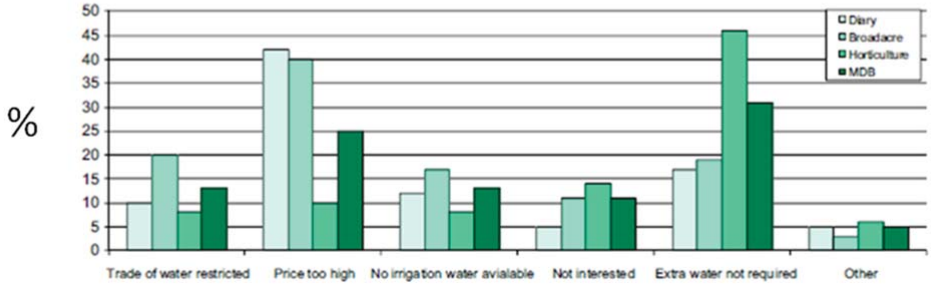



**Fig. 9.** Reasons for not buying water in the MDB in 2006–2007.
(Data source: Mallawaarachchi and Foster (2009)).

**Figure 4.4: Reasons irrigators/farmers do not sell (Fig. 8) or buy (Fig. 9) water in the MDB (from Wei et al., 2011)**

Based on the findings of Wei et al. (2011) it is clear that farmers could be better prepared to deal with a drier climate if their water management practices (e.g. irrigation methods and soil moisture measuring tools) are improved but also if the uncertainty of Australian water policy, water allocation and low water availability could be overcome. This supports comments made previously in this report and also the findings of Kiem et al. (2010). Wei et al (2011) conclude, as did Kiem et al. (2010), that key areas of focus include: the reduction of barriers, distortions and complexity associated with water trading; optimizing environmental water allocation; seeking mutual benefits between environmental water allocation and irrigated agriculture; improvement of the cost effectiveness of investments in water supply infrastructure; facilitating carryover and capacity sharing at larger scales; and provision of accurate, accessible and useful water information at different scales. Omitted from Wei et al. (2011) was consideration of the impacts of water trading on social aspects of rural communities which, as discussed above and illustrated by the MDB plan controversy, is important and not yet well understood. All these potential barriers need to be considered if the limitations of water trading as a climate change adaptation mechanism are to be reduced.

# 5. BARRIERS TO BETTER MANAGEMENT OF AUSTRALIAN WATER RESOURCES

The concepts of limits and barriers to adaptation are often used together or interchangeably by some researchers. However, IPCC (2007b) and Moser and Ekstrom (2010) differentiate between the two, as we do here. Limits, as defined by Moser and Ekstrom (2010) are "*obstacles that tend to be absolute in a real sense: they constitute thresholds beyond which existing activities, land uses, ecosystems, species, sustenance, or system states cannot be maintained, not even in a modified fashion*". Limits to adaptation are the residual impacts remaining after successful adaptation strategies have been implemented, as shown in Figure 5.1.

