



# Drought and the future of rural communities: Opportunities and challenges for climate change adaptation in regional Victoria, Australia



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## ABSTRACT

Australia's vulnerability to climate variability and change has been highlighted by the recent drought (i.e. the Big Dry or Millennium Drought), and also recent flooding across much of eastern Australia during 2011 and 2012. There is also the possibility that the frequency, intensity and duration of droughts may increase due to anthropogenic climate change, stressing the need for robust drought adaptation strategies. This study investigates the socio-economic impacts of drought, past and present drought adaptation measures, and the future adaptation strategies required to deal with projected impacts of climate change. The qualitative analysis presented records the actual experiences of drought and other climatic extremes and helps advance knowledge of how best to respond and adapt to such conditions, and how this might vary between different locations, sectors and communities. It was found that more effort is needed to address the changing environment and climate, by shifting from notions of 'drought-as-crisis' towards acknowledging the variable availability of water and that multi-year droughts should not be unexpected, and may even become more frequent. Action should also be taken to revalue the farming enterprise as critical to our environmental, economic and cultural well-being and there was also strong consensus that the value of water should be recognised in a more meaningful way (i.e. not just in economic terms). Finally, across the diverse stakeholders involved in the research, one point was consistently reiterated: that 'it's not just drought'. Exacerbating the issues of climate impacts on water security and supply is the complexity of the agriculture industry, global economics (in particular global markets and the recent/ongoing global financial crisis), and demographic changes (decreasing and ageing populations) which are currently occurring across most rural communities. The social and economic issues facing rural communities are not just a product of drought or climate change – to understand them as such would underestimate the extent of the problems and inhibit the ability to coordinate the holistic, cross-agency approach needed for successful climate change adaptation in rural communities.

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## 1. Introduction

Drought is a routine and prevailing feature of the Australian climate. Whilst there are numerous government policies and adaptation strategies that attempt to address the problems of drought in Australia, these approaches have not worked well in the past and are unlikely to be effective in the future (e.g. Edwards et al., 2009; Productivity Commission, 2009; Kiem, 2013),

especially given projections for increased drought risk across many parts of Australia due to anthropogenic climate change (e.g. IPCC, 2007). While significant uncertainties are associated with future climate projections (e.g. Parry et al., 2007; Randall et al., 2007), and likely always will be (e.g. Stainforth et al., 2007; Koutsoyiannis et al., 2008, 2009), especially for Australia and particularly for hydrological extremes like drought (e.g. Pitman and Perkins, 2008; Blöschl and Montanari, 2010; Montanari et al., 2010; Verdon-Kidd and Kiem, 2010; Kiem and Verdon-Kidd, 2011; IPCC, 2012), the fact remains that, regardless of uncertainties around drought causes and effects, improved strategies for adapting to drought are required. The need for robust (i.e. able to deal with uncertainty, climate variability and climate change) drought adaptation strategies was recently highlighted by the Big Dry or Millennium Drought (~1995–2010). Verdon-Kidd and Kiem

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(2009) demonstrate that, with respect to prolonged periods with below average rainfall, there have been comparable droughts in Australia's history (e.g. the World War II (WWII) and Federation droughts), however, the vulnerability of rural communities (which includes both farms and rural towns) appears to be much higher now (Alston, 2006; Alston and Kent, 2008; Fragar et al., 2010).

Therefore, this study focuses on the impacts of drought together with existing and potential adaptation strategies, knowledge that is needed now and the opportunities and limitations that exist. A case study approach is adopted consistent with calls for more connected and participatory approaches to studying drought impacts in agricultural regions (Senate Standing Committee on Rural and Regional Affairs and Transport, 2008). In this way, the project acknowledges that rural communities are at the forefront of creating, facilitating and enacting drought and climate change adaptation strategies. Although the case studies were chosen as exemplars of local impacts of drought, they also provide insights into what is occurring in the encompassing regions and in other locations. Therefore, a place-specific study such as this allows for holistic consideration of the complex issue of drought, how it is manifested and managed locally and how these experiences may assist in supporting other rural communities in their adaptation to drought and climate change (Golding and Campbell, 2009).

## 2. Method

### 2.1. Case study sites – from Kiem et al. (2011)

This study examines the Mildura (or Sunraysia) and Donald areas, two predominantly rural communities located in regional Victoria, Australia (Fig. 1). While both towns are geographically close, each has differing climates, water supplies, resource management policies, economics and demographics (see Kiem et al. (2011) for details). These rural communities have also experienced varied social and economic impacts as a result of drought and hence make good targets for comparative case studies. Both case studies are located in conservative rural regions, where considerable scepticism exists – not just about anthropogenic climate change but about scientists and the government in general. Nevertheless, belief in climate change is not necessary to elicit the lived experiences of farming communities confronting the impacts of climate change (e.g. Golding and Campbell, 2009).

### 2.2. Stakeholder interviews

During March 2010, 35 individuals, identified as representing local and regional organisations, government agencies, local

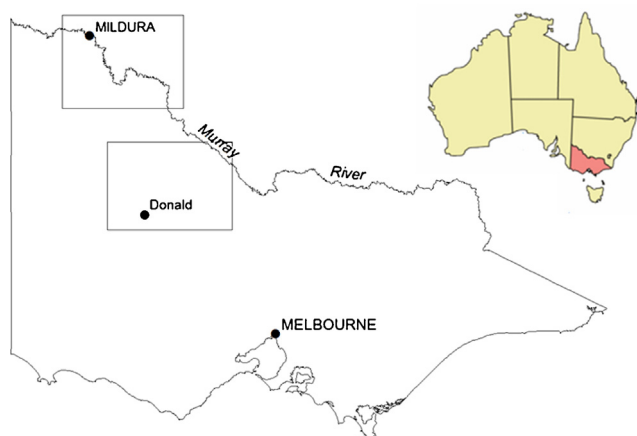


Fig. 1. Location of the two case study communities.

councils, private business, community and/or farming enterprises within one or both of the case study regions, participated in the project (refer to Appendix A in Kiem et al. (2011) for participant details). Participants were involved via face-to-face interviews, telephone interviews, and/or contribution of relevant written information (refer to Section 4.3 in Kiem et al. (2011) for details on the interview structure, selection of participants, participant background and demographics etc.). The interviews were undertaken as “conversations with a purpose” (Minichiello et al., 1995) through semi-structured questions, as a means of effectively engaging people from diverse backgrounds and also to ensure consistency and comparability across the responses (refer to Appendix B in Kiem et al. (2011) for the interview questions). The interviews were used to investigate current approaches to drought management, how drought is perceived and experienced by the people living in these areas, how the community is impacted by drought and how it copes with these impacts. It is important to note that the participant contributions should not be taken as the total truth but instead should be seen as an array of varied perspectives from a selection of rural community members (refer to Appendix A in Kiem et al. (2011) for information on the background and contribution of participants). As such there are obvious limitations with this approach, and it is neither as broad nor as in-depth as similar previous studies (e.g. BCG, 2008; Fragar et al., 2010; Rickards, 2012). Nevertheless, there are still interesting and important insights that emerge and the methodology is sufficient for placing drought into local contexts, comprehending the ways people living in rural communities experience drought and further understanding the potential for developing strategies to more effectively adapt to future droughts.

