AUSTRALIAN WORKPLACE INNOVATION AND SOCIAL RESEARCH CENTRE

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Rural Landholder Attitudes toward Climate Change in South Australia: Acceptability, Vulnerabilities and Responses

A COMPARISON OF COASTAL, MID-NORTH AND RIVERLAND GRAIN AND GRAPE GROWERS

Christopher Raymond and John Spoehr

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Report prepared with assistance from the *Premiers Science and Research Fund*, Government of South Australia

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The Australian Workplace Innovation and Social Research Centre (WISeR) *focuses on work and socio-economic change. WISeR is particularly interested in how organisational structure and practices, technology and economic systems, policy and institutions, environment and culture interact to influence the performance of workplaces and the wellbeing of individuals, households and communities.*

WISeR also specialises in socio-economic impact assessment including the distributional impacts and human dimensions of change on different population groups and localities. Our research plays a key role in informing policy and strategy development at a national, local and international level.

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SUMMARY

CONTEXT

Human-induced climate change is projected to have significant primary and secondary impacts on agriculture in South Australia, particularly grain and grape industries. Extensive research attention is being directed to understanding the biophysical dimensions of climate change adaptation in the rural sector, including the development of drought tolerant grain and grape varieties and shorter season varieties. However, comparatively less attention is being devoted to local community perceptions of climate change and their social vulnerability to projected impacts (Nelson et al., 2010; Nelson, Kokic, Crimp, Meinke, & Howden, 2010). Without an understanding of these human dimensions, it is difficult to answer the questions of “are farmers adapting to change?” If so, what are the drivers of this change? If not, what are the barriers? The aim of this project is to examine rural landholder acceptability of climate change and the barriers and facilitators of climate change adaptation in South Australia. Specifically, we compared and contrasted acceptability, adaptive capacity and barriers to change among a sample of grain and grape growers from Fleurieu, Mid North and Riverland sub-regions of South Australia.

It is important to note that the research was undertaken during a period of considerable instability in global commodity markets that has placed considerable pressure on exporters, particularly as a result of a relatively high Australian dollar and sustained volatility in the depressed European and US markets for rural commodities. Also of note was uncertainty surrounding the introduction of a price on carbon in Australia, a legislative initiative that was hotly contested at the time this research was being undertaken.

Specific objectives for the research are presented below. The research was undertaken by the Australian Workplace Innovation and Social Research Centre (WISeR) as part of “Adapting to climate change in South Australia: Human Dimensions Transect” project which was funded by the Premier’s Science and Research Council.

OBJECTIVES

The specific objectives of the study are to:

- Summarise current challenges facing rural landholders in different settings across South Australia;
- Present a method for assessing rural landholder acceptability of climate change and the projected winter/spring drying trend across multiple geographic areas. The pilot areas presented here are Adelaide and Mount Lofty Ranges, Mid-north and Riverland communities;
- Examine the relationships between adaptive capacity and existing and future responses to climate change across the three geographical areas.

METHODOLOGY

Three hundred surveys were administered to rural landholders from grains or viticultural industries who own greater than 10 hectares of land in South Australia using a computer assisted telephone interviews (CATI) technique. The 10 hectare threshold

was used in order to target the survey to commercial farmers involved in the grains or viticultural industry, rather than lifestyle or hobby farmers. To understand rural landholder attitudes toward climate variability and change across different rainfall zones, we stratified the sample into southern (Western Mount Lofty Ranges), central (mid-north) and western (Riverland) geographical areas. The survey consisted of eight parts:

1) Information about the property;
2) General challenges on the property;
3) Views on human-induced climate change;
4) Managing human-induced climate change;
5) Concern about the projected winter/spring drying trend;
6) Managing the projected winter/spring drying trend;
7) Differing views about climate change, and;
8) Socio-demographics.

KEY FINDINGS

- Respondents were asked about their views on the existence of human-induced climate change. Equal proportions of respondents accepted, rejected or were unsure about whether human-induced climate change exists. However, those respondents who rejected or were unsure about human-induced climate change were more likely to reject a projected winter/spring drying trend than accept it.
- We asked respondents who did not accept human-induced climate change about their reasons for rejection. They most strongly agreed that "it is climate variability rather than human-induced climate change" and "human-induced climate change models are unreliable" and least agreed that "the earth is cooling, rather than warming". Further, the majority of respondents were ambivalent that "human induced climate change has the potential to seriously damage farming."
- Compared with those respondents who were unsure about human-induced climate change, respondents who rejected the phenomenon held significantly stronger beliefs that climate change models are unreliable, climate change scientists are alarmist, and there is no evidence to support human induced climate change ($t > 2.15$, $p < 0.05$). Conversely, those respondents who were unsure about human induced climate change were more concerned about the impact of human induced climate change on future generations and were more likely to believe that human induced climate change has the potential to seriously damage farming ($t > 2.98$, $p < 0.001$).
- Proportionately more Riverland landholders did not accept that human-induced climate change exists (45.3%) than accepted (24.3%) and proportionately more Fleurieu landholders accepted than rejected its existence (27.0 vs. 14.7%).
- Farming families who had owned their property for a shorter period of time (mean = 64.91 years) were significantly more likely to accept climate change than those farming families who had owned their property for a longer period of time (mean = 81.95 years) (t (156) = 2.37, p = .019).
- Those landholders who had earned no farm income in 2009-2010 were more likely to reject rather than accept the existence of climate change (20.0 vs. 6.2%), and those landholders who had refused to provide their income were more likely to reject than accept human-induced climate change (21.1 vs. 9.7%).

- Survey participants were asked to rate the extent to which 10 items were a challenge to their primary production business. Overall, the greatest challenge identified was "the high Australian dollar", followed by "interest rates" and "rainfall variability". The lowest challenge identified was "climate change caused by human activity."
- Grains growers were significantly more likely than grape growers to agree that their community has been fine in the past and will be fine when faced with human-induced climate change ($t = 2.87$, $p < .01$), and were more likely to agree that human-induced climate change occurring in their areas has been greatly exaggerated ($t = 2.54$, $p < .05$).
- We asked respondents who accepted human-induced climate change and the projected winter-spring drying trend to rate their level of investment in 15 adaptation actions.
  - Respondents had invested most heavily in summer weed control and the use of salinity flushing irrigation applications and the least in lowering of seeding rates or the use of a disc seeder;
  - Those respondents who believed in human-induced climate change noted that they had made larger investments in cover crops to improve soil structure and water penetration and summer weed control than using a disc seeder or using lower seeding rates.
- We compared level of investment in adaptation actions across level of acceptability of human induced climate change.
  - On average, respondents who accepted human induced climate change or the winter/spring drying trend noted that they had invested a fair amount in the use of cover crops to improve soil structure and water penetration, technologies to control summer weeds and assess the moisture holding capacity of the soil;
  - Those respondents who accepted human-induced climate change had invested significantly more in technologies to sow crops earlier than those respondents who rejected climate change, but accepted the winter-spring drying trend, $F(2, 59) = 5.04$, $p = .010$. Those respondents who accepted human induced climate change had also invested significantly more in technologies to increase the capacity to harvest or store water than those respondents who were unsure or did not believe in human induced climate change, $F(2, 77) = 4.55$, $p = 0.014$.
- We asked landholders who had not invested in activities to manage the human-induced climate change or the projected winter/spring drying trend to rate a variety of barriers to the management of the phenomena.
  - Respondents most strongly agreed that the management of both phenomena were not seen as a priority with respect to other property risks or they did not have the finances to manage them;
  - Not having the support of friends or family members was the lowest rated barrier.
- We asked landholders who accepted human-induced climate change to rate the extent to which 20 items will be affected by the phenomenon.
  - The quantity of water for primary production was deemed to be most affected, followed by average yearly income and the yield of their crop. The least affected items related to the physical condition of the house, their ability to learn about NRM practices and the life of their property machinery;
  - Similar results were identified for those respondents who rejected the existence of human-induced climate change, but accepted the projected winter/spring drying trend.

Overall, the results indicate that there are divergent attitudes toward the existence of human-induced climate change in rural South Australia. The majority of respondents were either sceptical about the phenomenon or were unsure about its existence. Nonetheless, autonomous adjustment to property risks is occurring in rural South Australia. A high proportion of respondents had invested in technologies to manage farm risks, and this was largely independent of the level of acceptance of climate change. However, questions need to be raised about the magnitude and extent of this adaptation, and whether it is leading to transformational change in agriculture. This concept is discussed later in the report.

Policy Implications

Human-induced climate change remains a contested phenomenon within rural South Australia. The evidence gathered through this research suggests that it would be inappropriate for policy makers to assume that rural landholders accept it and prioritise its management ahead of other primary production business risks. Low acceptance of the existence of human-induced climate change together with more pressing business risks are key challenges to engaging rural landholders in adaptation responses. One third of respondents outright rejected the existence of human-induced climate change, one third was unsure and the remaining third accepted it. To effectively engage rural landholders in adaptation planning, we suggest that adaptation responses be tailored to these three segments. Those landholders who are sceptical about human-induced climate change may be more interested in policies and programs which support the management of everyday farm risks in the shorter-term. Those landholders who accept climate change are likely to embrace the need to adapt to the phenomena and be responsive to policy and programs which call for responses to longer-term changes in temperature and rainfall. The greatest opportunities for engagement exist with those landholders who are unsure about its existence. Tools and processes which show the impacts of local and regional effects of climate change on primary production livelihoods are likely to influence the views of this group.

Future Directions

This study focused on the socio-psychological drivers and behaviours of climate change adaptation in rural agriculture. Future research could examine the relationships between acceptability of climate change, adaptation response and the types of incentive schemes which would encourage further adaptation to both climate change and broader property risks. The psychometric scale for measuring adaptive capacity did not align with the hypothesised structure, suggesting that other items may be contributing to natural, physical and human capital in the three case study areas.

1 INTRODUCTION

1.1 PURPOSE OF THIS STUDY

To avoid dangerous climate change, there is general consensus among climate change scientists that rapid and sustained adaptation at global and regional scales is required by government, industry and local communities (see Richardson et al., 2009). Globally, there is evidence to suggest that climate change adaptation is occurring in agriculture through research support and the development of strategic plans, networks and legislation, and awareness raising and training programs in sustainability (Karl, Melillo, & Peterson, 2009; Lemmen, Warren, Lacroix, & Bush, 2008; Tompkins et al., 2010). However, research has concentrated on types of adaptation responses and drivers of response within formal institutions (e.g., national government ministries/agencies, and regional and local authorities), resulting in national scale adaptation policy recommendations. Much greater emphasis needs to be placed on the factors which encourage or discourage the implementation of adaptation measures at the local management scale, including rural landholders' capacity to adapt and barriers to adaptation (Arnell, 2010). There appears to be considerable awareness about climate change as a concept in regions like the Murray Darling Basin of South Australia where preliminary consultations with landholders on climate change adaptation have been undertaken (Siebentritt & Sharley, 2010). This work does not however shed light on the relationship between acceptance of climate change and adaptive responses by landholders. The present study is helps to fill this gap in knowledge.

The South Australian Government has also invested significant resources into the development of strategic plans and research initiatives to support an understanding of climate change at the state scale, but new methods are needed to measure landholder attitudes toward change and their adaptive capacity at sub-regional scales in order to achieve contextually relevant and locally acceptable adaptation responses. This view is supported by recent studies into climate change adaptive capacity at the national level (see Brown et al., 2010; Nelson et al., 2010).

This project was undertaken by the Australian Institute for Social Research in order to pilot a method for measuring rural landholder attitudes toward climate variability and change, and for measuring multiple elements of adaptive capacity at the sub-regional scale. The specific objectives of the study are to:

1) Summarise current challenges facing rural landholders in different settings across South Australia;
2) Present a method for assessing rural landholder acceptability of climate change and the projected winter/spring drying trend across multiple geographic areas. The pilot areas presented here are Adelaide and Mount Lofty Ranges, Mid-north and Riverland communities;
3) Present a conceptual and empirical framework for measuring landholder adaptive capacity to climate variability and change across natural, social, human, financial and physical capital;
4) Examine the relationships between adaptive capacity and existing and future responses to climate change across the three geographical areas.

This study is one of a number of studies for a larger initiative entitled "Adapting to climate change in South Australia: Human Dimensions Transect Project" which is funded by the Premier's Science and Research Council. The aim of this larger study is to assist with the establishment of a monitoring and evidence-based decision making tool on the human dimensions of climate change adaptation in South Australia. It will provide baseline information and a monitoring process across government and non-government in order to improve understanding of the human dimensions of climate change into the future.