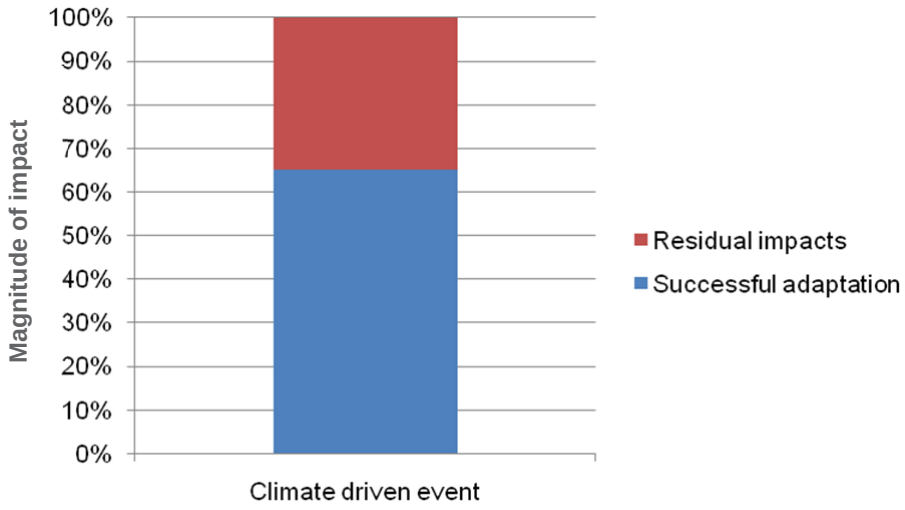



**Figure 5.1: Limits and barriers to adaptation**

Barriers differ to limits as they are "obstacles that can be overcome with concerted effort, creative management, change of thinking, prioritisation, and related shifts in resources, land uses, institutions etc" (Moser and Ekstrom, 2010). Hence, limits that can be overcome are viewed as barriers. While this report is focused on the limitations of water trading as a climate change adaptation mechanism it is important to realise that many of the limitations associated with water trading are actually due to barriers that could be, but have not yet been, overcome. Kiem et al. (2010) identified some of the specific barriers to climate change adaptation for small inland communities affected by drought, including:

- the dynamic nature of climate (extremes, spatial and temporal variability and change) and the potential for surprises – this is critical for informing realistic 'hydroclimatic baselines' on which to establish water allocation or trading schemes and to put future climate projections into context;
- uncertainty associated with climate change projections;
- uncertainty associated with global economic cycles;
- uncertainty associated with federal, state and local government drought/water policy and who controls the water;
- ineffective communication between climate scientists, policy makers, stakeholders in the agricultural industry;
- declining and aging population of rural communities;
- undervaluation of the farming enterprise and a shift in thinking with respect to the 'best' use of land (e.g. for solar/wind farms, mining etc as opposed to for agriculture).

Successful adaptation outcomes depend on decision-making based on the best available climate science information. However, a fundamental barrier exists, namely the disconnect between the information that climate science can provide and the information that is practically useful for (and needed by) natural resource managers and various other end users and decision makers (e.g. Kiem and Verdon-Kidd, 2011). This disconnect is emphasised within the agricultural and rural community context and was identified by Kiem et al. (2010) as the main barrier preventing well documented facts, themes and recommendations from being translated into successful adaptation outcomes. Until this disconnect is better understood, quantified and overcome the majority of the other barriers to adaptation will remain. A review of the literature reveals that it is not clear whether this disconnect is a communication issue, an education issue, a technological issue, or a fundamental philosophical issue (i.e. that scientists think about things differently than practitioners, decision makers and/or end-users do). As such, there is currently an ongoing project being conducted at the University of Newcastle (Australia) to investigate this issue and to quantify the source(s) and magnitude of the disconnect between climate science and the needs of practitioners and decision makers (refer to 0 for further information on this study).

The interviews and workshops conducted in Kiem et al. (2010) also identified the urgent need for more accurate and reliable seasonal forecasts and the need to determine what constitutes a ‘good’ climate forecast for rural community end users (e.g. what variables are useful? what format? what temporal and/or spatial scales are required?) and this is also currently being investigated by the Managing Climate Variability program (funded by the Grains Research and Development Corporation).

Further efforts are needed to coordinate ‘outcome-based’ research activities – a practice that not only provides the benefits of interdisciplinary and interagency knowledge, but also respects those we are working with by not overburdening them with separate and disconnected research interventions. Research needs to be engaging and worthwhile for those at the forefront of rural climatic change. As highlighted by the two studies mentioned, urgent investigation is required into why the already well-documented solutions and priorities have not been implemented, what are the barriers that are preventing implementation, and how these barriers can be overcome. A clear example of this is the difficulties associated with the Murray-Darling Basin Plan (draft released on October 2010) and the problems associated with its implementation. This is indicative of the complexities associated with implementing policy or strategies that aim for sustainability and to give equal weight to environmental, social and economical needs. This is a complicated task at any time but even more so given some of the potential threats associated with anthropogenic climate change.

