



# Engaging local communities in climate adaptation: a social network perspective from Orange, New South Wales, Australia

## Summary report

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## Acronyms

ABS	Australian Bureau of Statistics
CBO	Community-Based Organisation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPI	Department of Primary Industries
GHG	Greenhouse Gas Emissions
LLS	Local Land Services
NGO	Non-Government Organisation
NSW	New South Wales
OEH	Office of Environment and Heritage
PV	Photovoltaic solar cell
SNA	Social Network Analysis

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# Executive Summary

Community engagement is a critical component of resolving complex public policy problems, such as climate change. Yet, engaging communities can be a challenging task for planners and policy makers particularly where decisions are complex and contested and seek to address longer term implications such as climate change. Adding to the complexity of community engagement is the fact that communities are not homogeneous and perceptions of risk vary between and within communities across Australia. By improving our understanding of the community's structure, specific needs, concerns and position in relation to climate change and adaptation, the effectiveness of planning and policy decisions can be significantly enhanced. Community structures may be understood more deeply by uncovering the underlying social networks that are activated around particular issues, such as climate change. By using social network analysis (SNA) we explored the social structures around this particular topic in the Orange<sup>1</sup> region of NSW. We also used semi-structured interviews to elicit the experiences and perceptions of the key stakeholders in relation to climate change to determine their major concerns and information needs to enhance their capacity to adapt.

Key to this case study is the flow of information through both formal and informal channels, though both networks highlight the importance of local community actors (informal) who are strong believers and active participants in sustainability agendas such as climate change. Community leaders, active in sustainability matters, in concert with key industry professionals and state government agencies (LLS) provide important avenues for disseminating information about climate change. The relatively fragmented nature of both networks resulting in a low percentage of reach throughout the community suggests that multiple modes and channels of communication are required to improve knowledge flow across the Orange community in the context of climate adaptation (e.g. social media, mass media, mass communications, state and local government). While most participants were broadly aware of climate change, though not all supporters and believers, the majority were unsure about what they could do at the local scale to make a difference. Not everyone in the community shared the same view in terms of climate change

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<sup>1</sup> Note: This research was conducted in the Orange region prior to the announcement of local government amalgamations between Orange City Council, Blayney Shire Council and Cabonne Shire.

adaptation, which indicates that framing is important, and also sector and context specific. Importantly, community engagement efforts and information dissemination need to be well timed (e.g. around an extreme event) and information simplified, localised and personalised to ensure broader participation and uptake of adaptation policy. Many participants reported that Orange, due to its location and elevation, was fairly well 'buffered' from any climatic extremes and therefore felt the region maintained a consistent climate and was at an advantage compared to many neighbouring regions. This however, was not a view held by all participants and many were concerned about changes in temperature, rainfall, water supply, pest species and extreme weather events in the region.

# 1 Background

Climate change is a significant challenge for planners and policy makers (Pidgeon et al., 2014). Decisions about when and how to adapt to a changing climate are complex and contested. While mitigation efforts remain a significant global challenge, there is widespread acknowledgement that adaptation to unavoidable climate change impacts at the local and regional scale is a critical component of the planning and policy challenge (McEvoy et al., 2010; Agrawal et al., 2012; Huggel et al., 2015). Climate change adaptation is a multi-scale planning and policy 'process that needs to consider different sources of knowledge and also societal and cultural values, objectives and risk perceptions of those involved' (Huggel et al., 2015, p. 80). Understanding how the different types of responses play out within and across different communities is critical to the success of climate change adaptation. Given the diverse sets of interests, actors and values that are mobilised as a result of climate change, community engagement and policy design remain a critical but complex task for planners and policy makers (Serrao-Neumann et al., 2014). There can be no 'one size fits all' approach to community engagement as every community is unique (Green et al., 2009). The effectiveness of planning and policy decisions at the local scale can be significantly enhanced by improving our understanding of community structure and a community's specific needs, concerns and position in relation to climate change and adaptation.

Climate adaptation can be planned or autonomous, anticipatory or reactive (Smit and Wandel, 2006). While the success of government-led policy approaches largely relies on the uptake of policies at the local scale (Harman et al., 2015), it is also important to note that many communities are already adapting to climate change autonomously (Juhola and Westerhoff, 2011). Through autonomous measures many communities may not even be aware that they are making explicit contributions to adaptation. In this regard, the design of climate adaptation policy must recognise the importance of an improved understanding of the community structure for planned adaptation and the subliminal nature of local autonomous action. Community structures may be understood more deeply by uncovering the underlying social networks that are activated around different issues, concerns and interests (Cunningham et al., 2015).