In the remainder of this introduction, we present current climate trends and future projections for South Australia and then outline the likely impacts of such change on the grains and viticultural industries. Finally, we present the Commonwealth and South Australian Governments' strategies to adapt to change.

1.2 Climate Change: Current trends and future projections

Climate has a significant influence on the agricultural sector in South Australia, particularly the cereal growing and viticultural industries. For example, in low rainfall grain producing areas, 80% of the profit is typically made from the best three years in ten, whilst a loss is typically made in the worst three years in ten (Rebbeck, Dwyer, Bartetzko, & Williams, 2007). The variability in climate records makes it difficult to plan for future variability and change at the farm scale. Whilst observed climate data indicate a general warming trend since the 1900s, there has been substantial decadal variability in rainfall.

Since the 1900s, there has been a warming trend in South Australia. Temperature records indicate that between 1969 and 2007, the area experiencing exceptionally hot years in SA has been 11.7%, which is double the long-term average for Australia of 5% (Hennessy et al., 2008). Since 1950, South Australia's maximum temperature has increased by 1.2ºC and the average temperature by 1.1ºC (Suppiah et al., 2006).

However, the observed trend in rainfall is least clear in South Australia out of all Australian states. A slight increase has been observed in the pastoral regions and a slight decrease over the agricultural areas. Decadal fluctuations in winter and spring rainfall have occurred (IPCC, 2007). For example, Southwest Australia experienced a hydrological drought in the early 2000s, characterised by a near absence of very wet years (Hennessy, et al., 2008). Drought conditions have been relieved by above average rainfall in the last two years, with 21% of South Australia experiencing record September rainfall in (Bureau of Metereology, 2010).

Despite this variability, climate change models suggest that South Australia will experience a warming and drying trend by 2050. This trend is characterised by:

An increase in frequency and extent of exceptionally hot years. By 2010-2040, exceptionally hot years are likely to affect about 70% of the southwest region of Australia and occur every 1.5 years on average (Hennessy, et al., 2008);

An increase in exceptionally dry years. By 2010-2040, exceptionally low rainfall years are likely to affect about 8% of the region and occur about once every years on average (Hennessy, et al., 2008). Climate models indicate that drying is most likely to occur in winter and spring;

An increase in exceptionally low soil moisture years. By 2030, exceptionally low moisture years are likely to affect about 9% of the southwest region (Hennessy, et al., 2008).

There is a level of uncertainty related to these projections. Scientists have greater confidence in the warming than the drying trend. They have high confidence that warming will be greater for inland than coastal regions and moderate confidence that the frequency and intensity of heatwaves in summer will increase (Hayman, Leske, & Nidumolu, 2009). However, they have low to medium confidence that rainfall will decrease in winter and spring (IPCC, 2007).

Failure to adapt will expose us to possibly severe and change adaptation framework long-term consequences including reduced productivity, property and financial losses, threats to biosecurity, higher costs for goods and services, serious health issues, reductions in social and human capital, and the loss of unique and essential natural systems and species.

1.3 South Australian Government's response to climate change

The South Australian Government has prepared a Draft Climate Change Adaptation Framework (Government of South Australia, 2010a) to respond to the threat of climate change. The Framework recognises that climate change and its economic, social and environmental impacts will vary across South Australia and therefore proposes that locally relevant adaptation responses are developed across the 12 existing State Government regions. Agriculture is one important sector which fits into this framework

The strategy is guided by four objectives:

1. Leadership and strategic direction for building a more resilient state;
2. Policy responses that are founded on the best scientific knowledge;
3. Resilient, well-functioning natural systems and sustainable, productive landscapes, and;
4. Resilient, healthy and prosperous communities.

This study is pertinent to objective 4 and strategy 4.1: "To build the resilience and adaptive capacity of businesses and communities at the regional and local levels".

Prior to building adaptive capacity, policy makers need to develop a baseline of existing capacity. Whilst several approaches are available for capacity measurement, few approaches allow self-assessment of capacity across the five capitals of natural, human, social, financial, and built at the local scale. This research project develops a conceptual and empirical framework for measuring adaptive capacity at the sub-regional scale. The next section presents the likely impacts of climate change across grains and viticultural industries and recommended adaptation responses.

1.4 Climate Change impacts and adaptation responses

1.4.1 Climate change and the grains industry

The grains industry sector is the highest contributing sector in the South Australian food industry. In 2005/06, the sector made up 28% (or $2.8 billion) of the Gross State Food Revenue of $10.1 billon. In addition to the food revenue, the sector also provides an important feed (grain and fodder) input to the livestock industry worth an additional $0.6 billion. In total, this values the food and feed grain industry sectors at $3.4 billion (PIRSA, 2011).

Climate variability has influenced the grains industry in South Australia in recent years. In 2008-2009, a high proportion of grain farmers in South Australia reported adverse seasonal conditions (Crooks & Levantis, 2009). However, overall total winter grain production increased by approximately 15% in 2009-2010. A comparison of time periods shows a slowdown in productivity growth in the grains industry. Many factors could explain this decline, with two major influences likely to be extended poor seasonal conditions and a long-term slowdown in growth in public research and development investment (Sheng et al. 2010).

Luo, Bellotti, Williams and Wang (2009) investigated the effect of climate change, particularly available soil moisture and nitrogen, on grain production in South Australia. They found that climate change had a negative impact on wheat grain yield under both high (15%) and low (10%) plant available water capacity conditions.

Researchers have suggested a variety of options for managing dryer than normal seasons (Easterling et al., 2007; Stokes & Howden, 2010)). They include:

1) Adopting zero-tillage practices;
2) Develop minimum disturbance techniques;
3) Planting later in the season when enough water in profile to get a crop;

4) Lowering plant populations;
5) Staggering planting times;
6) Assessing fertiliser inputs;
7) Applying nitrogen to a wheat cover crop and applying fungicides to wheat crops to minimise leaf diseases.

Efficient moisture use can be enhanced by:

1) Increasing residue cover;
2) Establishing crop cover in high loss periods;
3) Weed control;
4) Maximising capture and storage of rainfall.

Pest animals can be managed by:

1) Genetic modification of crop to create insect or disease resistant and herbicide tolerant varieties;
2) Chemical pesticides and increasing bio-pesticides;
3) Cultural practices such as crop rotations, missed crops, use of physical barriers to reduce disease transmission.

1.4.2 Climate change and the wine industry

In 2008-2009, SA's gross wine revenue totaled $2.15 billion, 73% of which was generated through wine exports (Goverment of South Australia, 2010b). Recently, there has been a major structural imbalance in the wine industry. In 2009, there was a surplus of over 100 million cases of wine across Australia and 20% of grapes on vines had no market, leading to a recommendation to reduce 20,000 ha of existing vines nationally (Winmeakers Federation of Australia, 2009). Environmental factors including climate change are an additional risk to the industry. In its 2010-2015 partnerships strategy, The SA Wine Industry Council identified a priority need to improve understanding of the impact of environmental factors on industry, particularly the interaction between sustainable water allocation and climate change (Goverment of South Australia, 2010b).

Hayman et al., (2009) assessed the likely impact of climate change on the wine industry in South Australia. They found that changes to mean temperature would influence phenology and ripening time of grapes. Extreme high temperatures would have a direct impact on physiological processes and water use, whereas extreme low temperatures would lead to high levels of frost risk. Higher temperatures are likely to advance phenology, with ripening shifting to warmer periods. Changes to rainfall patterns would influence the water balance, which will have a direct impact on disease and grape quality.

James and Liddicoat (2008) engaged experts in an assessment of the threats and opportunities posed by climate change to the viticultural industry in the McLaren Vale region. The main issues identified for the McLaren Vale region's viticulture industry was the potential emergence of soil salinity and water insecurity. There were additional concerns that industry-wide salinity flushing practices (i.e. excess irrigation water applied to leach accumulated salts) may cause water tables to rise, and potential salinity impacts to soil and groundwater may be a risk to the industry's branding. Further high risks were associated with potential heat impacts causing yield and quality problems, and increased cost pressures on viticultural businesses.

A drier climate and possible regional water shortages represent significant risks. Less available water (e.g. through restrictions or varying allocations) and increased water demand will have direct impacts on the productivity of growers and the industry. Less winter/spring rainfall will reduce winter leaching of salts from the root zone, and soil moisture deficits will require growers to start irrigating earlier, possibly increasing the salt load added to soils. Growers were unanimous that winter rainfall is critical to the success of the coming season. It lessens the effect of heat on soil moisture, evaporation and the need for irrigation. The rainfall received over the 2006 season was ideally placed for white but not red varieties.

The expert review highlighted the following strategies for managing the effect of climate change on the viticultural industry:

- Develop appropriate salinity avoidance practices;
- Encourage growers to shift to least saline water supplies;
- Ensure growers are informed regarding salinity avoidance practices;
- Identify areas at high risk of salinity accumulation;
- Advocate for research into heat resistant varieties and heat management techniques;
- Identify ongoing need (quantity, cost, timing) for salinity flushing irrigation applications.

1.5 Barriers to climate change adaptation

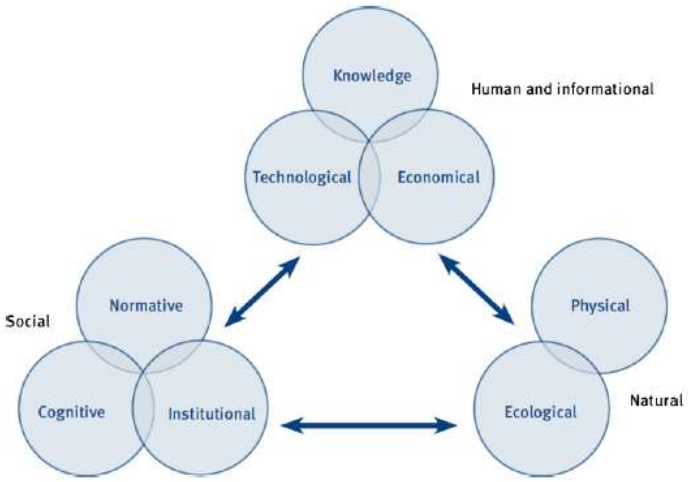
A variety of barriers exist to engagement with climate change in agriculture. Jones and Boyd (2011) (2011)categorised the barriers to adaptation into three areas of natural, social and human and informational . Natural barriers relate to the ecological and physical limits to adaptation. For example, temperature rises may result in thresholds beyond which species can adapt. The second category is identified as human and informational. These limits are associated with spatial and temporal uncertainties associated with climate models, low levels of awareness and information among policy makers on how best to adapt to change. Lorenzoni, Nicolson, Cole and Whitmarsh (2007) identified a variety of human and information barriers to engagement with climate change which arise as a result of knowledge, technological and financial limitations.

They include:

- Lack of knowledge about the causes, consequences and potential solutions;
- Uncertainty and scepticism about the causes of climate change, seriousness, necessity and effectiveness of actions;
- Distrust in information sources;
- Externalising responsibility and blame;
- Translating climate change into a distant threat;
- Reluctance to change lifestyles;
- The notion it is too late to do anything (fatalism).

Researchers have recently identified a variety of social barriers to climate change adaptation and adaptive capacity which can be classified as normative, cognitive and institutional (W. N. Adger et al., 2009; Jones & Boyd, 2011). A cognitive barrier is a belief that uncertainty is too great to warrant taking adaptation action now or a lack of acceptance of risks associated with implementing adaptation action. Normative behaviour relates to persistence with traditional forms of coping strategies. Institutional and governmental barriers relate to how inequities and social discrimination restrict access and entitlement for certain groups and how the lack of institutional flexibility creates social and cultural rigidity (Jones & Boyd, 2011). The challenge is to develop policy which addresses these multiple categories of barriers at multiple scales of governance.

FIGURE 1 A FRAMEWORK FOR CONCEPTUALISING BARRIERS TO ADAPTATION TO CLIMATE CHANGE (PREPARED BY JONES AND BOYD, IN PRESS)



1.6 SUPPORTING SUCCESSFUL ADAPTATION

Stokes and Howden (2010) suggest that successful adaptation to climate change requires flexible, risk-based approaches that deal with future uncertainties and are robust enough to cope with a range of possible local climate outcomes and variations. Government has an important role in providing support for farmers as they make transitions to new systems, land uses and forms of livelihood and building capacity in farming communities to take up adaptation strategies. Jones and Boyd (2011) further suggest that government has an important role in addressing institutional restrictions in behaviour, altering restrictive and maladaptive perceptions, morns and cultural constraints.