### 2.3. Stakeholder workshop

A ‘scenario planning’ workshop was undertaken in Donald in June 2010 to expand on insights drawn from the stakeholder interviews (refer to Section 4.4 in Kiem et al. (2011) for details). Mildura workshops were performed as part of previous studies (Treeby et al., 2008; Park et al., 2009) and the insights from those studies are also utilised here to check for similarities and differences. The Donald workshop was aimed at identifying the main future challenges for rural communities, specifically Donald in this case, and what actions are required to successfully adapt to these challenges. The identification and prioritisation of human, natural, social and financial assets enabled examination of current and future adaptation options for rural communities and also assists in projecting future viability and identifying areas where support is required. The workshop outcomes, combined with information from the interviews and literature review, allows assessment of the capacity to adapt to drought, both now and in the future. Importantly, the assessment is done by local stakeholders (i.e. those with the most knowledge as to what is feasible and what is most important), thereby increasing the likelihood that successful policies and/or adaptation strategies will emerge.

## 3. Results

### 3.1. Historical and future drought conditions in the Mildura and Donald regions

While abnormally low rainfall occurred during the Big Dry, in terms of annual rainfall totals other similarly dry epochs have occurred – particularly the Federation (~1895–1905) and WWII (~1935–1945) droughts (e.g. Verdon-Kidd and Kiem, 2009). However, often it is the timing and location of rainfall that is important for hydrology and agricultural production (Hayman

et al., 2010; Kiem and Verdon-Kidd, 2010) and the temporal and spatial nature of the rainfall deficits associated with the Big Dry are unique in observed history (since ~1890). Rainfall deficits for the Big Dry occurred predominantly in autumn (e.g. Verdon-Kidd and Kiem, 2009; Gallant et al., 2012) and encompassed much of the Murray-Darling Basin – an area known as the ‘food bowl’ of Australia that encompasses both the Mildura and Donald cased study areas. For Mildura, where water supply comes almost entirely from the Murray River this resulted in an ‘irrigation drought’ as well as a ‘rainfall drought’ which was ‘*unchartered territory*’ (Productivity Commission, 2009). For Donald, an economy based on dryland agriculture (i.e. rain fed as opposed to irrigated), the critical issue during the Big Dry was lack of rain, more specifically the failure of autumn rains and often a lack of late spring rainfall, as rain in these periods is crucial within the annual cropping cycle.

For both the Mildura and Donald regions the climate is projected to become warmer, with more hot days (over 30 °C) and fewer frosts (DSE, 2008a, 2008b). The greatest warming is likely to be in summer and the least in winter. Rainfall is projected to decrease in all seasons and this decrease is expected to be the greatest in spring and winter. Potential evaporation is also projected to increase across all seasons, with the most significant changes occurring in winter. Lower rainfalls and higher evaporation rates would result in less soil moisture and lower river flow. This potentially means more ‘rainfall droughts’ for both regions, and also more ‘irrigation droughts’ for Mildura given that similar scenarios are projected for the upper Murray system. However, these projections are associated with significant uncertainties (e.g. Kiem and Verdon-Kidd, 2011) and must be treated as such—that is they provide some insight into what could happen not what will happen. Climate change (and drought) adaptation strategies must be robust enough to cope with this uncertainty if they are to be successful. This was a point raised frequently by project participants, that even if the projections for changes to primary climate variables like rainfall and temperature are to eventuate, a great deal of effort is still needed in translating the information about future changes into something that is useful to rural communities (e.g. how will the magnitude, duration and frequency of ‘droughts’, which are more complex than a reduction in rainfall, change?). Also important to note is that the recently released Special Report of the Intergovernmental Panel on Climate Change on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (IPCC, 2012) only focuses on dryness indicators, which are very different to an agricultural or hydrological drought. Further, IPCC (2012) concludes there is only ‘*low confidence in attribution of changes in recent drought at the level of single regions*’ and ‘*low confidence*’ in the projected changes to the magnitude and frequency of future droughts due to insufficient agreement amongst the climate models. These complexities and knowledge gaps in understanding and dealing with projected climate change impacts make it difficult for rural community stakeholders to know what to do and even where to get information – indeed, often the projected impacts of climate change vary depending on who provides the information, especially for rainfall related impacts (e.g. droughts) at the farm or rural town scale.

### 3.2. Drought and rural communities: impacts, attitudes and responses

Talking with people from rural communities confirmed many previously identified trends (e.g. declining and ageing rural populations, increasingly difficult climatic conditions, increasingly difficult socio-economic pressures, changes to water and drought policy, challenges associated with global influences on commodity

prices, changing nature of Australian agriculture etc.) (e.g. Aarons et al., 2008; BCG, 2008; BSC, 2008; RFCS, 2008; MCMA, 2009; MDC, 2009; Kiem et al., 2011; Connell and Grafton, 2011; Wei et al., 2011; Rickards, 2012; Kiem, 2013). The experiences of the people in Donald were often distinct from those in Mildura given the dryland areas of Donald are not so affected by the ‘marketisation and politicisation’ of irrigation water, although the emergence of water as a commodity was of concern to participants from Donald. While there will always be location or sector specific differences, some of the issues uncovered in this study are common to rural communities, common to drought-affected regions of Australia, and/or common to agriculture in general. Three key themes to emerge were:

- ‘It’s not just drought’: water markets, commodity prices, rural demographic shifts and a changing farming industry;
- Economic impacts: drought, drying and the demise of the family farm;
- Future scenarios and climate change adaptation.

As expanded on below, these themes highlight broader issues confronting rural communities, and agricultural production, under a changing climate and present challenges and opportunities for the future.

#### 3.2.1. ‘It’s not just drought’: water markets, commodity prices, rural demographic shifts and a changing farming industry

Drought is a challenge that confounds an already changing agricultural and economic context (e.g. Sherval and Askew, 2011). The Mildura region is confronting a rapidly evolving situation with respect to water availability as a result of ongoing drying, decreased water allocations and an expanding water market (MCMA, 2009; MDC, 2009). This change has come at a time of record low commodity prices for some of the main agricultural products of the region (e.g. wine grapes) which have suffered due to global oversupply and market competition. In addition, producers are confronting fundamental changes to the farming sector including the expansion of farms and farm trade, declines in farm succession (i.e. management and ownership of the farm being kept within the same family by passing it on from one generation to the next), and increasing uncertainty around crop selection and investment. Some of these issues are a direct result of drought, however, others are related to global trade and agricultural markets:

“We’ve been saying consistently it’s not just drought that has impacted this region, it’s water allocations, global financial crisis, international commodity prices, rising production costs, and farmers’ declining capital. So I think water scarcity was the straw that broke the camel’s back. What really hit us equally hard, if not harder, was commodity prices – and everything else.”

(CEO – Mildura Development Corporation)

Water reforms have continued the process of unbundling water from the land, to create a water market. The reforms were based on unquestioning ‘faith in markets’ that would lead to water being allocated “*to its most valuable use, thereby ensuring a range of socially optimal outcomes*” (Quiggin, 2007; Kiem, 2013). The responses to this marketisation process, however, range from confusion through to experimentation and learning to manipulate the water market:

“There wasn’t the understanding of how you manage water security being threatened. We might be able to manage drought but it’s been the policy issues and intervention in the [water] market which causes a whole range of other issues.”