# 6. CONCLUSIONS AND RECOMMENDATIONS

This report focuses on, and investigates further, the social, economic, and environmental costs of water trading and the implications of using 'market-based' instruments for climate change adaptation. On the whole it was found that water trading has potential as a climate change adaptation strategy with many benefits experienced in previous and current versions of water trading. However, there are also some significant limitations and the people and industries that are negatively impacted by water trading are hit hard. Water trading and the associated redistribution of industry (and associated jobs and population) has the potential to change rural communities permanently mostly via an acceleration of the aging and declining population already being experienced in most rural communities. These social impacts and limitations of water trading have not been thoroughly investigated and are not well understood.

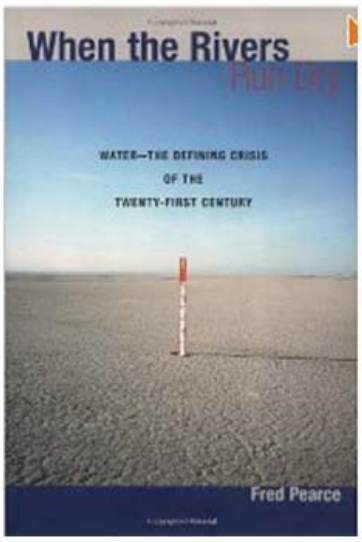
Similarly, as demonstrated by Wei et al. (2011) and the ongoing controversy surrounding the Murray-Darling Basin Plan, significant uncertainty also exists around the impacts of water trading on the environment (e.g. changed hydrological regimes, underestimation of sustainable environmental flows etc). Proper quantification of these impacts is needed, however, it is a very complex task given the current lack of understanding as to what is sustainable and what is not and how to best balance and optimise the water needs of the environment, agriculture, other non-agricultural industry, and human settlements.

In assessing the limitations of water trading, and MBIs in general, as a climate change adaptation tool it is crucial to note the difficulties of separating the impacts and issues attributable to water trading or water policy and those that are caused by drought or other climate impacts. The highly variable nature of Australia's climate poses a significant barrier to overcome when developing and assessing the performance of any water trading scheme. There is an urgent need for more research into this area in order to differentiate what part of the changes in water use (or limitations or failure of water policy) are due to inadequate water policy and which parts are due to variable (or permanently changed) hydroclimatic conditions (Kiem and Verdon-Kidd, 2011). The two are strongly related in that robust water policy (including a robust water trading scheme) should account for and be able to cope with changes in hydroclimatic conditions but to date there has been minimal effort focussed on assessing whether the existing and proposed water trading schemes are robust under the range of historical and projected Australian climate conditions or in fact whether such a 'climatically resilient' water trading scheme is even possible.

Finally, it appears, based on the MDB case study presented here and other international literature, that 'cap and trade' quantity-based MBIs such as water trading will eventually do what they are designed to do (i.e. reallocate a resource to 'high value' users). However, given that the 'low value' users in this case are agriculture and supply of drinking water and the 'high value' users are mining, manufacturing, and electricity production (i.e. industries with high greenhouse gas emissions) the question that must be asked is do we really want the water trading MBI to achieve its objective? And, what would the social and environmental ramifications of such a shift in water use within Australia be? These questions, along with the above-mentioned barriers, limitations and potential implications of using water trading (and MBIs in general) as a climate change adaptation tool, must be carefully considered and rigorously investigated before implementing if past drought and water policy failures are not to be repeated.

*"Water can flow up…*

*…but only to money"*



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# APPENDIX A. ONGOING RESEARCH PROJECT: "BARRIERS TO CLIMATE CHANGE ADAPTATION – UNDERSTANDING AND QUANTIFYING THE DISCONNECT BETWEEN CLIMATE SCIENCE AND END USER NEEDS"

As discussed in Section 5 there is an urgent need to better understand the source(s) and magnitude of the disconnect between climate science and the needs of practitioners and decision makers. In order to begin to address this, an Honours research project is being conducted by Emma Austin (supervised by Anthony Kiem) at the University of Newcastle, Australia. The project involves an online survey (included below) which has been distributed widely amongst climate science producers, climate science users, and people who would like to be climate science users. The aim is to get people's opinions on what we do and do not know with respect to climate science, what is and is not currently feasible with respect to production of climate science information, what end users and practitioners who are affected by climate need in terms of information from climate scientists. The survey responses will then be analysed to determine if there is any patterns associated with different groups of respondents to see if the source(s) of the disconnect (which to date has only been anecdotally and qualitatively established) can be identified.