Whilst significant effort has been invested into planned adaptation, governments cannot lose sight of the need to support informed, autonomous adaption to change. It is only through working at the community level and by appreciating, informing and supporting appropriate autonomous actions at this level that maladaptive elements will be overcome.

1.7 MEASUREMENT OF ADAPTIVE CAPACITY

The measurement of adaptive capacity has been criticised as a jargon-rich, multi-disciplinary research arena where multiple, often confusing, terms of adaptive capacity have been presented (Preston & Stafford-Smith, 2009). Further, Walcott and Wolfe (2008) argue that the underlying theory of adaptive capacity is not robust and the indicator measures of adaptive capacity attributes are inaccurate. There is a need to develop approaches to the assessment of adaptive capacity that reflect its nested nature while avoiding too much complexity.

Most climate-related research in Australian agriculture has focused on impact modelling using seasonal climate forecasts to manage the production impacts of climate variability within existing farming systems. This research has been comprehensively reviewed (see Hammer, 2000; McKeon et al., 2004, & Meine & Stone, 2005). Research in the early 2000s began to consider the capacity of individuals to adapt to climate change impacts. This early work, however was systems focussed. For example, Yohe and Tol (2002) suggests that adaptive capacity changes from system to system and therefore its assessment depends upon defining a coping range for the system. In their model, eight determinants of adaptive capacity exist:

- Range of available technological options;
- Availability of resources and their distribution across the population;

- Structure of crucial institutions;
- Stock of human capital including education and personal security;
- Stock of social capital – property rights;
- System's access to risk spreading processes;
- Ability of decision-makers to manage information;
- Public's perceived attributions of the source of stress.

More recent work recognises that adaptive capacity stems from both social vulnerability and biophysical vulnerability factors. Brooks (2003) was the first to separate social vulnerability from biophysical vulnerability. Factors which influence social vulnerability include poverty, inequality, health, access to resources, housing quality and social status. Factors determining adaptive capacity include measures of health, education, access to information, financial resources, natural resources, existence of social networks, and presence or absence of conflict.

Nelson, Kokic, Elliston, & King (2005) used multiple forms of survey data to generate indicators of adaptive capacity linked to both biophysical and social vulnerabilities. Data collected from the Population and Housing Census, the Agricultural Census and Surveys, General Social Survey, the NRM Survey, and the National Health Survey were used to measure five capitals consistent with the rural livelihoods framework (Ellis, 2000). These capitals are:

- Human capital – the skills, health and education of individuals that contribute to the productivity of labour and capacity to manage land;
- Social capital – networks and relationships that facilitate cooperative action and the social bridging and linking via which ideas and resources are accessed;
- Natural capital – the productivity of land, and actions to sustain productivity, as well as water and biological resources from which rural livelihoods are derived;
- Physical capital – capital items produced by economic activity from other types of capital – include infrastructure, equipment and improvements in genetic resources;
- Financial capital – level of variability and diversity of income sources, and access to other financial resources that contribute to wealth.

The five capitals framework was later expanded using data collected by the ABS (Nelson, Brown, Darbas, Kokic, & Cody, 2007; Sheng, Nossal, Zhao, Kokic, & Nelson, 2008). Whilst a comprehensive national assessment of adaptive capacity, the framework did not consider geographic differences in adaptive capacity. In response, Brown et al. (2010) developed a process which enabled local NRM officers to self- assess their adaptive capacity at the local scale. Each focus group was well informed and able to make judgements about the capacity of the people they were representing in the community and were long term members of the community. However, these workshop approaches have some limitations, including an appreciation of the influence of the workshop facilitator on capacity responses and non-consideration of differences in capacity to management variability and change. It is also difficult to generalise the findings of workshop responses, particularly if they are based on a non-systematic or purposeful sample.

We are not aware of any studies which have developed conceptual or empirical frameworks which enable a random and representative sample of rural landholders to self-assess their adaptive capacity at the local scale. In response, this study presents a new, quantitative measure of adaptive capacity.

1.8 Report outline

Section 3 outlines the survey method including the sampling strategy, survey content and analyses techniques. Section 4 presents both summary and detailed results and section 5 discusses the implications of the research for climate change adaptation policy and future directions for integrating this method within a statewide assessment of adaptive capacity.

2 Methodology

2.1 Study Areas

This study includes the Fleurieu, Mid North and Riverland areas of South Australia (Figure 2). We summarise some of the key feature of each area below.

2.1.1 Fleurieu region

The Fleurieu Peninsula region, as defined in this study (**Figure 2**), is a plateau which covers 259 700 ha, including Alexandrina, Victor Harbor and Yankalilla district council areas and the townships of Strathalbyn, Victor Harbor and Cape Jervis (AISR, 2011). It has a wet and cool climate (annual rainfall 500 – 800 mm) and predominantly winter rainfall. The region has a population of approximately 41 300, with 49% of males and 50% of females in the region over 50 years of age (ABS, 2010).

The Fleurieu has a mosaic of land uses. Primary production comprises approximately 70% of the total land use, followed by residential (21%) and conservation (6%) uses. The majority of primary production relates to livestock (45% of total land use) and agriculture (17%). Residential development is undergoing major growth along the coastal fringe. The regional hub of Victor Harbor, for example, is amongst the fastest growing communities in the state, with an average growth in excess of 3% per annum for the past ten years (ABS, 2010). A total of 25 individual conservation and recreation parks and reserves are encompassed by the study boundary, with the most frequently visited park being Deep Creek Conservation Park. Approximately 37 500 ha or 13% of the region is covered in native vegetation (AISR, 2011).

2.1.2 Mid North

The Mid North region covers an area of 2.7 million ha, which includes the coastal plain, the southern part of the Flinders Ranges, and the northern part of the Mount Lofty Ranges (**Figure 2**) and eight district council areas of Clare and Gilbert Valleys, Goyder, Mount Remarkable, Northern Areas, Orroroo/Carrieton, Peterborough, Port Pirie and Wakefield. It has a moderate-dry and cool climate (annual rainfall 250 – 500 mm) and predominantly winter rainfall. The region is sparsely populated, with approximately 48 600 persons. Approximately 41% of males and 42% of females are over 50 years of age (ABS, 2010).

Proportionately more of the land in the Mid-north region is used for primary production compared with the Fleurieu region (92% vs. 70%). Agriculture comprises 62.5% of the region and livestock 29.7%. A smaller proportion of the region is used for residential (3.7%) and conservation (1.6%) than the Fleurieu region (21% and 6%, respectively). A total of 13 individual conservation and recreation parks and reserves are encompassed by the study boundary. Native vegetation covers approximately 1.1 million hectares or (AISR, 2011) or 41% of the region, but much of this is semi-arid to arid native vegetation found on private land in the north of the region.

2.1.3 Riverland

The Riverland region covers an area of 1.2 million ha, which includes the River Murray Floodplain from Morgan to the SA-Victoria border and the district council areas of Berri Barmera, Loxton Waikerie and Renmark Paringa. A small proportion of Mid-Murray council area also exists in the Riverland region, but for aggregation purposes, we chose to omit it from our analyses. The region has a population of approximately 41 300, with 36% of males and 38% of females in the region over 50 years of age (ABS, 2010). The Riverland climate can be described as warm to temperate and much of the land around it is semi arid country. Consequently, the region is prone to hot spells in summer and winters tend to be mild.

Like the Mid-North region, primary production is the dominant land use in the region (89%). Agriculture comprises 61% of the region and livestock 21%. The Riverland is Australia's largest wine producing region, accounting for over one quarter of the national grape crush (ref). Conservation land use covers 6% of the region or 18 individual conservation and recreation parks and reserves. The total area with native vegetation is 470, 000 ha or 40% of the region.

FIGURE 2 THE THREE STUDY AREAS - FLEURIEU, MID NORTH AND RIVERLAND AREAS.

2.2 Sampling

We used a stratified random sampling strategy to select 300 rural landholders to be involved in the study. This involved dividing the state of South Australia into a North-South Transect from Hawker through to Goolwa and an East-West transect from the South Australian Border to Wallaroo. Three geographical areas were then selected along the transect; namely, the Fleurieu Peninsula, Mid-North and Riverland areas. The Fleurieu Peninsula included the townships of Victor Harbor, Goolwa, Langhorne Creek, Yankalilla and Strathalbyn; the Riverland area included the townships of Renmark, Berri and Barmera, and; the mid-north area included the townships of Hawker, Jamestown, Clare and Eudunda. Within each geographical area, we stratified the sample frame into two dominant land uses of viticulture and grains. Within each strata, we then randomly selected at least 50 landholders who own >10 ha properties. In each geographical area, the sampling strategy resulted in 100 participants and approximately 50 participants from each land-use.

2.3 Survey instrument

A survey was administered via computer-assisted telephone interview (CATI) to 292 landholders in August 2011. The survey instrument was divided into eight parts as follows:

1) Property characteristics;
2) Challenges on the property;
3) Attitudes toward human-induced climate change;
4) Managing human-induced climate change (adaptive capacity);
5) Attitudes toward the winter/spring drying trend;
6) Managing the projected winter/spring drying trend;
7) Reasons for scepticism about human-induced climate change, and;
8) Demographics.

The survey was structured so as to enable three types of responses:

1) Responses from landholders who accept human-induced climate change is a reality;
2) Responses from landholders who do not accept human-induced climate change but the parallel concept of the projected winter/spring drying trend, and;
3) Responses from landholders who are sceptical about both human-induced climate change and the projected winter-spring drying trend.

Landholders only responded to one of the above categories. Specific measures are presented in Appendix A.

2.4 Analyses

This report presents basic descriptive analyses of the results, as well as comparisons of means. We conducted cross-tabulations with a Chi-square statistic to compare categorical variables such as level of formal education (Riverland, Mid North and Fleurieu). We used independent samples t-test to examine differences in mean responses to interval-level variables such as adaptive capacity and attitudes toward climate variability and change across dominant land-use, and one-way ANOVA to examine differences in mean responses to the same variable across sub-region of residence.

3 Results

3.1 Respondent farm and personal characteristics

We found no proportional differences in the level of acceptance of human-induced climate change across gender, level of education, proportion of family income earned off-farm in 2010-11 or 2009-10 (Table 1). However, proportionately more Riverland landholders did not accept that human-induced climate change exists (45.3%) than accepted (24.3%) or were unsure of its existence (24.4%) and proportionately more Fleurieu landholders accepted than rejected its existence (27.0 vs. 14.7%). Those landholders who had earned no farm income in 2009-2010 were more likely to reject rather than accept the existence of climate change (20.0 vs. 6.2%), and those landholders who had refused to provide their income were more likely to reject than accept human-induced climate change (21.1 vs. 9.7%).

Table 1: Cross-tabulations of socio-demographic characteristics and level of acceptance of human-induced climate change

			Does human-induced climate change exist?				
Respondent variable	Categories	n	Yes	No	Unsure	X^2	*p*
% of overall sample		292	39.4	32.5	28.1		
				%			
Gender	Male	217	74.3	74.7	75.6	0.04	.979
	Female	73	25.7	25.3	24.4		
	Total	290	100.0	100.0	100.0		
Highest level of education	Primary school or high school	168	54.1	65.9	63.2	4.54	.338
	TAFE course	49	18.0	17.6	17.1		
	University or postgraduate degree	61	27.9	16.5	19.7		
	Total	278					
Area	Riverland	91	24.3	45.3	24.4	14.18	.007
	Mid-north	134	48.7	40.0	48.8		
	Fleurieu	67	27.0	14.7	26.8		
	Total	292	100.0	100.0	100.0		
Proportion of family income earned off-farm in 2010-11	0%	96	32.7	37.5	36.7	10.10	.120
	1-50%	124	52.9	35.2	48.1		
	50-99%	22	4.8	11.4	8.9		
	100%	29	9.6	15.9	6.3		
	Total	271	100.0	100.0	100.0		
Proportion of family income earned off-farm in 2009-10	0%	86	32.2	38.8	37.7	7.92	.244
	1-50%	106	51.1	33.8	47.8		
	50-99%	24	7.8	13.8	8.7		
	100%	23	8.9	13.8	5.8		
	Total	239					
Farm income in 2009-10.	0	31	6.2	20.0	6.1	24.70	.016
	< $50,000	53	18.6	14.7	22.0		
	$51,000-100,000	51	20.4	13.7	18.3		
	$101,000-200,000	38	16.8	8.4	13.4		
	$201,000-500,000	31	9.7	8.4	14.6		
	> $500,000	45	18.6	13.7	13.4		
	Do not know or refused	41	9.7	21.1	12.2		
	Total	290	100.0%	100.0%	100.0%		

Grape growers have attained higher levels of formal education than grain growers (Table 2), whereas grain growers have significantly larger property areas (t = 9.05, p < .001), and have been involved in farming for a significantly longer period of time, either individually (t = 3.14, p < *.01)* or as a family unit (t = 7.33, p < .001, Table 3). We found no proportional differences in gender, family income earned off-farm in 2009-10 or 2010-11 and farm income across grains and grapes land-uses (Table 2).