(CEO – Mildura Development Corporation)

*“Farmers that have lost their water would be critical of the unbundling of water. But some are more progressive and see an opportunity to use every asset that they’ve got, to trade off excess water or buy in cheap water at appropriate times.”*

(Coordinator – Rural Financial Counselling Service)

Interviews with farmers conducted in this study revealed that there is some anger at the water reforms because they challenge the traditions of perpetual irrigation supply (see also [Golding and Angwin \(2009\)](#)). However, many of the same farmers also displayed attachments to the river and a strong respect for water. Drawing on people’s close relationship with the river and water (e.g. commercially, recreationally, emotionally) can nurture new understandings of variable water availability and offer opportunities for adaptation and change (e.g. [Allon and Sofoulis, 2006](#); [Gibbs, 2006](#)). Through such a change in understanding, it may be possible to shift from the idea of water as taken-for-granted to water as economically, environmentally and socially valuable.

In Donald, drought and the longer-term drying of the cropping region is again just one of many challenges facing local farmers. As for Mildura, there are other pressing issues facing farmers, including commodity prices in a global marketplace, shifts in the farming industry, and broader demographic changes to rural towns and communities. Unlike Mildura, the problems of market pricing in the cropping sector are not so much the result of a commodity glut, rather farmers are still adjusting to selling grain without the ‘single desk’ of the Australian Wheat Board (AWB), which was abolished in July 2008. The single desk represented a central body through which to negotiate grain policy and prices, and market and sell grain globally ([Hopkins, 2006](#)). However, a series of scandals involving the AWB led to reviews and reforms ([Brindal, 2010](#)), the most recent of which was the replacement of the single desk with a free market system of marketing and exporting grain. Most grain farmers felt that this change, combined with fluctuating grain prices, increased the pressures they experienced:

*“Farmers in Victoria wanted to keep a single desk. . . or at least a mixture of both single desk and free market. But the government decided and we now have to live with it. So the prices are rock bottom and don’t look like getting any better. . . despite the fact that we had an alright season last year for the first time in ten years.”*

(Dryland Farmer – Donald)

These shifts are adding to farmers’ workloads as the Mayor of Buloke Shire explains: *“the farmer now has to market [grain] himself so he is harvesting, stripping, carting, and trying to find a good price to sell at”*. As a result, farmers now have less time to spend with their families, on social activities or participate in community events due to new demands that are, in many cases, outside their existing skill range.

In addition to water reforms and drought, there have also been broader shifts in the farming sector associated with changing global markets and rural demographics. In particular, interviewees discussed the rise of the large amalgamated farm and multinational agri-business, with the associated decline of the family farm and farm succession (see also Section 3.2.2):

*“When the dried fruit industry went by the wayside 10–15 years ago we had to find something else, so the wine industry came along and like lemmings we all went to that. Then the managed schemes came and because you had a 100% depreciation allowance and could write money off in 12 months all the sharks came in and bought 1000s of acres. Very quickly we had oversupply because the Chileans and South Africans booted up at the same time and the outcome is now just coming into play.”*

(Farmer – Mildura Region)

*“Smaller growers have limited capital and limited opportunity for change. They’re the mum and dad partnerships. Children go off to tertiary education, good jobs in the city, and don’t want the farm. Mum and dad are sitting there with their labour force gone and just haven’t got the will or finances to do anything. The family farm has just about had it.”*

(Coordinator – Rural Financial Counselling Service)

*“Every thirty years farm size doubles, the width of headers doubles and with bigger, more complex machines the skills to keep it going are different. It used to be every town had a mechanic now they need staff skilled in GIS, complex hydraulics, sophisticated diesel engines and computerised guidance systems. Essentially, those traditional services withdraw out of towns like Donald.”*

(Senior Social Researcher – Victorian Department of Primary Industries)

*“We’re seeing the consolidation of properties and the role of towns as support centres for agriculture dropping off. With that some social connection is lost with farmers only seeing each other at clearing sales and funerals. Farming has become more complex, relying less on ‘let’s have a yarn over the fence’ and more on professional advice.”*

(Community Development Officer – Buloke Shire Council)

The changing nature of agriculture is having significant flow-on effects to farming families and communities. As farms increase in size and sophistication, the ability of farmers to work together and be serviced by local agri-business is diminished, and as a result, the natural sharing and learning between farmers is decreased. This is not to say that farmers are losing their professional and social ties to each other and the community, rather that the once customary and effortless opportunities to engage are declining. Subsequently, service providers are facilitating regular organised social events in which this sharing between farms and farming families can still be supported, even under changing farming contexts.

Perhaps the most threatening for many rural communities, is the pressures presented by broad rural demographic changes – an ageing and declining population base, with an influx of retirees and low socio-economic groups. These shifts are introducing potential problems that, even without the added pressures of drought, pricing and industry changes, will significantly change the make-up of rural communities:

*“Donald, like other cropping towns, has been slowly declining for generations. The population peaked after World War II. You’ve also had welfare migration and retiree migration. So the town population has been changing and the drought has sped up that change. . . they call it ‘dust change’. Cultural conflicts can come from that, between the long-term residents and newcomers who may not be interested in the same institutions.”*

*“We’re going to have significant service delivery challenges in small towns, as the people moving there don’t have the assets backing them that the farm community had. They’re often socially disadvantaged and don’t understand the costs or strategies of living there. For example, they discover the water’s run out and cannot afford the expense to have water carted. This is policy and planning failure and drought exacerbates that.”*

(Senior Social Researcher – Victorian Department of Primary Industries)

As a local community group leader explains: *“there is the farming community and there’s the town community, but one can’t be without the other. The town community relies on the farming*

community for business and farmers rely on the community for services and social connectedness". Many community groups such as 'Donald 2000', together with local council, are working to ensure the sustainability of these rural towns through the maintenance of such connections. However, all spoke of the difficulties faced by a declining skills base in rural communities, tired and 'burnt out' volunteers, and limited funding and resources to apply for grants and support schemes. Any support offered to rural communities, in the form of project or community development officers, are increasingly stretched across larger geographic areas and have little time and resources to spend on individual communities. The provision of local support workers to help maintain active, yet tiring, community leaders and volunteers is an essential component of increasing the adaptive capacity of rural communities.

The challenges presented by this combination of industry, market and demographic pressures are "more reliable than drought" (Senior Social Researcher – Victorian Department of Primary Industries). These are recent phenomena confronting rural communities that present a "huge learning experience, in which there's no living memory to draw on" (CEO – Mildura Development Corporation). For some the confrontation has been too much and they have left farming entirely (it should be noted that this is also occurring in non-drought stricken areas for the structural and social changes mentioned, reinforcing the idea that 'it's not just drought' that threatens the future of small rural communities). In order to maintain the healthy future of rural communities, foresight and planning will be required to support the farming industry given demographic changes already underway combined with issues associated with a variable and changing climate. Conventional government approaches to drought-assistance do not acknowledge the connections within rural communities, and thus cannot adequately support these transitions that are occurring (e.g. Kiem, 2013; Kiem and Austin, 2013b). Drought is just one of many threats to the survival of rural communities and a 'more-than-drought' service system is needed that takes a holistic and strategic planning approach encompassing the farm, farming families, rural community, and their encompassing regions.