With a few exceptions, there is a general lack of scientific inquiry on the role of social networks to understand and improve community engagement and local adaptation policy (Cunningham et al.



2015). This report presents findings from case study research in the Orange region, NSW conducted between November and December 2015. The results of this study build upon previous case study research in Shoalhaven (March and April 2014) and Bega (October and November 2014), NSW. The three case studies form part of a broader project to explore the science, policy and community interface in the context of climate change adaptation (New South Wales Government, undated-b). We adopt a mixed methods approach to map the social network and improve our understanding of how information around climate change adaptation is accessed and shared within this particular community. We used semi-structured interviews to elicit the experiences and perceptions of the key stakeholders to improve knowledge and inform policy design for climate change adaptation. In doing so, we investigate community perceptions about climate change and determine their major concerns and information needs to enhance their capacity to adapt to a changing climate.

## 2 Aims and approach

In addition to the formal governance networks by which information about climate change is shared and adaptation decisions are taken, a suite of informal networks also influences the ways in which individuals and groups engage with the process of adaptation (Stacey, 1996; Pelling et al., 2008). The main objective of this project is to understand the interaction between the formal and informal governance networks, with a view towards developing effective engagement options. Understanding the structure and influence of these networks is important to developing effective ways to engage with diverse communities at the local scale. The research project explored the following questions:

- What are the informal processes by which community members receive information related to adaptation?
- How can an understanding of the linkages between formal and informal networks lead to better targeted engagement options?
- How do diverse community members currently receive information about climate change and climate adaptation, and what alternative mechanisms are available to improve the communication of adaptation?
- How are messages about adaptation framed, and does this have implications for engagement in adaptation response?
- How can policy makers better engage with communities to improve the acceptance and uptake of climate adaptation policies/programs/strategies?

To answer these questions this study employed a mixed methods approach using both quantitative and qualitative techniques. The quantitative component of the research used social network analysis (SNA) to map the formal and informal social network in the Orange region. More specifically, the two social networks mapped in the region related to 'where participants *access* climate adaptation information' and the second network related to 'who they *share* their information with'. We used UCInet and Keyplayer software programs to undertake social network analysis (Borgatti and Freeman, 2002). These two programs were specifically selected on the basis that they provide a wide range of analysis options, including specific algorithms highly relevant to

the questions posed in this study (e.g. multiple cohesion measures). For a more detailed outline of social networks and the method for data capture and analysis see Borgatti et al. (2013).

Responses from the interviews were used to create affiliation and attribute data which included name, gender, location and association (e.g. employment, community organisation memberships). All of the entities identified through the interviews (e.g. individuals, websites, and media) were placed into directed symmetric matrices and analysed for a number of specific features. There were seven key measures that were calculated (see Table 1).

**Table 1: Description of network cohesion measures**

Network cohesion measure	Brief description
Average degree	The average number of ties attributed to each node
Average distance	The average geodesic distance amongst reachable pairs
Closure	Measure of the completeness of relational triads
Components	The number of cliques
Density	The number of ties divided by the maximum number possible
Diameter	The length of the longest geodesic across the network
Fragmentation	The proportion of pairs of nodes that are unreachable

These measures were selected specifically due to the research question and design. For example, networks with higher levels of cohesion mean that nodes within the network are more connected to each other. Higher cohesion in a social network may allow knowledge to flow more through the community. The social network visualisation tool NETDRAW was used to develop socio-grams based on the original social network and group composition network matrices resulting from the UCInet analysis. For the purpose of reporting, the layout of the figures is constrained by Euclidian distance, with the more central nodes being located at the centre of the image.