TABLE 2: CROSS-TABULATIONS OF SOCIO –DEMOGRAPHICS CHARACTERISTICS AND DOMINANT LAND-USE (GRAINS OR GRAPES)

			Dominant land-use			
Respondent variable	Categories	*n*	Grains	Grapes	X^2	*p*
% of overall sample		292	66.8%	33.2%		
			%			
Gender	Male	217	73.6	77.3	0.48	.488
	Female	73	26.4	22.7		
	Total	290	100.0	100.0		
Highest level of education	Primary school or high school	168	66.5	47.8	10.36	.006
	TAFE course	49	16.5	20.0		
	University or postgraduate degree	61	17.0	32.2		
	Total	278	100.0	100.0		
Proportion of family income earned off-farm in 2010-11	0%	96	31.5	43.3	5.26	.154
	1-50%	124	49.7	37.8		
	50-99%	22	7.2	10.0		
	100%	29	11.6	8.9		
	Total	271	100.0	100.0		
Proportion of family income earned off-farm in 2009-10	0%	86	32.3	44.0	3.50	.320
	1-50%	106	47.6	37.3		
	50-99%	24	9.8	10.7		
	100%	23	10.4	8.0		
	Total		100.0	100.0		
Farm income in 2009-10	$0	31	9.3	13.4	3.90	.690
	< $50,000	53	18.1	18.6		
	$51,000-100,000	51	20.2	12.4		
	$101,000-200,000	38	13.5	12.4		
	$201,000-500,000	31	10.9	10.3		
	> $500,000	45	14.5	17.5		
	Do not know or refused	41	13.5	15.5		
	Total	290	100.0	100.0		

Table 3 Mean differences in property characteristics between dominant land-uses

	Grains	Grapes	*t*	*df*	*p*
Property area	1629.43	116.20	9.05	202.127	.000
Years family has owned or operated the property	78.94	44.99	7.33	219.366	.000
Years respondent has been involved in primary production	34.20	28.92	3.14	290	.002

3.1.1 Sub-regional comparison

We found no proportional differences in socio-demographic characteristics across sub-region of residence (Table 4). A high proportion of land holders (approx 40%) earned some of their family income (1-50%) off-farm in both 2009-10 and 2010-11 financial years.

Table 4 Cross-tabulations of socio-demographic characteristics and sub-region of residence

			Sub-region of residence %				
Respondent variable % of overall sample	Categories	*n* 292	Riverland 31.2	Mid-north 45.9	Fleurieu 22.9	X^2	*p*
Gender	Male	217	79.1	69.7	79.1	3.39	.184
	Female	73	20.9	30.3	20.9		
	Total	290	100.0	100.0			
Highest level of education	Primary school or high school	168	64.0	57.3	61.5	9.53	.049
	TAFE course	49	23.6	16.9	10.8		
	University or postgraduate degree	61	12.4	25.8	27.7		
	Total	278	100.0	100.0			
Proportion of family income earned off-farm in 2010-11	0%	96	40.5	31.5	36.5	5.59	.471
	1-50%	124	40.5	51.6	41.3		
	50-99%	22	8.3	5.6	12.7		
	100%	29	10.7	11.3	9.5		
	Total	271	100.0	100.0	100.0		
Proportion of family income earned off-farm in 2009-10	0%	86	42.5	31.0	40.0	8.43	.208
	1-50%	106	43.8	49.2	30.0		
	50-99%	24	6.8	9.5	17.5		
	100%	23	6.8	10.3	12.5		
	Total	239	100.0	100.0	100.0		
Farm income	0	31	18.7	6.8	7.5	19.07	.087
	< $50,000	53	19.8	18.2	16.4		
	$51,000-100,000	51	17.6	18.9	14.9		
	$101,000-200,000	38	12.1	12.9	14.9		
	$201,000-500,000	31	7.7	10.6	14.9		
	> $500,000	45	6.6	18.9	20.9		
	Do not know or refused	41	17.6	13.6	10.4		
	Total	290	100.0	100.0	100.0		

3.1.2 Acceptability comparison

We examined proportional differences in acceptance of climate change across the socio-demographic variables of gender, level of forma education, off-farm income earned in each of 2010-11 and 2009-10 and farm income earned in 2009-10 (Table 5). Proportionately more respondents who had earned no farm income in 2009-2010 financial year rejected rather than accepted human induced climate change (20.0 vs. 6.2%), whereas proportionally more respondents who had earned greater than $500,000 that financial year accepted rather than rejected the phenomenon (18.6% vs. 13.7%). No proportional differences in gender, level of education and off-farm income were identified for both acceptance of climate change and the warming/drying trend.

We also examined mean differences in property characteristics by acceptance of climate change or the warming/drying trend. There were no proportional differences in acceptance of climate change or the warming drying trend by dominant land uses of grain and grapes or sub-region of residence ($p > 0.05$). However, those grape growers who owned larger areas of land for grape production were more likely to accept than reject climate change (t (156) = 2.00, p =.04). Further, farming families who had owned their property for a shorter period of time (mean = 64.91 years) were significantly more likely to accept climate change than those farming families who had owned their property for a longer period of time (mean = 81.95 years) (t (156) = 2.37, p = .019).

Table 5 Influence of socio-demographic characteristics on acceptance of climate change and the winter/spring drying trend

			Believe in HI climate change?						Believe in winter/spring drying?			
Respondent variable	Categories	*n*	Yes	No	Unsure	X^2	*p*	*n*	Yes	No	X^2	*p*
Gender	Male	217	74.3	74.7	75.6		0.042	0.979	69.0	77.0	1.10	0.295
	Female	73	25.7	25.3	24.4			44	31.0	23.0		
	Total	290	100.0	100.0	100.0			177	100.0	100.0		
Highest level of education	Primary school or high school	168	54.1	65.9	63.2	4.54	.338	65	65.0	64.6	1.32	0.517
	TAFE course	49	18.0	17.6	17.1				12.5	18.9		
	University or postgraduate degree	61	**27.9**	**16.5**	19.7				22.5	16.5		
	Total	278	1.0	1.0	1.0				100.0	100.0		
Proportion of family income earned off-farm in 2010-11	0%	96	32.7	37.5	36.7	10.10	.120	62	31.7	38.9	6.63	0.085
	1-50%	124	52.9	35.2	48.1			69	56.1	36.5		
	50-99%	22	4.8	11.4	8.9			17	2.4	12.7		
	100%	29	15.9	6.3	6.3			19	9.8	11.9		
	Total	271	1.0	1.0	1.0			167	100.0	100.0		
Proportion of family income earned off-farm in 2009-10	0%	86	32.2	38.8	37.7	7.91	.244	57	37.1	38.6	5.91	0.116
	1-50%	106	51.1	33.8	47.8			60	54.3	36.0		
	50-99%	24	7.8	13.8	8.7			17	5.7	13.2		
	100%	23	8.9	13.8	5.8			15	2.9	12.3		
	Total	239	100.0	100.0	100.0			149	100.0	100.0		
Farm income in 2009-10	0	31	**6.2**	**20.0**	6.1	**24.70**	**.016**	24	9.5	14.8	5.73	0.454
	< $50,000	53	18.6	14.7	22.0			32	26.2	15.6		
	$51,000-100,000	51	20.4	13.7	18.3			28	19.0	14.8		
	$101,000-200,000	38	16.8	8.4	13.4			19	14.3	9.6		
	$201,000-500,000	31	9.7	8.4	14.6			20	9.5	11.9		
	> $500,000	45	**18.6**	**13.7**	13.4			24	11.9	14.1		
	Do not know or refused	41	**9.7**	**21.1**	12.2			30	9.5	19.3		
	Total	290	100.0	100.0	100.0			177	100.0	100.0		

3.2 Challenges to the primary production business

We asked survey participants to rate the extent to which the following 10 items were a challenge to their primary production business. Mean responses were then ranked from 1-10. We found few significant differences in mean responses to primary production challenges across dominant land-use and sub-region of residence. Overall, the greatest challenge identified was “the high Australian dollar”, followed by “interest rates” and “rainfall variability”. The lowest challenge identified was “climate change caused by human activity” (Table 6).

Table 6: Ranking of challenges to the primary production business

Challenge	*n*	Mean	Rank
The high Australian dollar	291	4.46	1
An increase in interest rates	286	3.93	2
Rainfall variability	291	3.82	3
Pest plant control	292	3.74	4
Pest animal control	291	3.55	5
Your ability to hand down your property to your children	259	3.33	6
Lack of skilled labour	276	3.19	7
Low water availability	290	3.18	8
Your health	290	3.08	9
Climate change caused by human activity	281	2.74	10

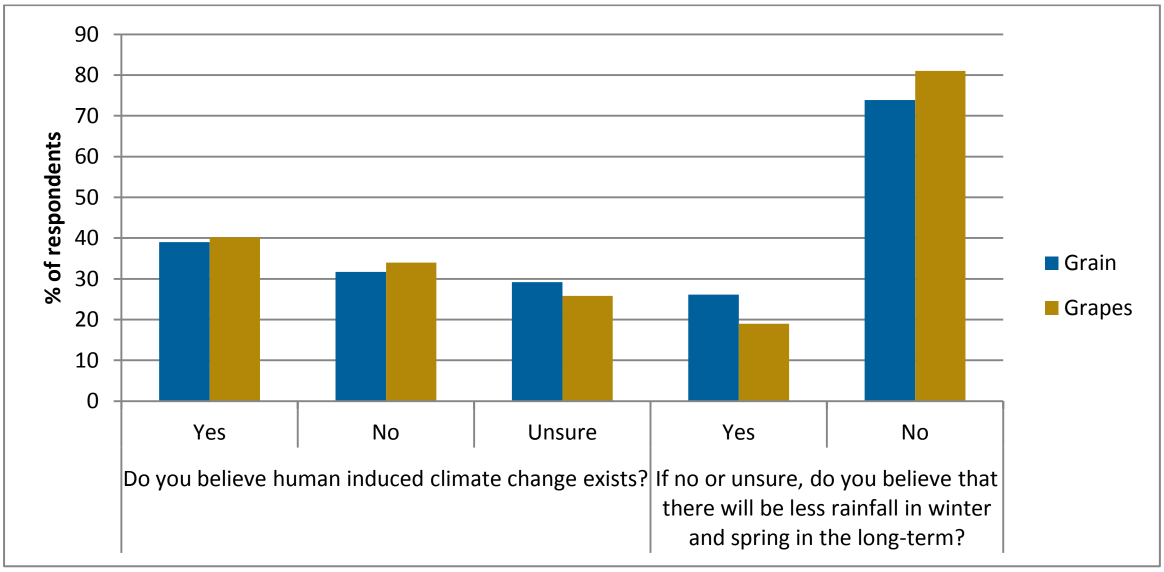
3.3 Acceptance of climate variability and change

A diversity of views exists with respect to the existence of climate change across the sampled areas. An equal proportion of respondents accepted, rejected or were unsure about whether human-induced climate change exists. However, those respondents who rejected or were unsure about human-induced climate change were more likely to reject the concept of a projected winter/spring drying trend than accept it (Table 7 and Figure 3). No proportional differences in the level of acceptance of climate change exist across dominant land-use.