### 3.2.2. Economic impacts: drought, drying and the demise of the family farm

In Mildura, diversification into non-agricultural sectors (e.g. transport, property, mining) is occurring but agriculture, and the services that support it, remain central to the region's economic viability. Hence, due to agriculture experiencing a financial downturn, resounding effects are evident across the Mildura community. On the farm, financial returns and reserves are dwindling after years of drought and low commodity prices. This has the combined effect of decreasing everyday spending income and increasing the strain of ongoing and accumulating debts. The Rural Financial Counselling Service (RFCS) is dealing not only with a significant rise in clients seeking financial advice, but also escalating client debt (from \$15 million in 2000–01 to \$48.2 million in 2005–06, with a surge to \$275 million in 2007–08 (RFCS, 2008)). Many families are no longer in a position to borrow funds, which impedes their ability to change and adapt via new technologies or crops. In addition, many families are diversifying their income through secondary off-farm employment (MDC, 2009). The financial position of farmers is such that, even if the pressures of drought and commodity prices were to break immediately, the financial stress on farming families would continue:

*"Farmer's built up asset capital has been whittled away during the drought. A lot of people have second incomes but this can also be a problem as it seems to have held back some small blocks from getting out, getting bigger, doing something different, because they've got a fail safe."*

(Senior Planner 1 – Victorian Department of Planning and Community Development)

*"The structure of family is changing. . . often wives have not worked off-farm before. They come from a family of irrigators that have to go through a mind shift. That's really tough when you're under pressure but they've run out of options and can't put the banks off anymore."*

(Project Manager – Mildura Rural City Council)

For many, their focus has been narrowed to economic survival – 'holding on', 'getting through'. The diversification into off-farm income may offer an effective short-term solution to some financial strains. However, off-farm incomes also enhances the narrow focus on economic survival and limits more strategic financial and farm planning. Moreover, the adoption of secondary employment has impeded the ability of farmers to undertake training out of work hours and on weekends (Project Officer – Victorian Department of Primary Industries & Farmer). Secondary employment is also putting increasing strain on family relationships, as farming families (including children) are working more off-farm just to cover on-farm expenses.

Many describe a burgeoning "welfare industry" in the Mildura region (Director – Sunraysia Mallee Ethnic Communities Council), created and sustained by reactive government support programmes (see Kiem, 2013; Kiem and Austin, 2013b). The welfare system provides much needed assistance to farmers but this is problematic when farmers become reliant on government-funded financial support – "you can't blame the farmers, if it's there you take it but we do see it causing social problems" (Coordinator – Rural Financial Counselling Service). These social problems may indeed indicate a "welfare disaster", especially when combined with the increasing influx of low socio-economic groups to the area in search of low-cost housing. Note that this does not mean, and should not be taken to imply, that all farmers or rural community members are welfare dependent.

Perhaps the most devastating economic impacts on Mildura farming families have been the changing nature of farm assets. Historically, farmers were asset-rich, which buttressed seasonal and market-derived income fluctuations (Botterill, 2000). However, traditional assets are being whittled away by a changing farming sector, shifting land and water regulations, and increasing farm debt. In most cases, the farm is regarded as the last asset but for many this has become largely worthless:

*"The changes to do with subdivision of land has impacted farmers radically. There are lots who could have sold off water to get themselves out of debt, then could have subdivided their land for their superannuation, but that option's gone now."*

(Senior Planner 1 – Victorian Department of Planning and Community Development)

*"With unbundling of water from land, land value is not in the dirt itself, it is in the water component. So things like loans with banks are based on value including the water, so there was a substantial shift in how farms are valued."*

(CEO – Mildura Development Corporation)

In Donald, the interconnected nature of the dryland farm and rural town (and wider community) means that economic impacts on the farm quickly resonate in the town. Dryland farmers are experiencing a declining cash surplus from the farming enterprise, with many surviving at 'break even' or with increasing debts. While zero or negative income is common during drought, the persistence of low incomes during the Big Dry and levels of debt in 2010 were unprecedented. In addition, the compounding and

multiple issues facing dryland farming mean that many problems will persist even if/when it rains:

*“Even if it rains overnight, the drought doesn’t break, all it’s done is rain. The rest’s still got to happen, they’ve got to plant, grow, harvest. It costs a farmer a minimum of \$85,000 on average, just to spray a crop and get weeds out and chemicals are getting more expensive.”*

(Coordinator – Donald Community Centre)

*“Cash surplus is declining in cropping. But the impact in the cropping areas has not been to send more people off farms. When drought hits, and commodity prices are low, not many people are interested in buying. The drought has not forced people out of dryland farming, but it’s made them live on less or live on welfare to hang on, so they can sell when times are better.”*

(Senior Social Researcher – Victorian Department of Primary Industries)

*“Frankly, the farmers haven’t got any cash. They’re living on borrowed money, some for the first time. So whether they’re prepared to continue to pull out \$50,000 and pay interest on it is the decision. The position now is they hold so much of the bank’s money that the bank’s got to lend them again in hope of a better year.”*

(Mayor – Buloke Shire Council)

Unlike Mildura, welfare assistance is relatively new to the Donald region and farmers are holding on to properties, rather than exiting, in the hope of better years to either continue farming or sell-up (Kiem and Austin, 2013b). Farmers are viewed as ‘doing well’ if their farms are running at ‘break even’ but this situation does not support investment, adaptation, or long-term planning for the future. Moreover, increasing farm debts are often silent contributors to the financial strains on farms and need to be addressed to ensure that bank loaning policies are not at odds with projected climatic impacts. The feasibility of farm debt mediation was also raised by interviewees (see also Altobelli and Francis, 2009).

In addition, declining cash surplus of farmers has obvious impacts on the economics of the surrounding rural communities. Local businesses and employment are suffering as farmers and their families are forced to curb spending:

*“Economically the town has backed off. Businesses have really suffered because there was no relief for them, there was relief for farmers but not much for business.”*

(Coordinator – Donald Community Centre)

*“The businesses suffer as the farmers suffer, with little cash flow on the farms people only spend what they absolutely have to.”*

(Councillor – Buloke Shire Council)

The financial flow-on effects to rural towns are often overlooked in government planning for farmers’ assistance and support. Although income assistance to farmers may indirectly benefit rural towns, assistance to local businesses beyond tax relief may be necessary to ensure the survival of key towns within rural communities. Further, despite one of the drivers of farmer financial assistance being the idea that it does assist local communities, there are unresolved questions as to whether farmers/farm families actually do spend financial assistance money in businesses belonging to their local community (or does the assistance money go to cover essential bills and expenses with businesses that are not part of the local community?) (refer to Pritchard et al. (2012) for further discussion on this issue).

The insights summarised above give some perception of the financial impacts of drought, commodity prices and rural/farming shifts. Farmers are struggling even to “hold dead level” (Dryland Farmer, Donald) and it is evident that people are waiting for a better year in which to either make back their losses (or perhaps make a profit) or to sell their property at a reasonable price. In the meantime, long-term planning has mostly been put on hold and debts are increasing rapidly.