The online survey is included below and can also be found at: https://www.surveymonkey.com/s/climatescienceinfoandclimatechangeadaptation.

## Information Statement for the survey:

## Using climate science to inform adaptation in Australian rural communities

*This research is being conducted as part of a fourth year Bachelor of Environmental Science and Management (Honours) student project (Student Researcher: Emma Austin; Supervisor: Dr Anthony Kiem).*

*Recipients of this invitation were identified through the researchers' professional networks and via publically available information. Participation in this survey is entirely voluntary and confidential and participants are not required to identify themselves unless they choose to. Participants are asked to give their opinion on the strengths and weaknesses of existing climate science information and its applicability to Australian rural communities.*

*All data collected during this research will be stored on secure computers requiring a password for access. Files will not be transferred to shared computers or computers without password protection. All hard copy data will be stored in locked filing cabinets in the allocated space of researchers. All data will be destroyed after being stored in this way for five years.*

*Information collected during this project will be used for research purposes including student researcher's thesis, and may be submitted for publications and/or conference presentations.*

*Please contact Emma Austin at Emma.Austin@newcastle.edu.au if you would like to provide feedback on the online survey. Alternatively, you can provide feedback in the space provided in the survey.*

*This project has been approved by the University's Human Research Ethics Committee, Approval No. H-2011-0093.*

*Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au*

**Please return completed surveys to:**

**Emma Austin**
**Geology Building**
**University of Newcastle**
**Callaghan**
**NSW 2308**

**Thank you for completing the survey. Your contribution is greatly appreciated.**

Alternatively, to complete the survey online, please go to
www.surveymonkey.com/s/climatescienceinfoandclimatechangeadaptation

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**PERSONAL DETAILS**

Please complete the following questions about yourself.

IF YOU ARE UNCLEAR ABOUT ANY OF THE QUESTIONS OR TERMS USED, PLEASE COMMENT ON THIS IN THE SPACES PROVIDED.

1. Gender

- ☐ Male
- ☐ Female

2. Year of birth

__ __ __ __

3. Please select the highest level of formal education you have completed

- ☐ Did not complete Year 10 or equivalent
- ☐ Year 10 or equivalent
- ☐ Year 12 or equivalent
- ☐ Trade certificate/diploma or equivalent
- ☐ Tertiary education at university

4. Please provide your postcode

__ __ __ __

5. Which of the following BEST DESCRIBES you:

- ☐ I am a climate scientist or researcher
- ☐ I am a scientist or researcher in a field other than climate
- ☐ I am someone who uses (or would like to use) information about future climate change impacts to make policy decisions
- ☐ I am someone who uses (or would like to use) information about future climate change impacts to make business/operational decisions
- ☐ I have a nonprofessional interest in climate change information and/or climate change adaptation

6. Please provide your job title/role/position

_____

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7. Please select the statement that BEST DESCRIBES your circumstances:

| | |
|---|---|
| | I produce information about future climate change impacts that could potentially be used by people in rural communities |
| | I produce information about future climate change impacts that is NOT relevant to rural communities |
| | I use information about future climate change impacts to make policy decisions that affect rural communities |
| | I use information about future climate change impacts to make policy decisions, however these decisions DO NOT affect rural communities |
| | I use information about future climate change impacts to make business/operational decisions and I AM a rural community member |
| | I use information about future climate change impacts to make business/operational decisions and I AM NOT a rural community member |
| | I DO NOT use information about future climate change impacts to make business/operational decisions and I AM a rural community member |
| | I DO NOT use information about future climate change impacts to make business/operational decisions and I AM NOT a rural community member |

**AVAILABLE INFORMATION ABOUT THE FUTURE IMPACTS OF CLIMATE CHANGE**

8. Do you think that currently available information about future climate change impacts is useful?

| | |
|---|---|
| | Yes |
| | No |
| | I do not use information about future climate change impacts |

Why?

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9. Where do you source the climate information that you use?