Table 7 Cross-tabulation of acceptance of climate variability and change and dominant land-use

		n	Grains	Grape	X^2	*p*
Does human-induced climate change exist?	Yes	115	38.9	40.2	0.40	0.819
	No	95	31.7	34.0		
	Unsure	82	29.2	25.7		
	Total	292	100.0	100.0		
If no or unsure, do you believe that there will be less rainfall in winter and spring in the long-term?	Yes	42	26.1	19.0	0.32	0.819
	No	135	73.9	81.0		
	Total	177	100.0	100.0		

Figure 3 Histogram showing level of acceptance of human-induced climate change alongside level of acceptance of the projected winter/spring drying trend by dominant land-use

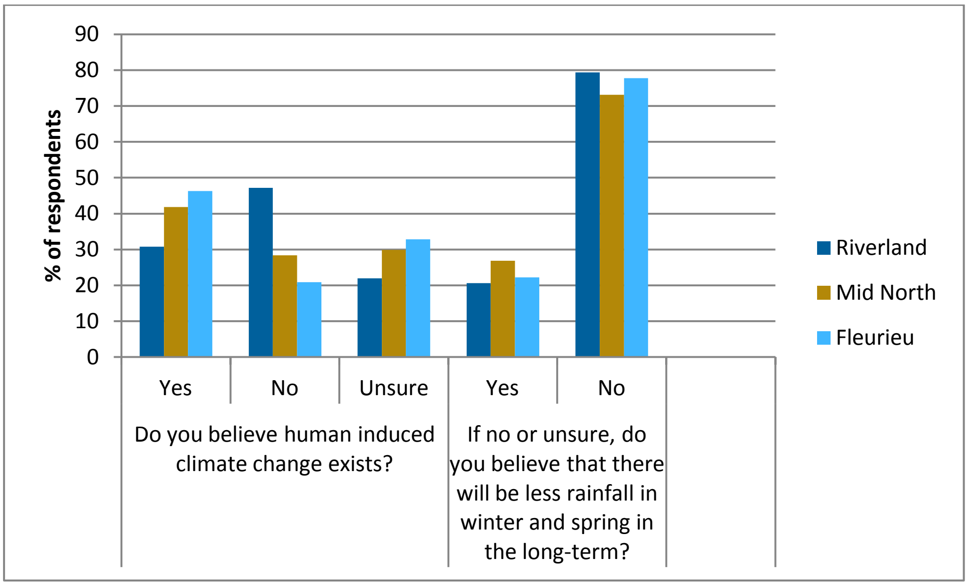


Proportionately more Riverland respondents rejected the existence of human-induced climate change (47.3%) than Mid North (28.4%) and Fleurieu (20.9%) respondents (Table 8). The majority of respondents across all sub-regions of residence disagreed that there would be less rainfall in winter and spring in the long-term (> 73.1%).

TABLE 8: CROSS-TABULATION OF ACCEPTANCE OF CLIMATE VARIABILITY AND CHANGE AND SUB-REGION OF RESIDENCE

		n	Riverland	Mid-north	Fleurieu	X2	p
Does human-induced climate change exist?	Yes	115	30.8	41.8	46.3	14.18	0.007
	No	95	47.3	28.4	20.9		
	Unsure	82	22	29.9	32.8		
If no or unsure, do you believe that there will be less rainfall in winter and spring in the long-term?		42	20.6	26.9	22.2	0.82	.664
	Yes	42	20.6	26.9	22.2		
	No	135	79.4	73.1	77.8		
	Total	177	100.0	100.0	100.0		

FIGURE 4 HISTOGRAM SHOWING LEVEL OF ACCEPTANCE OF HUMAN-INDUCED CLIMATE CHANGE ALONGSIDE LEVEL OF ACCEPTANCE OF THE PROJECTED WINTER/SPRING DRYING TREND BY SUB-REGION OF RESIDENCE



3.3.1 PERCEIVED IMPACT OF CLIMATE CHANGE

Grains growers were significantly more likely than grape growers to agree that their community has been fine in the past and will be fine when faced with human-induced climate change (t = 2.87, p < .01), and were more likely to agree that human-induced climate change occurring in their areas has been greatly exaggerated (t = 2.54, p < .05, Table 9). The majority of respondents across both dominant land-use and sub-region of residence were somewhat prepared for human-induced climate change (Figure 5 and Figure 6). No significant differences in perceived impact of climate change were found among sub-region of residence.

Table 9 Mean differences in perceived impact of climate change between grain and grape growers

	Grains	Grapes	*t*	*p*
Years of below average rainfall in winter and spring on your property over past 10 yrs	5.43	5.82	-.86	.392
Increased frequency of pest plant outbreaks	2.84	3.19	-1.64	.104
A decrease in water availability	3.64	3.82	-.81	.418
Increased frequency of below average rainfall in winter and spring	3.59	3.95	-1.70	.092
I am extremely worried about the possibility of human induced climate change in this area	3.11	3.50	-1.82	.071
This community has been fine in the past and it will be fine when faced with human induced climate change	3.24	2.64	**2.87**	**.005**
The likelihood that human induced climate change will occur in this area has been greatly exaggerated	3.11	2.55	**2.54**	**.013**

Figure 5 Level of preparedness for human-induced climate change across dominant land-use

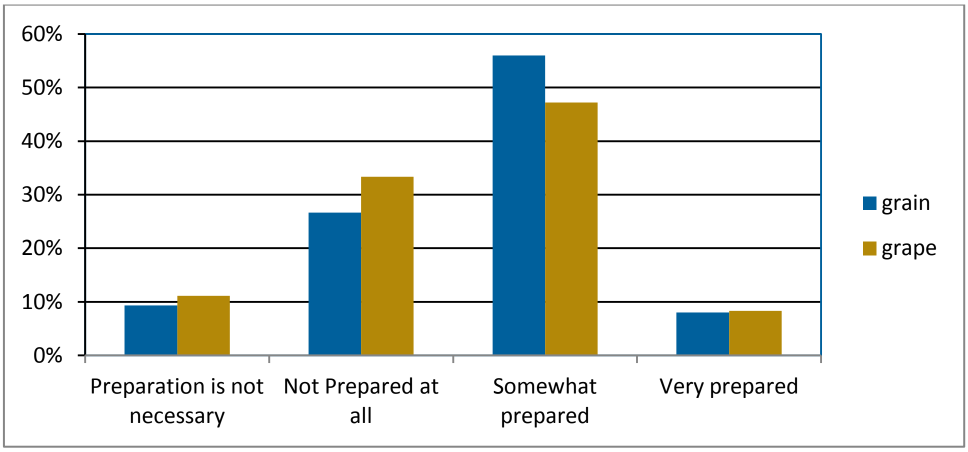
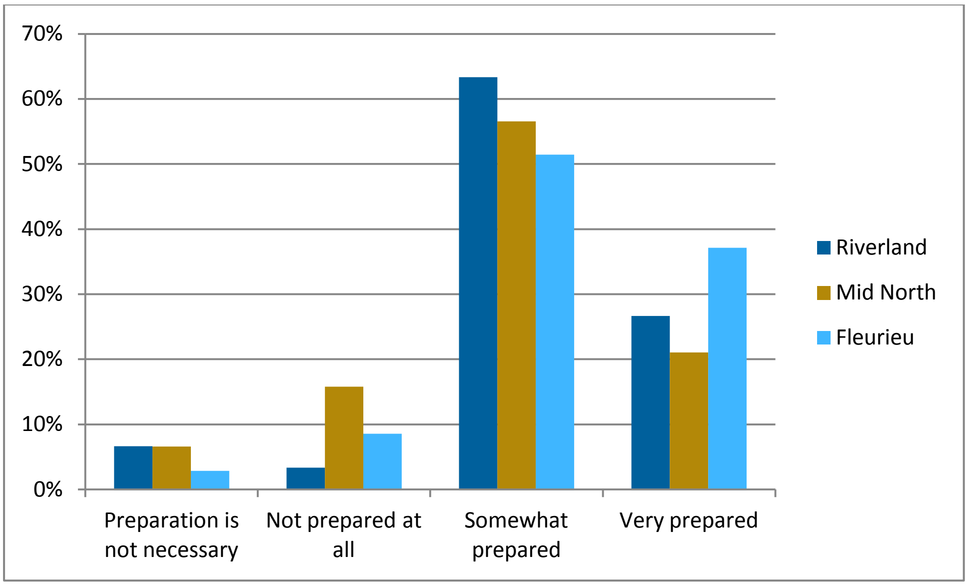


Figure 6 Level of preparedness for human-induced climate change across sub-region of residence



3.3.2 Level of acceptance about the projected warming-drying trend

We also examined mean differences in the perceived impact of the projected warming-drying trend between grain and grape growers (Table 10). There were no significant differences in perceived impact across these dominant land, uses. However, grape growers felt they were significantly better prepared for five consecutive winter and spring growing seasons of below average rainfall than grain growers (t = -2.48, p < .05).

Table 10 Mean differences in perceived impact of the projected warming-drying trend between grain and grape growers

	Grain	Grapes	*t*	*p*
I am extremely worried about rainfall variability in this area	3.23	2.98	1.32	.187
This community has been fine in previous winter and spring seasons of low rainfall and it will be fine in	3.41	3.47	-0.41	.683
The projection that winter and spring rainfall will decrease in this area over the long term has been	3.67	3.50	1.00	.319
How well prepared are you and your household for five consecutive winter and spring growing seasons of below average rainfall	2.95	3.26	**-2.48**	**.014**

3.3.3 Reasons for scepticism about climate change

We found few significant differences in the level of agreement about reasons for scepticism about climate change across dominant land-use and sub-region of residence. Overall, respondents most strongly agreed that “it is climate variability rather than human-induced climate change” and “human-induced climate change models are unreliable” and least agreed that “the earth is cooling, rather than warming” (Table 11). Interestingly, respondents were ambivalent that “human induced climate change has the potential to seriously damage farming.”

TABLE 11 RANKING OF MEAN RESPONSES TO THE LEVEL OF AGREEMENT ABOUT REASONS FOR CLIMATE CHANGE SCEPTICISM

Reason	*N*	Mean	Rank
It is climate variability rather than human induced climate change	129	4.19	1
Human induced climate change models are unreliable	118	4.00	2
Climate change scientists are alarmist	127	3.87	3
Animals and plants can adapt to human induced climate change	122	3.71	4
There is no consensus on human induced climate change science	125	3.46	5
There's no evidence to support human induced climate change	122	3.35	6
We need to keep global warming below two degrees Celsius	110	3.29	7
Carbon dioxide in the atmosphere was higher in the past	92	3.20	8
I am concerned about the impact of human induced climate change on future generations	126	2.99	9
Human induced climate change has the potential to seriously damage farming	128	2.89	10
The earth is cooling, rather than warming	103	2.87	11

We asked those survey participants who rejected the concepts of both human-induced climate change and the winter/spring drying trend to respond to a series of statements about different views on human-induced climate change. We then compared responses across those respondents who rejected human-induced climate change and those respondents who were unsure about human-induced climate change (Table 12). Compared with those respondents who were unsure about human-induced climate change, respondents who rejected the phenomenon held significantly stronger beliefs that climate change models are unreliable, climate change scientists are alarmist, and there is no evidence to support human induced climate change ($t > 2.15$, $p < 0.05$). Conversely, those respondents who were unsure about human induced climate change were more concerned about the impact of human induced climate change on future generations and were more likely to believe that human induced climate change has the potential to seriously damage farming ($t > 2.98$, $p < 0.001$).

TABLE 12: MEAN DIFFERENCES IN ATTITUDES TOWARD HUMAN-INDUCED CLIMATE CHANGE

	N	Rejected HI climate change	Unsure about HI climate change	*t*	*p*	Rank
It is climate variability rather than human induced climate change	138	4.24	4.10	0.94	0.351	1
Human induced climate change models are unreliable	127	**4.15**	**3.72**	2.52	0.013	2
Climate change scientists are alarmist	126	**4.03**	**3.63**	2.23	0.027	3
Animals and plants can adapt to human induced climate change	121	3.75	3.67	0.46	0.646	4
There is no consensus on human induced climate change science	124	3.53	3.38	0.72	0.471	5
There's no evidence to support human induced climate change	121	**3.51**	**3.09**	2.16	0.032	6
We need to keep global warming below 2 degrees Celsius	109	**3.00**	**3.74**	-3.77	0.000	7
Carbon dioxide in the atmosphere was higher in the past	91	3.27	3.11	0.77	0.444	8
I am concerned about the impact of human induced climate change on future generations	125	**2.59**	**3.61**	-5.87	0.000	9
Human induced climate change has the potential to seriously damage farming	127	**2.66**	**3.24**	-2.98	0.003	20
The earth is cooling, rather than warming	102	2.89	2.88	0.07	0.948	11

3.4 ADAPTIVE CAPACITY

3.5 SUB-REGIONAL COMPARISON

We asked landholders who accepted human-induced climate change to rate the extent to which 20 items will be affected by human-induced climate change. Mean responses were then ranked as presented in

Table 13. The quantity of water for primary production was deemed to be most affected, followed by average yearly income and the yield of their crop. The least affected items related to the physical condition of the house, their ability to learn about NRM practices and the life of their property machinery.