### 3.2.3. Future scenarios and climate change adaptation

Climate change adaptation research must consider ways in which projected climatic changes are likely to alter the socio-economics of rural communities, the responses of people living in these regions, and their willingness and ability to adapt. Effective adaptation involves working with people to gather knowledge about adaptive capacity and the strength and responsiveness of communities in the face of future climatic changes (Howden, 2008; Stokes and Howden, 2010). It is often argued that the extent to which Australians have already adapted to difficult and changing climates should provide capacity to manage projected impacts of climate change (Berkhout et al., 2006; Heyhoe et al., 2007; Nelson et al., 2010). This section highlights how Mildura and Donald communities are undertaking adaptation measures, the areas where adaptive capacity is lacking, and how efforts to change and adapt may be better supported.

First, it is important to note how people perceive the future and how they imagine climate might change. Participants acknowledged that the future will probably involve less water and, as a result, a changed farming and irrigation landscape:

*“We’re going to see an irrigation area that’s much more concentrated and areas changing from irrigated to dry farmland systems. We’re going to see, and we’ve already seen, bigger farms. We’re also seeing a need for farmers to be more opportunistic and make the most of what conditions occur in any particular year.”*

(Delivery Manager – North Central Catchment Management Authority)

*“In the future I see certain areas becoming hobby farms, with horses and whatever, not permanent plantings, and they’ll be small holdings. Remaining irrigators that are here long-term will get bigger and bigger and have economies of scale needed to survive.”*

(Project Officer – Victorian Department of Primary Industries)

Participants, as with most rural areas, were typically conservative and concepts of anthropogenic climate change often elicit scepticism and disbelief – with most advocating notions of a variable climate: “we’re in a cycle” (Coordinator – Donald Community Centre); “I confess to being a bit of a climate change sceptic, it just goes up and down” (Councillor – Buloke Shire Council); “I don’t know if I agree with climate change, I say ‘we’re living in a changing climate’” (Rural Services Officer – Centrelink). However, climate change scepticism does not always limit people’s ability to undertake adaptive on-farm practices, or imagine different climatic futures for the region (e.g. Golding and Campbell, 2009; Kiem and Austin, 2013b). People are thinking about climate, and managing and adapting to its changes:

*“Already, climate change has had a huge impact. Historically, 50% of Victoria’s grain has been grown within 100 km of Birchip but not now. Prime grain growing has switched down to the Western District, which historically was wool.”*

(Community Development Officer – Buloke Shire Council)

*“This area may become unviable for grain cropping. If you can believe what you read, the rainfall in the long term will reduce and*

*it'll become hotter so this area may become too climatically different for dryland farming."*

(Director – Sunraysia Mallee Ethnic Communities Council)

Whether people believe in 'climate change' or a 'changing climate', they still seem to support the view that the region's climate will continue to change and that this will affect farming. This acknowledgement provides a digression from presumptions about conservative rural communities' adaptive abilities and provides a foundation for effective climate change adaptation.

The farming sector is increasingly undertaking scenario planning for a number of futures from continued drying through to flood, with strategic on- and off-farm planning for each scenario. The most challenging aspect of this process is the change in thinking required to envision and plan for different futures. A Project Officer for Victorian Department of Primary Industries said *"irrigators and farmers are starting to think more outside the square, starting to think about other things rather than just production issues, develop a strategic plan, get information and learning, but the next challenge is what do we do now, where do we go from here?"*. Some farmers keenly subscribe to adaptation, research and development, and change in their on-farm practices and describe themselves, as do other people in the community, as responsive, up-to-date and willing to change:

*"The drought's been good in one way, that people have learnt to get by with a lot less water. So they're changing farm practices. People seem to think farmers aren't good with change but they run a business and have to be on top of it. I don't know how they cope but they do it – they're always looking for change."*

(Rural Services Officer – Centrelink)

*"Adaption has been increased by the drought. If you see somebody who's adopted more modern farming methods and they're getting a benefit, then you adapt and change as well. So the adoption by other people has been very quick – it's a case of do it and survive or have poor yields and go. There's been an unbelievable change to living in the Mallee and we're all very proud of what we've done, but we get absolutely no recognition."*

(Dryland Farmer – Ouyen (farming area between Mildura and Donald))

For many farmers in the Mildura region, the question of *'where do we go from here?'* has resulted in experimentation and investigation of different crops, the uptake of advanced irrigation systems, and on-farm technology:

*"On-farm irrigation efficiency has gone to a high level and I can't see much more water savings in the Mildura region."*

(Consultant – RM Consulting Group)

*"Wine grape growers are diversifying into passionfruit commercially and into fish farming. Some have looked into dates and pomegranates."*

(Project Officer – Victorian Department of Primary Industries)

*"People are talking about more annual crops, which you don't have to plant if there's less water. So a mixture of permanent plantings that need water every year and annuals that you vary according to water availability. Also production in other regions so you can still supply the markets."*

(Consultant – RM Consulting Group)

*"We're beginning to see companies coming in to less attractive farming sites and trying to generate a return from environmental offsets."*

(Delivery Manager – North Central Catchment Management Authority)

Dryland farmers are also experimenting and trying different crops, ways of growing, and techniques. All acknowledge the vital role played by the Birchip Cropping Group (BCG) who provide locally based and technologically advanced support for the dryland farming sector. Farmers also note that this type of adaptation is hastened during drought, because it is a matter of survival.

Therefore, rural areas appear to offer potential opportunities for development and uptake of effective adaptation due to the innate nature of experimentation in farming activity. Most people interviewed acknowledged the importance of undertaking positive and practice-oriented activities in rural communities, as a farmer from the Mildura region explains: *"you're less inclined to pick up the hype of scientists saying, 'the world's ruined, now you've got to change'. We've had all the doom and gloom. Farmers need something that's positive that they can pick up and go home and play with. If government really wanted to do something, they would be the facilitator for those types of programs and road shows"*.

Naturally, individual farmers' ability to adapt is influenced by the socio-economic impacts they are experiencing. Those on the cusp of financial viability and/or experiencing health issues and/or with limited education are not always able to make the changes required:

*"A number of farmers haven't quite caught up with what's happening. Part of that is financial. If you haven't got the financial backing then you can't really buy what's needed to adapt. For smaller growers, they have limited capital and opportunity for change. Some just haven't got the will or finances to do anything."*

(Coordinator – Rural Financial Counselling Service)

*"Some in the grape industry are doing wheel spins at the moment because of grape prices – people are eating into their reserves. So the adaptation is minimal but on the other hand there are a few people who are young and energetic and financial enough to change."*

(Farmer – Mildura Region)

*"If we keep getting another 10 years of dry it'll be very interesting. Everybody will be too scared to do anything."*

(Dryland Farmer – Donald)

It is clear from these comments that while government and service providers can envision, and are supporting, adaptation to climate change and alternate futures, there are many who will not be able to keep up and will need assistance to make a transition out of farming in a dignified and supported manner.