   If you do not use climate information please tell us why.

10. What are the STRENGTHS of the information about future climate change impacts that you use?

11. What are the WEAKNESSES of the information about future climate change impacts that you use?

12. Please add any further comments you have regarding the usefulness of information about future climate change impacts.

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**WHAT YOU KNOW ABOUT INFORMATION ON FUTURE CLIMATE CHANGE IMPACTS**

13. Please rate the following questions in the table below:

| | None | Low | Fair | High | Excellent |
|---|---|---|---|---|---|
| Please rate the AVAILABILITY of information about future climate change impacts that you require. | | | | | |
| Please rate your AWARENESS of where to find the information about future climate change impacts that you require. | | | | | |
| Please rate your level of UNDERSTANDING of the available information about future climate change impacts. | | | | | |
| Please rate your awareness of what information about future climate change impacts actually EXISTS. | | | | | |
| Please rate how well the FORMAT of information about future climate change impacts meets your needs. | | | | | |
| Please rate how well the available information about future climate change impacts matches the level of DETAIL you require. | | | | | |
| Please rate the RELEVANCE of the information about future climate change impacts. | | | | | |
| Please rate the CREDIBILITY of the available information about future climate change impacts. For the purpose of this study, credibility refers to the SCIENTIFIC ADEQUACY of the evidence and arguments presented in the available information about future climate change impacts. | | | | | |
| Please rate the LEGITIMACY of the available information about future climate change impacts. For the purpose of this study, legitimacy refers to the PRODUCTION of information about future climate change impacts, and whether that information represents and satisfies the needs of all stakeholders. | | | | | |

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**USING INFORMATION ABOUT FUTURE CLIMATE CHANGE IMPACTS TO INFORM ADAPTATION**

14. What information about future climate change impacts is required for successful climate change adaptation (or to reduce climate related risks)?

15. What are the STRENGTHS of the ways end users and decision makers use existing information about future climate change impacts?

16. What are the WEAKNESSES of the ways end users and decision makers use existing information about future climate change impacts?

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**HOW OFTEN DO YOU USE INFORMATION ABOUT FUTURE CLIMATE CHANGE IMPACTS?**

17. How often do you use information about future climate change impacts:

| | |
|---|---|
| | Daily |
| | Weekly |
| | Monthly |
| | Never |

If you selected 'never', please tell us why.

18. How frequently do you source climate change information from the Bureau of Meteorology website?

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Daily | | Weekly | | Monthly | | Yearly | | Never |

19. How frequently do you source climate change information from the CSIRO (Commonwealth Scientific and Industrial Research Organisation) website www.climatechangeinaustralia.gov.au?

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Daily | | Weekly | | Monthly | | Yearly | | Never |

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20. What is the best form of media for you to receive information about future climate change impacts?
You may select more than one.

- ☐ Local newspaper
- ☐ Local radio
- ☐ Automated telephone service
- ☐ Website
- ☐ Email
- ☐ Posted mail
- ☐ Face-to-face
- ☐ Workshops/meetings
- ☐ Television

Other (please specify):

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**THANK YOU FOR PARTICIPATING**

21. Do you agree to a member of the research team from the University of Newcastle contacting you to obtain further information?

- ☐ Yes
- ☐ No

If you agree to be contacted, please provide your name and contact details. ALL INFORMATION AND RESPONSES ARE KEPT CONFIDENTIAL

22. If you agree to be contacted, how would you prefer to answer future surveys?

- ☐ Online
- ☐ Paper copy mailed to me
- ☐ Face-to-face
- ☐ Telephone

23. Please provide feedback on the survey.

***THANK YOU!***

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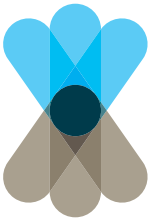

NCCARF
National
Climate Change Adaptation
Research Facility

Griffith University Gold Coast Campus
Parklands Drive, Southport
QLD 4222, Australia
Telephone 07 5552 9333
Facsimile 07 5552 7333
www.nccarf.edu.au

Australian Government
Department of Climate Change
and Energy Efficiency

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QUT

University of the
Sunshine Coast

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