The qualitative component of the research was used to elicit the experiences and perceptions of the key stakeholders to improve knowledge and inform policy design for climate change adaptation. In doing so, we investigated community perceptions about climate change and determined the community's major concerns and information needs to enhance their capacity to adapt to a changing climate. We used a snow-ball sampling technique to recruit participants and ensure the most appropriate people were identified for interviews. Our initial scoping phase involved a desk top review of the region to identify a cross section of the community to ensure we

had representation from a mix of stakeholders that cut across government, industry, non-government organisations and the broader community. In total, 31 interviews were conducted between November and December 2015. A demographic breakdown of participants can be seen in Table 2. All interviews were audio recorded, transcribed, and imported into NVivo for coding and analysis. Interviews were conducted by the first and third authors with the first and second authors completing all coding and qualitative analysis. A strategy of pre-coding was used to become familiar with the transcripts and identify potentially important segments of text (Layder, 1998). To ensure consistency in coding between the authors a common coding framework was applied based on the interview questions and the findings from the previous case studies. In addition, the first and second authors met on several occasions to discuss the framework and the themes which emerged as a result of the coding. Any new themes identified were discussed and either added to the framework or integrated. The themes were checked for overlap and duplication before further refinement. The quantitative data collection was undertaken as a distinctive sub-component of the semi-structured interviews, with specific questioning at the end of each interview. In broad terms the interviews explored:

- i. perceptions of climate change and adaptation;
- ii. community concerns and personal experiences;
- iii. roles and responsibility for adaptation policy;
- iv. adequacy and usefulness of information and community engagement processes;
- v. types of information that hold the greatest interest for people; and
- vi. potential changes people have made to improve liveability and business efficiency under changing climatic conditions.

**Table 2: Breakdown of interviewees**

Type	Gender	Residency	Network
Community Based Organisation	M	< 5 years	Informal
Non-Government Organisation	F	Between 5-20 years	Informal
State Government	F	Resident outside of Orange	Formal
State Government	F	< 5 years	Formal
Local Government	M	Between 5-20 years	Formal
Community Based Organisation	F	< 5 years	Informal
Community Based Organisation	M	> 20 years	Informal
Non-Government Organisation	M	> 20 years	Informal
Community Based Organisation	M	> 20 years	Informal
State Government	M	> 20 years	Formal
Other	M	> 20 years	Formal
Individual	M	> 20 years	Informal
Research	M	Between 5-20 years	Informal
Community Based Organisation	M	Between 5-20 years	Informal
Local Government	M	Resident outside of Orange	Formal
Local Government	F	< 5 years	Formal
Local Government	M	Between 5-20 years	Formal
Individual	F	Between 5-20 years	Informal
Community Based Organisation	F	Between 5-20 years	Informal
Research	M	Between 5-20 years	Informal
State Government	F	Between 5-20 years	Formal
State Government	F	> 20 years	Formal
Non-Government Organisation	M	> 20 years	Informal
Local Government	M	> 20 years	Formal
Community Based Organisation	M	> 20 years	Informal
Local Government	M	Between 5-20 years	Formal
State Government	M	Between 5-20 years	Formal
Individual	M	> 20 years	Informal
Individual	M	> 20 years	Informal
Local Government	F	> 20 years	Formal
Local Government	M	> 20 years	Formal

*The study area – Orange City*

The City of Orange is located in the New South Wales Central Tablelands, approximately 270 kilometres north of Canberra and 260 kilometres west of Sydney (See Figure 1). Orange covers an area of approximately 285km<sup>2</sup> of which 90% is rural land (Australian Bureau of Statistics, 2016). While wheat growing was the primary agricultural land use post European settlement, there are a number of orchards and wineries which utilised the region's cool temperate climate and rich soils (NSW National Parks and Wildlife Services, 2003; Orange City Council, undated). Orange is a fruit growing district producing apples, pears and other stone fruits such as cherries, peaches, apricots and plums. The growth of the wine industry along with the development of Orange as a gourmet food region, has ensured its status as a prominent tourism destination (Visit Orange, undated). In addition to the agricultural industries there is a large open cut gold and copper mine located approximately 25km south of Orange called the Cadia-Ridgeway Mine (Newcrest Mining Limited, undated). The region also has strong cultural history with links to the Wiradjuri Aboriginal people who have inhabited the region prior to European settlement in the early 1820s (Orange City Council, undated). See table 3 for an overview of the region.