An important part of climate change adaptation is the place that the rural community takes within these scenarios. While for many rural communities, the future can look grim, for Mildura, its size and industry scope has provided some buffering from recent changes and pressures. Moreover, many are looking to futures that are not as reliant on agriculture (e.g. renewable energy production, tourism etc.):

*"Mildura is fortunate as we have other things besides farming propping the economy up. We've got infrastructure, we've got shops, we've got some tourist attractions, and we've got housing and transport logistics. It's the smaller areas that will struggle. Mildura will be a sponge city, there will be people moving here from small towns that may not survive."*

(Coordinator – Rural Financial Counselling Service)

*"The region will survive but we're very conscious of trying to help people move to a different future. I think in future horticulture will probably decrease. We're looking at investment in solar farms."*

*Farmers who can't afford to buy water anymore might be able to convert to solar farming."*

(CEO – Sunraysia Institute of Technical and Further Education (TAFE))

However, for smaller communities like Donald the future is more uncertain, as people, services, schools and businesses are depleted – a pattern which is likely to be enhanced under a drying climate. Nevertheless, interviewees and workshop participants from Donald offered a view of their future which noted the challenges they face and also provided alternative visions and strategic plans for their survival with emphasis on retaining and gaining population, and making the town attractive and liveable:

*"One of Donald's big concerns is to retain and attract population. We're seeing younger families going to bigger centres, and then we're seeing older people just retired come and buy property here. They take a look at the place, love the lifestyle and the cheaper real estate. The future of these towns is very much around the ageing population and ensuring the liveability of the town."*

(Community Development Officer – Buloke Shire Council)

*"Based on government figures, we're going to have double the population in Victoria in 15–20 years. I think a lot are going to come this way, and also from Queensland when it gets too hot. The country community has an opportunity to use technology to invite people to live here: people with skills who can come into our towns and keep the population at a sustainable level, to service ourselves, and what is an ageing population."*

(Mayor – Buloke Shire Council)

In addition, some interviewees from Donald also had visions of the region not just retaining and attracting population, but changing the foundations of the rural community itself:

*"Technology is the answer for a lot of things. In 10 years the world will be nothing like it is now. We'll have a health system where you communicate via video link. Same with pharmacies. That's how rural towns will have to evolve. I think we're close to that with things like video teaching which is already at the school here."*

(Mayor – Buloke Shire Council)

*"If it's going to get hotter, the positive side is solar power. We've got more sun than anywhere else and should capitalise on it. I'd like to see more government spending for solar farms. We've got the space, we've got the gridline, we've got the people. We also grow excellent canola which could make biodiesel to sell to places unable to grow canola but the government taxes biodiesel. . .if they were serious they would scrap the tax."*

(Business Owner – Donald)

Similar to those in Mildura, the people living and working in the dryland farming regions are talking about their future and the changes required, and most importantly, are active in undertaking any initiatives that will aid in their survival. In addition, different futures are being considered, where isolation and service demands are managed through technology, and alternative industries and energies potentially offer a sustainable and economically viable way forward. Importantly, interviewees noted that there is no panacea to the challenges and that a "balance of things" is needed in order to survive, a view perhaps "borne out of the common farming practice of spreading risk" (Chairman – Ouyen Inc.).

#### 4. Discussion and recommendations

This study presents a complex picture of the changes rural communities are facing. These challenges are often mixed given

there is real disadvantage and distress, requiring immediate attention and support, but also evidence of resilience and optimism. Several key insights were gained, some of which are applicable specifically to drought in the study regions, while others are relevant to all areas and people affected by drought or other rural community pressures. These insights lead to the following broader recommendations:

1. There is advantage in comparative, case-study based research into climate change impacts and adaptation. The actual experiences of drought and other climatic extremes from people living in rural communities are important for advancing our knowledge of how to respond and adapt to such conditions, and how this might vary between different areas. Such an approach is important in addressing the specifics of regional climatic issues, while also informing a coordinated government response to climate change adaptation (see also [Rickards, 2012](#)). There are a number of specific issues that need further attention in research into drought-affected rural communities including: mental health and well-being issues associated with change and uncertainty; the potential challenges faced in ageing communities with growing socio-economic disadvantage; and the issues of debt and declining asset-base of farmers and how this might be better anticipated and supported. Further, research that examines, identifies and builds on existing adaptive capacity and knowledge of rural communities is also required as is better understanding into the less optimistic vulnerability, maladaptation and negative experiences identified in this study. It is particularly important to maintain this focus when it rains and drought is temporarily forgotten.
2. There is a clear need for change in the way governments support drought-affected rural regions. Strategies and policies are needed that encompasses short-term social support measures with long-term planning and programmes that facilitate progression to more viable futures. The fact that the National Drought Policy has been suspended and is under review presents a good opportunity to further investigate and implement the required changes. Key to such a holistic approach will be reshaping the language and approach of support services, broadening from a focus on drought as an 'exceptional circumstance' to notions of 'constant change'. In drought prone rural communities there is a need to move from notions of drought as an unexpected event to acknowledging the variable availability of water and the potential for more frequent multi-year periods of significantly reduced water availability.
3. While not discussed in the results presented here, it was evident during this project (see [Kiem et al., 2011](#)) that there is an urgent need for more accurate (not to be confused with precise) and reliable climate forecasts and projections that are relevant at the farm-scale. Unfortunately, significant uncertainties exist around climate change forecasts and projections, especially for rainfall at the farm-scale, and this uncertainty will remain for the foreseeable future (e.g. [Stainforth et al., 2007](#); [Koutsoyiannis et al., 2008, 2009](#); [Koutsoyiannis et al., 2008](#); [Blöschl and Montanari, 2010](#); [Montanari et al., 2010](#); [Kiem and Verdon-Kidd, 2011](#); [IPCC, 2012](#)). Therefore, while reduced uncertainty around climate projections would undoubtedly be beneficial, the more urgent, and more achievable, objective should be to robustly quantify this uncertainty, translate uncertainty into risk, and build resilience such that rural communities are capable of adapting to climatic changes whatever they might be. Farmers are adept at dealing with uncertainty and risk but are frustrated that the information about climate change they need to make their decisions is either unavailable, inaccessible, or not in a format they have the time or ability to utilise. This highlights the



disconnect between climate science providers and the needs of end-users and decision makers (e.g. Meinke et al., 2006; Kiem and Verdon-Kidd, 2011; Kiem and Austin, 2013a). There was consensus amongst project participants that the decrease in region-based conduits between the government and rural communities (e.g. Victorian Department of Primary Industries extension workers) was causing this disconnect to widen. It was clear that a 'knowledge broker' is urgently needed who could translate and package the climate science such that it is useful for end-users and also to ensure that scientists are aware of and working towards addressing the needs of end-users. A separate National Climate Change Adaptation Research Facility (NCCARF) project (<http://www.nccarf.edu.au/publications/decision-making-under-uncertainty>) has recently looked into this.