Table 13 Ranking of mean responses to the extent to which the following items will be affected by climate change

Climate change impact	*N*	Mean	Rank
The quantity of water for primary production (N)	113	2.77	1
Your average yearly income (F)	111	2.63	2
The yield of your crop (N)	113	2.63	3
The value of the commodities you produce (F)	110	2.62	4
The population of young people in your area (H)	110	2.56	5
Opportunities for regional employment (F)	109	2.40	6
Your ability to diversify your on farm income (F)	110	2.37	7
The size of your grain or fruit (N)	110	2.32	8
Your ability to conserve natural resources (N)	111	2.24	9
The availability of skilled labour to support your primary production business (H)	108	2.22	10
The amount of time you invest in natural resource management activities (S)	113	2.22	11
The quality of the roads you use in your local area (P)	109	2.20	12
Your level of trust in advice provided by natural resource management agencies (S)	109	2.14	13
Your source of support in time of crisis (S)	103	2.10	14
The operation of your property machinery (P)	108	2.04	15
Your personal health (H)	112	1.99	16
Your ability to ask for small favours (S)	102	1.93	17
The physical condition of your house (P)	110	1.90	18
Your ability to learn about natural resource management practices (H)	110	1.89	19
The life of your property machinery (P)	109	1.89	20

We then compared mean responses in adaptive capacity across sub-region of residence. Riverland residents believed that they would be more able to ask for small favours when faced with human-induced climate change than Mid North landholders. Further, Fleurieu landholders noted they would have a significantly higher level of trust in the advice provided by NRM agencies than Mid North landholders. Riverland residents believed that human-induced climate change would have a greater effect on the physical condition of their house than Mid North landholders (Table 14). No significant differences in adaptive capacity were found across the remaining scale items.

Table 14 Mean comparison of adaptive capacity to human-induced climate change across sub-region of residence

Capital	Riverland	Mid North	Fleurieu	*F*	*p*
Natural					
The yield of your crop (N)	2.79	2.56	2.61	0.58	.561
The quantity of water for primary production (N)	3.14	2.57	2.77	2.60	.079
The size of your grain or fruit (N)	2.52	2.21	2.32	0.83	.439
Your ability to conserve natural resources (N)	2.26	2.20	2.30	0.09	.914
Human					
The population of young people in your area (H)	2.89	2.43	2.50	1.50	.228
Your ability to learn about natural resource management practices (H)	2.25	1.81	1.68	2.40	.095
Your personal health (H)	2.18	1.80	2.17	1.78	.173
The availability of skilled labour to support your primary production business (H)	2.26	2.26	2.11	0.16	.849
Financial					
Your average yearly income (F)	2.75	2.59	2.59	0.27	.761
Your ability to diversify your on farm income (F)	2.68	2.25	2.29	1.45	.238
The value of the commodities you produce (F)	2.89	2.48	2.61	1.28	.283
Opportunities for regional employment (F)	2.63	2.28	2.41	1.16	.316
Social					
Your ability to ask for small favours (S)	2.38[a]	1.57[b]	2.10[ab]	**6.36**	**.003**
The amount of time you invest in natural resource management activities (S)	2.57	2.06	2.19	2.41	.094
Your source of support in time of crisis (S)	2.19	1.94	2.29	1.13	.326
Your level of trust in advice provided by natural resource management agencies (S)	2.08[ab]	1.93[a]	2.57[b]	**4.13**	**.019**
Physical					
The quality of the roads you use in your local area (P)	2.46	2.15	2.07	0.92	.403
The physical condition of your house (P)	2.41[a]	1.69[b]	1.83[ab]	**5.33**	**.006**
The operation of your property machinery (P)	2.21	2.04	1.86	0.84	.436
The life of your property machinery (P)	2.08	1.81	1.86	0.58	.563

Like responses to human-induced climate change, landholders identified that the quantity of water for primary production was likely to be most significantly affected by the projected winter/spring drying trend. The population of young people in their area was also cited to be highly impacted, whereas their personal health and the physical condition of their house were identified to be least impacted (Table 15).

Table 15: Ranking of mean responses to the extent to which the following items will be affected by climate the projected winter/spring drying trend

Winter/spring drying trend impact	*N*	Mean	Rank
The quantity of water for primary production	36	3.06	1
The population of young people in your area	37	2.92	2
Your average yearly income	39	2.87	3
Opportunities for regional employment	38	2.66	4
The yield of your crop	40	2.63	5
The size of your grain or fruit	39	2.62	6
Your ability to diversify your on farm income	38	2.58	7
The availability of skilled labour to support your primary production business	39	2.54	8
The value of the commodities you produce	39	2.51	9
Your ability to conserve natural resources	41	2.51	10
The quality of the roads you use in your local area	41	2.32	11
Your level of trust in advice provided by natural resource management agencies	40	2.28	12
The operation of your property machinery	41	2.24	13
The amount of time you invest in natural resource management activities	40	2.18	14
Your source of support in time of crisis	39	2.13	15
The life of your property machinery	41	2.12	16
Your ability to ask for small favours	36	2.08	17
Your ability to learn about natural resource management practices	39	2.05	18
Your personal health	38	2.03	19
The physical condition of your house	40	1.95	20

Mid North residents believed that the quality of roads in their local area would be more severely impacted by the projected winter-spring drying trend than Riverland and Fleurieu landholders, and the physical condition of their house would be more severely affected than Fleurieu landholders (Table 16).

TABLE 16: MEAN COMPARISON OF ADAPTIVE CAPACITY TO THE PROJECTED WINTER/SPRING DRYING TREND ACROSS SUB-REGION OF RESIDENCE

Capital	Riverland	Mid North	Fleurieu	*F*	*p*
Natural					
The yield of your crop	2.58	2.75	2.38	0.63	.539
The quantity of water for primary production	3.18	2.94	3.13	0.20	.817
The size of your grain or fruit	2.75	2.75	2.00	1.71	.195
Your ability to conserve natural resources	2.38	2.55	2.63	0.22	.806
Human					
The population of young people in your area	2.92	3.05	2.50	0.63	.537
Your ability to learn about natural resource management practices	1.92	2.15	2.00	0.28	.756
Your personal health	2.17	2.11	1.57	1.25	.298
The availability of skilled labour to support your primary production business	2.62	2.68	2.00	1.10	.345
Financial					
Your average yearly income	3.00	3.00	2.38	1.73	.192
Your ability to diversify your on farm income	2.42	2.70	2.50	0.31	.736
The value of the commodities you produce	2.25	2.75	2.29	1.42	.256
Opportunities for regional employment	2.50	2.89	2.29	0.97	.390
Social					
Your ability to ask for small favours	2.42	2.70	2.50	2.67	.084
The amount of time you invest in natural resource management activities	1.92	2.35	2.14	0.88	.423
Your source of support in time of crisis	1.83	2.32	2.13	1.16	.326
Your level of trust in advice provided by natural resource management agencies	1.85	2.45	2.57	2.54	.093
Physical					
The quality of the roads you use in your local area	1.77^{a}	3.00^{b}	1.50^{ac}	**10.28**	**.000**
The physical condition of your house	1.85^{ab}	2.25^{a}	1.29^{b}	**3.74**	**.033**
The operation of your property machinery	2.08	2.50	1.88	2.12	.134
The life of your property machinery	2.08	2.25	1.88	0.43	.656

3.6 EXTENT OF CURRENT ADAPTATION TO CLIMATE CHANGE

We then asked respondents who believed in climate change to rate their level of investment in activities to manage human-induced climate change. Those respondents who believed in human-induced climate change noted that they had made larger investments in cover crops to improve soil structure and water penetration and summer weed control than using a disc seeder or using lower seeding rates (Table 17). Few significant differences in level of investment in the 15 activities were found across sub-region of residence. A key exception being that Riverland landholders had invested significantly more in salinity flushing irrigation applications than Fleurieu and Mid North landholders ($F = 7.80$, $p < .05$).

Table 17: Ranking of mean responses to the extent to which landholders have invested in the following activities to adapt to human-induced climate change

	N	Mean	Rank
Used cover crops to improve soil structure and water penetration	31	3.29	1
Paid greater attention to summer weed control	70	3.21	2
Assessed the moisture holding capacity of the soil	33	3.06	3
Monitored salinity build up in the soil profile	33	3.03	4
Minimised water loss through the use of mulches	33	3.03	5
Sowed crops earlier	45	2.76	6
Used salinity flushing irrigation applications	32	2.75	7
Delayed nitrogen fertilizer application	42	2.71	8
Significantly increased your capacity to harvest or store water	58	2.62	9
Used global positioning system technologies to improve crop management	67	2.58	10
Trialled earlier maturing varieties of crop	68	2.35	11
Trialled low water use varieties of crop	68	2.25	12
Practiced inter row sowing	42	2.00	13
Used a disc seeder	44	1.80	14
Used lower seeding rates	40	1.60	15

We then compared the level of investment in general activities to management of human-induced climate change across grain and grape growers. Grain growers had made significantly larger investments in the trialling of earlier maturing varieties of crop and the use of global positioning systems to improve crop management (

Table 18).

Table 18: Mean differences in level of investment in general activities to manage human-induced climate change across dominant land-use

	Grains	Grapes	*t*	*p*
Trialled low water use varieties of crop	2.29	2.17	.384	.703
Trialled earlier maturing varieties of crop	2.84	1.39	6.836	.000
Paid greater attention to summer weed control	3.35	2.96	1.746	.085
Used global positioning system technologies to improve crop management	3.02	1.62	4.803	.000
Significantly increased your capacity to harvest or store water	2.70	2.40	.938	.352

We asked respondents who accepted the projected winter-spring drying trend to rate their level of investment in the 15 activities. Respondents had invested most heavily in summer weed control and the use of salinity flushing irrigation applications and the least in lowering of seeding rates or the use of a disc seeder (

Table 19). Again, grain landholders had invested significantly more in the use of global position system technologies to improve crop management than grape growers in order to manage the projected winter/spring drying trend (Table 20).

TABLE 19: RANKING OF MEAN RESPONSES TO THE EXTENT TO WHICH LANDHOLDERS HAVE INVESTED IN THE FOLLOWING ACTIVITIES TO ADAPT TO THE PROJECTED WINTER/SPRING DRYING TREND

	N	Mean	Rank
Paid greater attention to summer weed control	25	3.16	1
Used salinity flushing irrigation applications	9	3.00	2
Monitored salinity build up in the soil profile	9	2.78	3
Assessed the moisture holding capacity of the soil	9	2.67	4
Delayed nitrogen fertilizer application	15	2.47	5
Used global positioning system technologies to improve crop management	24	2.46	6
Used cover crops to improve soil structure and water penetration	9	2.44	7
Minimised water loss through the use of mulches	9	2.22	8
Trialled earlier maturing varieties of crop	25	2.16	9
Practiced inter row sowing	16	1.94	10
Trialled low water use varieties of crop	25	1.84	11
Sowed crops earlier	17	1.82	12
Significantly increased your capacity to harvest or store water	22	1.82	13
Used lower seeding rates	16	1.75	14
Used a disc seeder	16	1.25	15

TABLE 20 MEAN DIFFERENCES IN LEVEL OF INVESTMENT IN GENERAL ACTIVITIES TO MANAGE THE PROJECTED WINTER/SPRING DRYING TREND ACROSS DOMINANT LAND-USE

	Grain	Grapes	*t*	*p*
Trialled low water use varieties of crop	1.82	1.88	-0.12	.906
Trialled earlier maturing varieties of crop	2.18	2.13	0.11	.913
Paid greater attention to summer weed control	3.00	3.50	-1.40	.175
Used global positioning system technologies to improve crop management	2.94	1.50	3.25	.004
Significantly increased your capacity to harvest or store water	1.86	1.75	.22	.825

We examined mean differences in on-farm responses to climate phenomena based upon level of acceptability of climate change and the winter-spring drying trend (Table 21). On average, respondents who accepted human induced climate change or the winter/spring drying trend noted that they had invested a fair amount in the use of cover crops to improve soil structure and water penetration, technologies to control summer weeds and assess the moisture holding capacity of the soil. However, uptake of some technologies varied according to the level of acceptance of climate change. Those respondents who accepted human-induced climate change had invested significantly more in technologies to sow crops earlier than those respondents who rejected climate change, but accepted the winter-spring drying trend, $F(2, 59) = 5.04$, $p = .010$. Those respondents who accepted human induced climate change had also invested significantly more in technologies to increase the capacity to harvest or store water than those respondents who were unsure or did not believe in human induced climate change, $F(2, 77) = 4.55$, $p = 0.014$; however, those respondents who rejected the human-induced climate change but accepted the winter/spring drying trend were more likely to invest in technologies to lower seeding rates, $F(2, 53) = 5.38$, $p = .007$.