4. Also not explicitly mentioned in the results above, but reiterated by numerous interview and workshop participants, was the growing issue of 'survey/research fatigue' amongst end-users, decision makers, and community members. People living and working in drought-affected communities/regions are tired of 'yet another' drought or climate change research project when they have been involved in so many before and seen few positive outcomes. This issue is significant and needs to be managed carefully in order to maintain the stakeholder engagement that is essential in development and implementation of positive climate change adaptation strategies (e.g. Kiem et al., 2011; Rickards, 2012). Effort is needed to coordinate 'outcome-based' research activities that respect target groups by not overburdening them with separate and disconnected research interventions. Facilities such as NCCARF are a step in the right direction but only if redundancies and parallel projects being run by other organisations (sometimes with different research aims but the same stakeholders) can be minimised. Research needs to be engaging and worthwhile for all those involved – not just the researchers. To date, a lot of drought and climate change adaptation research has been, and continues to be, conducted, but the well documented facts, key themes and recommendations continue to emerge with little evidence of effective implementation.

## 5. Conclusions

Rural Australia, as demonstrated through the Mildura and Donald case studies, has and continues to experience changes in its traditional economic base (i.e. agriculture) and its socio-demographic structure. In many ways, drought has merely accelerated what was already occurring. The socio-economic impacts of these shifts are comprehensive and complex and as a result existing support services are being stretched to their limits. Solutions will require multiple service/support strategies, joined-up agency working and proactive approaches in envisioning, planning for and adapting to different climatic and socio-economic futures. Through this process, it is vital to work with local people to gauge and utilise the practical knowledge, experiences and insights gained from confronting drought and climate change in real and locally specific ways (e.g. What did people do to deal with this and previous droughts? What worked and what did not? Would they have coped better with more or different resources or policy and if so what specifically needs to be increased or changed? What are the specific principles that rural community members facing drought over the generations have worked out for surviving? How can these principles inform policy? etc.). Moreover, it will be important for rural communities to be well-supported through the processes of change, in ways that are respectful and revitalising for people who are fatigued from seemingly chronic climatic extremes in addition to non-climatic pressures.

The required proactive approach means that drought need no longer be the centrepiece of government policy – in fact it would be detrimental to continue with such a drought-centric approach. As demonstrated, the issues facing these rural communities are more than just drought or climate change, and only understanding and addressing them in this way will offer an effective means of support into a future that is inherently uncertain. At the centre of this is the need for government and local communities to work together to move beyond just coping and reacting to drought, towards strategic planning that deals with ongoing change (climatic and otherwise) and uncertainty. There is also much evidence, despite the typically conservative nature of rural communities, of adaptation and openness to change which offers opportunities for building and sustaining proactive and practice-oriented support services and programmes that accommodate future scenarios. Worth noting though is that some farmers and rural community members readily subscribe to change while some have not got the will or finances to do anything – further investigation is needed to determine if there is a typology of who does and does not seek change and what is influencing those differences.

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## References

- Aarons, H., Glossop, B., Vinson, T., 2008. Mildura Social Indicators Report 2008. Mildura Rural City Council.
- Allon, F., Sofoulis, Z., 2006. *Everyday water: cultures in transition*. *Australian Geographer* 37 (1) 45–55.
- Alston, M., 2006. 'I'd Like to Just Walk Out of Here': Australian women's experience of drought. *Sociologia Ruralis* 46 (2) 154–170.
- Alston, M., Kent, J., 2008. The Big Dry: the link between rural masculinities and poor health outcomes for farming men. *Journal of Sociology* 44 (2) 133–147.
- Altobelli, T., Francis, K., 2009. *Research into Farm Debt Mediation Act 1994 for the Rural Assistance Authority of NSW*. University of Western Sydney-Macarthur.

- BCG, 2008. Critical Breaking Point? The Effects of Drought and Other Pressures on Farming Families. Birchip Cropping Group (BCG), [www.bcg.org.au/cb\\_pages/SocialResearchProjects.php](http://www.bcg.org.au/cb_pages/SocialResearchProjects.php).
- Berkhout, F., Hertin, J., Gann, D.M., 2006. Learning to adapt: organisational adaptation to climate change impacts. *Climatic Change* 78, 135–156.
- Blöschl, G., Montanari, A., 2010. Climate change impacts – throwing the dice? *Hydrological Processes* 24, 374–381, <http://dx.doi.org/10.1002/hyp.7574>.
- Botterill, L.C., 2000. Government responses to farm poverty: the policy development process. *Rural Society* 10 (1) 15–27.
- Brindal, R., 2010, May 20. AWB still paying a high price for Iraq kickbacks. *The Australian*.
- BSC, 2008. Community Profile: Buloke Shire 2001 and 2006 Census Information. Buloke Shire Council (BSC).
- Connell, D., Grafton, R.Q., 2011. Water reform in the Murray-Darling Basin. *Water Resources Research* 47, W00G03, <http://dx.doi.org/10.1029/2010WR009820>.
- DSE, 2008a. Climate Change in the Mallee. Victorian Department of Sustainability and Environment (DSE).
- DSE, 2008b. Climate Change in the North Central Region. Victorian Department of Sustainability and Environment (DSE).
- Edwards, B., Gray, M., Hunter, B., 2009. A sunburnt country: the economic and financial impact of drought on rural and regional families in Australia in an era of climate change. *Australian Journal of Labour Economics* 12 (1) 109–131.
- Fragar, L., Stain, H.J., Perkins, D., Kelly, B., Fuller, J., Coleman, C., et al., 2010. Distress among rural residents: does employment and occupation make a difference? *Australian Journal of Rural Health* 18 (1) 25–31.
- Gallant, A.J.E., Kiem, A.S., Verdon-Kidd, D.C., Stone, R.C., Karoly, D.J., 2012. Understanding hydroclimate processes in the Murray-Darling Basin for natural resources management. *Hydrological and Earth System Sciences* 16, 2049–2068, SRef-ID: 1607-7938/hess/2012-16-2049.
- Gibbs, L.M., 2006. Valuing water: variability and the Lake Eyre Basin, central Australia. *Australian Geographer* 37 (1) 73–85.
- Golding, B., Campbell, C., 2009. Learning to be drier in the southern Murray-Darling Basin: setting the scene. *Australian Journal of Adult Learning* 49 (3) 423–450.
- Golding, B., Angwin, J., 2009. Bearing the risk: learning to be drier mid-river. *Australian Journal of Adult Learning* 49 (3) 472–496.
- Hayman, P.T., Whitbread, A.M., Gobbett, D.L., 2010. The impact of El Niño Southern Oscillation on seasonal drought in the southern Australian grainbelt. *Crop and Pasture Science* 61 (8) 528.
- Heyhoe, E., Kim, Y., Kocik, P., Levantis, C., Ahammad, H., Schneider, K., Crimp, S., Nelson, R., Flood, N., Carter, J., 2007. Adapting to climate change: issues and challenges in the agriculture sector. *Australian Commodities* 14 (1) 167–178.
- Hopkins, P., 2006, 23 February. The pros and cons of the single desk. *The Age*.
- Howden, P., 2008. Making Sense for a Sustainable Agricultural Future: An Overview of the Concept of Sensemaking. Victorian Department of Primary Industries.
- IPCC, 2007. Climate Change 2007: The Physical Science Basis, Summary for Policy Makers. Intergovernmental Panel on Climate Change (IPCC) Cambridge University Press, [www.ipcc.ch](http://www.ipcc.ch).
- IPCC, 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK/New York, USA. Available from [www.ipcc.ch](http://www.ipcc.ch).
- Kiem, A.S., 2013. Drought and water policy in Australia: challenges for the future illustrated by the issues associated with water trading and climate change adaptation in the Murray-Darling Basin. *Global Environmental Change* (submitted for publication).
- Kiem, A.S., Verdon-Kidd, D.C., 2010. Towards understanding hydroclimatic change in Victoria, Australia – preliminary insights into the “Big Dry”. *Hydrology and Earth System Sciences* 14, 433–445, [www.hydrol-earth-syst-sci.net/14/433/2010/](http://www.hydrol-earth-syst-sci.net/14/433/2010/).
- Kiem, A.S., Verdon-Kidd, D.C., 2011. Steps towards ‘useful’ hydroclimatic scenarios for water resource management in the Murray-Darling Basin. *Water Resources Research* 47, W00G06, <http://dx.doi.org/10.1029/2010WR009803>.
- Kiem, A.S., Austin, E.K., 2013a. On the disconnect between science and end-users as a barrier to climate change adaptation. *Climate Research* (submitted for publication).
- Kiem, A.S., Austin, E.K., 2013b. Socio-economic stresses associated with drought and rural communities in Australia: strengths and weaknesses of government policy and support. *Weather, Climate, and Society* (submitted for publication).
- Kiem, A.S., Askew, L.E., Sherval, M., Verdon-Kidd, D.C., Clifton, C., Austin, E.K., McGuirk, P.M., Berry, H., 2011. Drought and the future of rural communities: drought impacts and adaptation in regional Victoria, Australia. In: Technical Report Prepared for the National Climate Change Adaptation Research Facility (NCCARF), <http://www.nccarf.edu.au/publications/drought-and-future-rural-communities>.
- Koutsoyiannis, D., Efstratiadis, A., Mamassis, N., Christofides, A., 2008. On the credibility of climate predictions. *Hydrological Sciences Journal* 53 (4) 671–684.
- Koutsoyiannis, D., Montanari, A., Lins, H.F., Cohn, T.A., 2009. Climate, hydrology and freshwater: towards an interactive incorporation of hydrological experience into climate research – DISCUSSION of “The implications of projected climate change for freshwater resources and their management”. *Hydrological Sciences Journal* 54 (2) 394–405.
- MCMA, 2009. 2008–09 Drought Impact: Irrigation Status Report for the Sunraysia Pumped Irrigation Districts. Mallee Catchment Management Authority (MCMA).
- MDC, 2009. Mildura Region Economic Profile – An Analysis of the People, Economy and Industries of the Mildura Region. Mildura Development Corporation (MDC).
- Meinke, H., Howden, M., Nelson, R., 2006. Integrated assessments of climate variability and change for Australian agriculture – connecting the islands of knowledge. In: 3rd Biennial Meeting of the International Environmental Modelling and Software Society, Burlington, Vermont, USA, 9–12 July 2006.
- Minichiello, V., Aroni, R., Timewell, E., Alexander, L., 1995. In-Depth Interviewing: Principles, Techniques, Analysis. Longman, Melbourne, Australia.
- Montanari, A., Blöschl, G., Sivapalan, M., Savenije, H., 2010. Getting on target. *Public Service Review: Science and Technology* 7, 167–169.
- Nelson, R., Kocik, P., Crimp, S., Meinke, H., Howden, S.M., 2010. The vulnerability of Australian rural communities to climate variability and change. Part I. Conceptualising and measuring vulnerability. *Environmental Science and Policy* 13 (1) 8–17.
- Park, S., Dowd, A., Mendham, E., van Kasteren, Y., 2009. Planning for Community Sustainability-Workshop 1. CSIRO Sustainable Ecosystems.
- Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E., 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.
- Pitman, A.J., Perkins, S.E., 2008. Regional projections of future seasonal and annual changes in rainfall and temperature over Australia based on skill-selected AR4 models. *Earth Interactions* 12, 1–50, <http://dx.doi.org/10.1175/2008EI260.1>.
- Pritchard, B., Argent, N., Baum, S., Bourke, L., Martin, J., Mcmanus, P., Sorensen, A., Walmsley, J., 2012. Local – if possible: how the spatial networking of economic relations amongst farm enterprises aids small town survival in rural Australia. *Regional Studies* 46 (4) .
- Productivity Commission, 2009. Government drought support. In: Inquiry Report – Australian Government, 27 February, , 486 pp.
- Quiggin, J., 2007. Key Issues in Australian Water Policy. Australian Chief Executive, February, , pp. 38–47.
- Randall, D.A., Wood, R.A., Bony, S., Colman, R., Fichefet, T., Fyfe, J., Kattsov, V., Pitman, A., Shukla, J., Srinivasan, J., Stouffer, R.J., Sumi, A., Taylor, K.E., 2007. Climate models and their evaluation. In: Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., Miller, H.L. (Eds.), *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom/New York, USA.
- RFCS, 2008. Public Submission to Drought Policy Review, Submission No. 30. Rural Financial Counselling Service (RFCS), Sunraysia.
- Rickards, L., 2012. Critical Breaking Point: the effects of climate variability, change and other pressures on farm households. In: Report for the Birchip Cropping Group and the Sustainable Agriculture Initiative Platform Australia. , [www.bcg.org.au/cb\\_pages/publications.php](http://www.bcg.org.au/cb_pages/publications.php).
- Senate Standing Committee on Rural and Regional Affairs and Transport, 2008. Climate Change and the Australian Agricultural Sector: Final Report. Senate Printing Unit, Department of the Senate.
- Sherval, M., Askew, L.E., 2011. Experiencing ‘drought and more’: local responses from rural Victoria, Australia. *Population and Environment* 149 , <http://dx.doi.org/10.1007/s11111-011-0149-x>.
- Stainforth, D.A., Allen, M.R., Tredger, E.R., Smith, L.A., 2007. Confidence, uncertainty and decision-support relevance in climate predictions. *Philosophical Transactions of the Royal Society A* 365, 2145–2161, <http://dx.doi.org/10.1098/rsta.2007.2074>.
- Stokes, C., Howden, M. (Eds.), 2010. *Adapting Agriculture to Climate Change: Preparing Australian Agriculture, Forestry and Fisheries for the Future*. CSIRO Publishing, Collingwood, Victoria, Australia.
- Treby, J., Henderson, K., Welsh, C., 2008. Resilient Agribusiness for the Future of Sunraysia. Sustainable Landscapes Mallee – Irrigation. Draft Scenario Booklet. Department of Primary Industries, Mildura September 2008.
- Verdon-Kidd, D.C., Kiem, A.S., 2009. Nature and causes of protracted droughts in Southeast Australia – comparison between the Federation, WWII and Big Dry droughts. *Geophysical Research Letters* 36, L22707, <http://dx.doi.org/10.1029/2009GL01067>.
- Verdon-Kidd, D.C., Kiem, A.S., 2010. Quantifying drought risk in a non-stationary climate. *Journal of Hydrometeorology* 11 (4) 1019–1031.
- Wei, Y., Langford, J., Willett, I.R., Barlow, S., Lyle, C., 2011. Is irrigated agriculture in the Murray Darling Basin well prepared to deal with reductions in water availability? *Global Environmental Change* 21, 906–916.