TABLE 21: DIFFERENCES IN ADAPTIVE RESPONSES TO CLIMATE PHENOMENON AMONG LANDHOLDERS WHO BELIEVE, ARE UNSURE OR DON'T BELIEVE IN HUMAN INDUCED CLIMATE CHANGE

	Accept HI CC	Unsure about HI CC, believe in drying	Don't accept HI CC, believe in drying	df	*F*	*p*	Rank
Used cover crops to improve soil structure and	3.29	2.75	2.20	2, 37	2.92	.067	1
Paid greater attention to summer weed control	3.21	3.31	3.00	2, 92	0.41	.666	2
Assessed the moisture holding capacity of the soil	3.06	3.25	2.20	2, 39	1.59	.216	3
Minimised water loss through the use of mulches	3.03	2.50	2.00	2, 39	2.52	.093	4
Monitored salinity build up in the soil profile	3.03	3.00	2.60	2, 39	0.36	.703	5
Sowed crops earlier	2.76[a]	2.00[ab]	1.63[b]	2, 59	**5.04**	**.010**	6
Used salinity flushing irrigation applications	2.75	3.00	3.00	2, 38	0.15	.862	7
Delayed nitrogen fertilizer application	2.71	2.22	2.83	2, 54	0.84	.437	8
Significantly increased your capacity to harvest or store	2.62[a]	1.82b	1.82b	2, 77	**4.55**	**.014**	9
Used global positioning system technologies to	2.58	2.54	2.36	2, 88	0.14	.869	10
Trialled earlier maturing varieties of crop	2.35	2.08	2.25	2, 90	0.37	.690	11
Trialled low water use varieties of crop	2.25	1.77	1.92	2, 90	1.47	.235	12
Practiced inter row sowing	2.00	1.33	2.71	2, 55	3.08	.054	13
Used a disc seeder	1.80	1.00	1.57	2, 57	2.48	.093	14
Used lower seeding rates	1.60[a]	1.00[ac]	2.50[b]	2, 53	**5.38**	**.007**	15

Note: different lettered superscripts reflect significant differences, based upon Bonferroni post-hoc analyses; bolded numbers reflect significant mean differences ($p < 0.05$)

3.7 Barriers to adaptation

We asked landholders who had not invested in activities to manage the human-induced climate change or the projected winter/spring drying trend to rate a variety of barriers to the management of the phenomena. In Respondents most strongly agreed that the management of both phenomena were not seen as a priority with respect to other property risks or they did not have the finances to manage them. Not having the support of friends or family members was the lowest rated barrier (Table 22 and Table 23).

Table 22: Level of agreement about barriers to the management of human-induced climate change

	N	Mean
I don't see it as a priority with respect to other property risks	43	3.37
I don't have the finances	44	3.30
I don't have the skilled labour	44	3.23
I don't have the time	44	3.02
Government regulations prevent me from adapting to the impacts of human induced climate change	40	2.98
I don't have the support of friends or family members	44	2.68

Table 23: level of agreement about barriers to the management of the projected winter/spring drying trend

	N	Mean
I don't see it as a priority with respect to other property risks	13	3.54
I don't have the finances	15	3.47
Government regulations prevent me from adapting to the impacts of human induced climate change	13	3.31
I don't have the time	14	3.14
I don't have the skilled labour	15	3.07
I don't have the support of friends or family members	16	2.44

4 Discussion

A variety of national and international scientific reports and articles encourage the development of new policies and programs to support adaptation to climate change in the rural agricultural sector. However, this report suggests that questions about the acceptability of human-induced climate change need to be answered prior to formulating adaptation policies for rural landholders. Two-thirds of the sample were either uncertain or did not accept the existence of human-induced climate change. This result supports previous studies which have found that less than half of respondents agreed that they would be affected by the negative effects of climate change (Lorenzoni et al., 2007). Lack of acceptability can be attributed to uncertainty and distrust in information sources, uncertainty and scepticism about the causes of climate change (Lorenzoni et al., 2007), as well as active and casual denial, blame-shifting, deliberate apathy and unrealistic/wishful thinking (Stafford-Smith, Horrocks, Harve, & Hamilton, 2011).

A high proportion of respondents have engaged in activities to manage on-farm risks; however, it is still questionable whether these actions will lead to incremental or transformational adaptation, or simply maladaptation. Adger and Barnett (2009) suggest that there is widespread existing maladaptation in rural agriculture and encourage decision makers to adjust their practices and decision-making frameworks to account for these realities. They suggest selecting 'no-regret' strategies that yield benefits even in absence of climate change; favouring reversible and flexible options, buying safety margins in investments, promoting soft adaptation strategies and reducing decision time horizons. The results of our study support this conclusion. Our results suggest that maladaptation is not occurring in rural South Australia. Rather, many respondents are choosing to adopt soft adaptation strategies, such as management of salinity on-farm, leading to incremental changes in adaptation. The major challenge is to encourage transformational decisions in adaptation which change variables that control the functioning of natural and agricultural systems (Stafford-Smith et al., 2011). Focusing on adaptation as a continual incremental process of adjustment is useful for decision-makers but it does not help cope with larger climate changes, such as an increase in global temperatures of 3-4 degrees C. Coping with such temperature rises require deep structural changes such as changing out of farming to another land-use, which may be unpalatable to rural landholders who currently reject or are unsure about the existence of climate change. The challenge for policy makers is to develop and apply policy instruments which lead to transformational change in rural South Australia. The following section outlines some possible options.

4.1 Implications for climate change adaptation policy

South Australia's Climate Change Adaptation Framework (Draft) encourages the development of sustainable food and farming systems, including biofuels, soil carbon capture technologies and the development of farming options that are better suited to climate variability. These opportunities are most likely to be realised in relation to those landholders who accept the existence and consequences of human-induced climate change, approximately 33% of the state, extrapolating responses to this survey. It is therefore important to tailor climate change communications to different audiences (see Poortinga et al., 2011), including those landholders who accept, reject or are unsure about human-induced climate change. Framing technologies with respect to the management of everyday farm risks is one approach to tailoring communications. This approach is likely to engage landholders who reject human-induced climate change, but accept the winter-spring drying trend. We found that a high proportion of respondents engaged in activities to manage on-farm risks, even though they did not accept the concept of human-induced climate change.

Other studies also support the need to reframe climate change in order to address conflict among individuals who have different understandings and levels of acceptance of the phenomenon. Nisbett (2009) outlines that climate change conflicts in the United States is in part driven by the different ways in which trusted sources have framed the nature and implications of climate change for Republicans and Democrats over the past decade. Democrat leaders such as President Obama have invoked a public accountability frame (i.e., listening to what scientists have to say) and an increasing majority of Republicans have questioned the validity of climate science and have dismissed the problem. To increase public engagement in climate change, Nisbett suggests moving to a unifying interpretation frame of climate change adaptation not only involving science, but also which has health implications for citizens and embraces moral and ethical concerns.

Environmental managers also need to consider how they can develop engagement models, policies and programs which support individual landholders to holistically manage property risks. One possible model is for agencies to support communities of practice, including farm systems groups in rural areas of Australia, which are actively trialling new crops and technologies to address a warming drying trend. Raymond and Robinson (under review) found that these groups present their technologies with respect to the management of water availability, pest, plant and soil structure risks. Support may entail the provision of direct or in-kind assistance to communities of practice, in addition to the provision of the latest research and development findings and the support of knowledge exchange programs such as field days, workshops and newsletters.

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Appendix A. CATI SURVEY ADMINISTERED IN THIS STUDY

INTRODUCTION TEXT

[A]

Hello, my name is..........and I'm calling on behalf of the Australian Institute for Social Research at the University of Adelaide. We are conducting important research into the challenges and opportunities facing grain growers and viticulturists in the 21st Century for the South Australian Government. The results of this survey may inform how the South Australian Government supports natural resource management programs in your region. Could I please speak to someone in your household who owns or manages the property?

*[IF PERSON SPEAKING, GO TO **B**]*

[IF PERSON UNAVAILABLE, GET FIRST NAME AND ARRANGE CALL-BACK]

*[IF DIFFERENT PERSON COMES TO PHONE, RETURN TO **A**]:*

[B]

We are interested in your views. The questions take about 10 minutes. Have you got time now?

*[IF YES, GO TO **C**]*

[IF NO, MAKE A TIME TO CALL BACK]

[C]

I can assure you that information you give will remain confidential. The answers from all people interviewed will be gathered together and presented in a report. No individual answers will be passed on. Of course, you are free to stop the interview at any time. For training purposes, the interview may be monitored by my supervisor.

[IF REFUSED, THANK AND TERMINATE]

1 ABOUT YOUR PROPERTY

1.1 We are speaking with landholders about issues related to years of exceptionally low rainfall and other climate conditions on their property. The property represents all the parcels of farming land you own, lease, share or agist in South Australia.

1.1.1 **Could I please check the size of the property you manage.** *[TERMINATE IF < 10 HA OR 25 ACRES]*

____________________Acres ______________Hectares

1.1.2 Approximately how much of this land is used for grain production or viticulture? (Grain production includes the production of beans, lentils, lupins, oat, pea and wheat. Viticulture includes the production of table and wine grapes, and sultana grapes for drying)

____________________Acres ______________Hectares

[VARY ORDER OF GRAIN OR VITICULTURE ACCORDING TO STATUS GIVEN IN SAMPLING FILE, TERMINATE IF NEITHER >50% OF PROPERTY AREA]

1.1.3 In which local government area is the majority (>50%) of your property situated?

____________________Local Government Area

1.1.4 How many years has the property on which you live been owned or operated by your family? (Includes owned by extended family, e.g., parents, grandparents)

______________Years

1.1.5 How many years have you been involved in primary production?

______________Years *[ASK FOR YEAR OF BIRTH IF THEY RESPOND WITH "ALL MY WORKING LIFE"]*

1.1.6 Is the majority of your property owned by you or someone in your household, or is it leased?

Owned	1
Leased	2

2

2 CHALLENGES ON THE PROPERTY

2.1 The items listed below may or may not be current challenges to the operation of your primary production business. For each of the following items, please indicate your level of *agreement* or *disagreement* about whether the item is a current challenge to the operation of your primary production business.

[READ OPTIONS. SINGLE RESPONSE]

Strongly Agree	1
Agree	2
Neither Agree nor Disagree	3
Disagree	4
Strongly Disagree	5
Not stated/ Unsure *[DON'T READ]*	6
Not applicable *[DON'T READ]*	7

2.1.1 The high Australian dollar

2.1.2 An increase in interest rates

2.1.3 Lack of skilled labour

2.1.4 Your ability to hand down your property to your children

2.1.5 Climate change caused by human activity

2.1.6 Low water availability

2.1.7 Rainfall variability

2.1.8 Pest animal control

2.1.9 Pest plant control

2.1.10 Your health

2.2 Are there any other important current challenges to the operation of your primary production business?

Other ....

3 YOUR VIEWS ON HUMAN-INDUCED CLIMATE CHANGE

3.1 There has been a lot of discussion in the community about climate change in recent times. We want to know what you think about climate change caused by human activity, which is often referred to as human-induced climate change.

3.1.1 Do you believe human-induced climate change exists? *[READ OPTIONS. SINGLE RESPONSE]*

1. Yes, it's real
2. No, it's not real *[GO TO SECTION 5]*
3. Unsure *[GO TO SECTION 5]*

3.2 Over the past 10 years, how many years have you experienced below average rainfall in winter and spring on your property?

..................................years

Not stated/ Unsure *[DON'T READ]*

(ASK FOR NUMBER OF YEARS EVEN IF RESPONDENT HAS OWNED FARMING LAND FOR LESS THAN 10 YEARS)

3.3 To what extent do you agree or disagree that human-induced climate change may result in the following impacts in your area?

[READ OPTIONS. SINGLE RESPONSE]

Strongly Agree	1
Agree	2
Neither Agree nor Disagree	3
Disagree	4
Strongly Disagree	5
Not stated/ Unsure *[DON'T READ]*	6

3.3.1 Increased frequency of pest plant outbreaks

3.3.2 A decrease in water availability

3.3.3 Increased frequency of below average rainfall in winter and spring

3.3.4 Other…………….. *[NO SCALING REQUIRED]*

3.4 Australians might respond to human-induced climate change in a variety of ways. For each of the statements I am going to read out, can you please tell me whether you strongly agree, agree, disagree or strongly disagree.

[READ OPTIONS. SINGLE RESPONSE:]

Strongly Agree	1
Agree	2
Neither Agree nor Disagree	3
Disagree	4
Strongly Disagree	5
Not stated/ Unsure *[DON'T READ]*	6

3.4.1 I am extremely worried about the possibility of human-induced climate change in this area.

3.4.2 This community has been fine in the past and it will be fine when faced with human-induced climate change too.

3.4.3 The likelihood that human-induced climate change will occur in this area has been greatly exaggerated.

3.5 How well prepared are you and your household for human-induced climate change. Would you say that you are:

[READ OPTIONS. SINGLE RESPONSE:]

Very prepared	1
Somewhat prepared	2
Not prepared at all	3
Preparation is not necessary	4
Don't know/not prepared to answer *[DON'T READ]*	5

[ASK – "HOW WELL PREPARED ARE YOU" IF THE RESPONDENT IS AN EMPLOYEE AND THEIR HOUSEHOLD IS NOT INVOLVED IN FARMING]

4 MANAGING HUMAN-INDUCED CLIMATE CHANGE

4.1 To what extent do you think the following things will be affected by human-induced climate change? Please say if you think it will be affected…not at all, a little, a fair amount, or a great deal.

[READ OPTIONS. SINGLE RESPONSE:]

Not at all	1
A little	2
A fair amount	3
A great deal	4
Not stated/ Unsure *[DON'T READ]*	5

4.1.1 The yield of your crop (N)

4.1.2 Your average yearly income (F)

4.1.3 The population of young people in your area (H)

4.1.4 Your ability to ask for small favors (S)

4.1.5 The quality of the roads you use in your local area (P)

4.1.6 The size of your grain or fruit (N)

4.1.7 Your ability to learn about natural resource management practices (H)

4.1.8 Your personal health (H)

4.1.9 Your ability to diversify your on-farm income (F)

4.1.10 The amount of time you invest in natural resource management activities (S)

4.1.11 The operation of your property machinery (P)

4.1.12 The quantity of water for primary production (N)

4.1.13 The physical condition of your house (P)

4.1.14 The value of the commodities you produce (F)

4.1.15 Your level of trust in advice provided by natural resource management agencies (S)

4.1.16 Your ability to conserve natural resources (N)

4.1.17 The availability of skilled labor to support your primary production business (H)

4.1.18 The life of your property machinery (P)

4.1.19 Opportunities for regional employment (F)

4.1.20 Your source of support in time of crisis (S)

4.2 Have you invested in any activities to manage the impacts of human-induced climate change on your property?

[READ OPTIONS. SINGLE RESPONSE:]

Yes

No

[IF YES, GO TO 4.3; IF NO, GO TO 4.4]

8

4.3 If yes, to what extent have you invested in the following activities to adapt to human-induced climate change on your property?

[READ OPTIONS. SINGLE RESPONSE:]

Not at all	1
A little	2
A fair amount	3
A great deal	4
Not stated/ Unsure *[DON'T READ]*	5
Not applicable [*DON'T READ*]	6

4.3.1 Trialed low water-use varieties of crop

4.3.2 Trialed earlier maturing varieties of crop

4.3.3 Paid greater attention to summer weed control

4.3.4 Used global positioning system technologies to improve crop management

[SINGLE RESPONSE - GRAIN PRODUCERS ONLY]

4.3.5 Sowed crops earlier

4.3.6 Used a disc seeder

4.3.7 Used lower seeding rates

4.3.8 Practiced inter-row sowing

4.3.9 Delayed nitrogen fertilizer application

[SINGLE RESPONSE – VITICULTURALISTS ONLY]

4.3.10 Minimised water loss through the use of mulches

4.3.11 Monitored salinity build up in the soil profile

4.3.12 Used salinity flushing irrigation applications

4.3.13 Assessed the moisture-holding capacity of the soil

4.3.14 Used cover crops to improve soil structure and water penetration

4.4 If no, to what extent do you agree or disagree with the following potential barriers to the management of human-induced climate change?

[READ OPTIONS. SINGLE RESPONSE:]

Strongly Agree	1
Agree	2
Neither Agree nor Disagree	3
Disagree	4
Strongly Disagree	5
Not stated/ Unsure *[DON'T READ]*	6

4.4.1 I don't see it as a priority with respect to other property risks

4.4.2 I don't have the time

4.4.3 I don't have the finances

4.4.4 I don't have the skilled labour

4.4.5 I don't have the support of friends or family members

4.4.6 Government regulations prevent me from adapting to the impacts of human-induced climate change

4.4.7 Other……………………

[GO TO SECTION 8]

4.4 If no, to what extent do you agree or disagree with the following potential barriers to the management of human-induced climate change?

[READ OPTIONS. SINGLE RESPONSE:]

Strongly Agree	1
Agree	2
Neither Agree nor Disagree	3
Disagree	4
Strongly Disagree	5
Not stated/ Unsure *[DON'T READ]*	6

4.4.1 I don't see it as a priority with respect to other property risks

4.4.2 I don't have the time

4.4.3 I don't have the finances

4.4.4 I don't have the skilled labour

4.4.5 I don't have the support of friends or family members

4.4.6 Government regulations prevent me from adapting to the impacts of human-induced climate change

4.4.7 Other……………………

[GO TO SECTION 8]

5.3 How well prepared are you and your household for five consecutive winter and spring growing seasons of below average rainfall? Would you say that you are:

Very prepared	1
Somewhat prepared	2
Not prepared at all	3
Preparation is not necessary	4
Don't know/not prepared to answer *[DON'T READ]*	5

5.4 Overall, do you believe that there will be less rainfall in winter and spring in this area over the long-term?

Yes – *(GO TO SECTION 6)*

No –*(GO TO SECTION 7)*

6 MANAGING THE PROJECTED WINTER/SPRING DRYING TREND

6.1 Climate models indicate that rainfall is likely to decrease in winter and spring in Southern Australia by 2030. In this section, we refer to this projection as the winter/spring drying trend. To what extent do you think the following things will be affected by the projected winter/spring drying trend? Please say if you think it will be affected…not at all, a little, a fair amount, or a great deal.

[READ OPTIONS. SINGLE RESPONSE:]

Not at all	1
A little	2
A fair amount	3
A great deal	4
Not stated/ Unsure *[DON'T READ]*	5

6.1.1 The yield of your crop (N)

6.1.2 Your average yearly income (F)

6.1.3 The population of young people in your area (H)

6.1.4 Your ability to ask for small favors (S)

6.1.5 The quality of the roads you use in your local area (P)

6.1.6 The size of your grain or fruit (N)

6.1.7 Your ability to learn about natural resource management practices (H)

6.1.8 Your personal health (H)

6.1.9 Your ability to diversify your on-farm income (F)

6.1.10 The amount of time you invest in natural resource management activities (S)

6.1.11 The operation of your property machinery (P)

6.1.12 The quantity of water for primary production (N)

6.1.13 The physical condition of your house (P)

6.1.14 The value of the commodities you produce (F)

6.1.15 Your level of trust in advice provided by natural resource management agencies (S)

6.1.16 Your ability to conserve natural resources (N)

6.1.17 The availability of skilled labor to support your primary production business (H)

6.1.18 The life of your property machinery (P)

6.1.19 Opportunities for regional employment (F)

6.1.20 Your source of support in time of crisis (S)

6.2 Have you invested in any activities to manage the impacts of the winter/spring drying trend on your property?

[READ OPTIONS. SINGLE RESPONSE:]

Yes

No

[IF YES, GO TO 6.3; IF NO, GO TO 6.4]

14

6.3 If yes, to what extent have you invested in the following activities to adapt to the projected winter/spring drying trend on your property?

[READ OPTIONS. SINGLE RESPONSE:]

Not at all	1
A little	2
A fair amount	3
A great deal	4
Not stated/ Unsure *[DON'T READ]*	5
Not applicable [*DON'T READ*]	6

6.3.1 Trialed low water-use varieties of crop

6.3.2 Trialed earlier maturing varieties of crop

6.3.3 Paid greater attention to summer weed control

6.3.4 Used global positioning system technologies to improve crop management

[SINGLE RESPONSE - GRAIN PRODUCERS ONLY]

6.3.5 Sowed crops earlier

6.3.6 Used a disc seeder

6.3.7 Used lower seeding rates

6.3.8 Practiced inter-row sowing

6.3.9 Delayed nitrogen fertilizer application

[SINGLE RESPONSE – VITICULTURALISTS ONLY]

6.3.10 Minimised water loss through the use of mulches

6.3.11 Monitored salinity build up in the soil profile

6.3.12 Used salinity flushing irrigation applications

6.3.13 Assessed the moisture-holding capacity of the soil

6.3.14 Used cover crops to improve soil structure and water penetration

6.4 If no, to what extent do you agree or disagree with the following potential barriers to the management of the projected winter/spring drying trend?

[READ OPTIONS. SINGLE RESPONSE:]

Strongly Agree	1
Agree	2
Neither Agree nor Disagree	3
Disagree	4
Strongly Disagree	5
Not stated/ Unsure *[DON'T READ]*	6

6.4.1 I don't see it as a priority with respect to other property risks

6.4.2 I don't have the time

6.4.3 I don't have the finances

6.4.4 I don't have the skilled labour

6.4.5 I don't have the support of friends or family members

6.4.6 Government regulations prevent me from managing the projected winter/spring drying trend

6.4.7 Other……………………

[GO TO SECTION 8]

7 DIFFERING VIEWS ABOUT CLIMATE CHANGE

7.1 We acknowledge that there are different views in the community about human-induced climate change, including the possibility of less rainfall in winter and spring. In this section we would like to know the extent to which your agree, disagree or are unsure about the following statements.

[READ OPTIONS. SINGLE RESPONSE:]

Strongly Agree	1
Agree	2
Neither Agree nor Disagree	3
Disagree	4
Strongly Disagree	5
Not stated/ Unsure *[DON'T READ]*	6

7.1.1 It is climate variability rather than human-induced climate change

7.1.2 We need to keep global warming below 2 degrees Celsius

7.1.3 The earth is cooling, rather than warming

7.1.4 I am concerned about the impact of human-induced climate change on future generations

7.1.5 There is no consensus on human-induced climate change science

7.1.6 Human-induced climate change has the potential to seriously damage farming

7.1.7 Human-induced climate change models are unreliable

7.1.8 Animals and plants can adapt to human-induced climate change

7.1.9 There's no evidence to support human-induced climate change

7.1.10 Climate change scientists are alarmist

7.1.11 Carbon dioxide in the atmosphere was higher in the past

7.1.12 Other…………………………..

[GO TO SECTION 8]

8 DEMOGRAPHICS

And finally, just a couple more questions about you, so that we can understand how different people have answered these questions.

8.1.1 What year were you born.................(year)

8.1.2 What is the highest level of education that you have completed?

Primary school	1
Part or all of high school	2
TAFE course	3
A university degree	4
A postgraduate degree	5
Other	6

8.1.3 In the 2010-2011 financial year, what proportion of your family's income was earned off-property?

0%	1
25%	2
50%	3
75%	4
All	5
Not Applicable *[DON'T READ BUT RECORD REASON FOR NON-RESPONSE E.G., VINEYARD EMPLOYEE]*	6

8.1.4 What was your property income (before tax) in the 2009-2010 financial year?

0	1
< $50,000	2
$51,000-100,000	3
$101,000-200,000	4
$201,000-500,000	5
>$500,000	6
Don't Know/Refused *[DON'T READ]*	7
Not Applicable *[DON'T READ BUT RECORD REASON FOR NON-RESPONSE E.G., VINEYARD EMPLOYEE]*	8

[RECORD GENDER OF RESPONDENT]

Male	1
Female	2

[RECORD POSTCODE FOR NUMBER DIALLED]

18