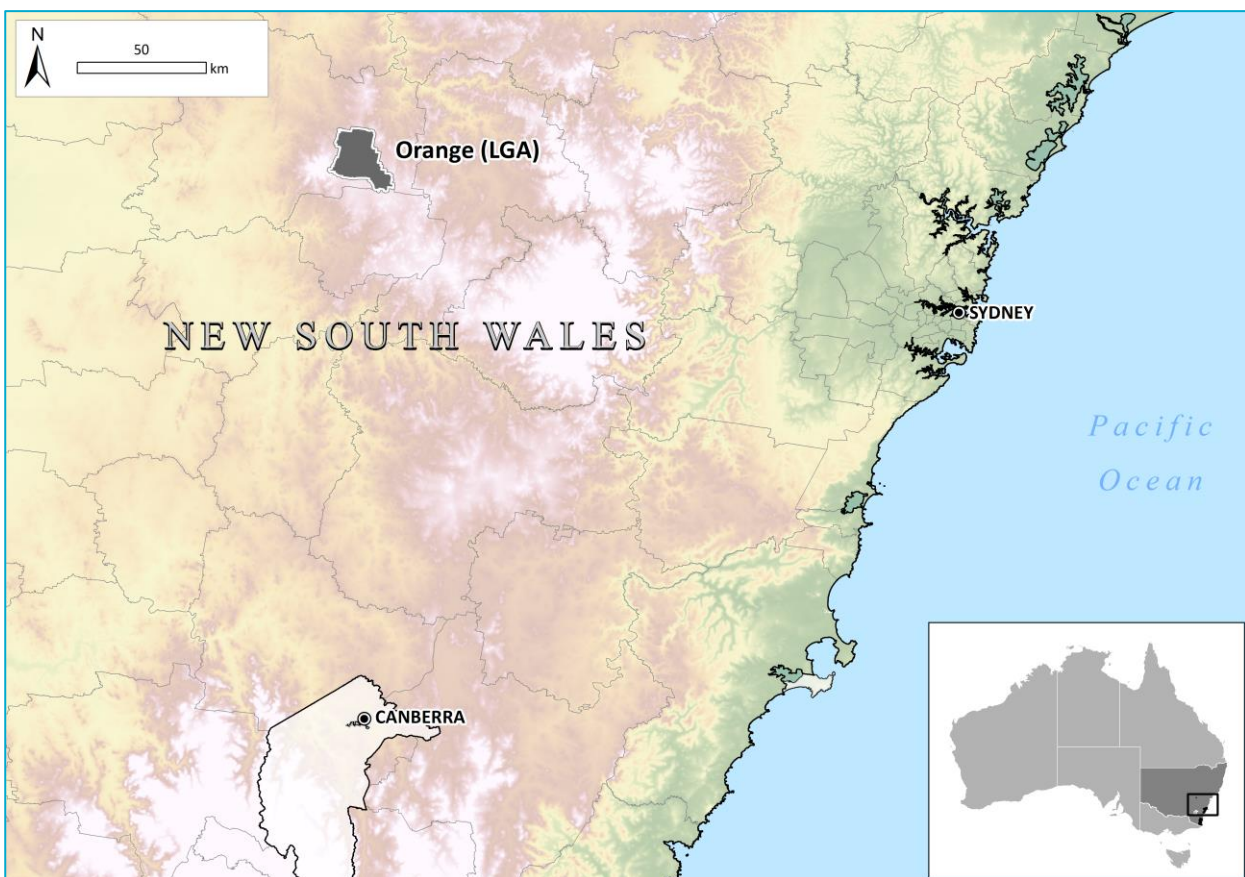


Figure 1: Orange Local Government Area (LGA), New South Wales

In 2011 Orange had an estimated population of 35,990 (Australian Bureau of Statistics, 2016). In terms of the age profile for Orange in comparison to the broader NSW region, Orange has a higher percentage of people aged between 0-19, 75-79 and 85 years and over (see Figure 2). The median age of people in Orange was 35 years (Australian Bureau of Statistics, 2016). Orange’s domestic water supply comes mainly from Suma Park Dam, but they are also able to release water from Spring Creek Reservoir to Suma Park Dam. Importantly, the city does not have a major river making it completely reliant on surface water run-off for water supply. In recognition of the pressures placed on its finite water resource, Orange City has demonstrated best practice water management by utilising a number of strategies to supplement its water supply. The two most significant of these include the stormwater harvesting to augment potable water supplies (arguably the first in Australia) and the Macquarie River Pipeline project. More recently Orange City Council have commissioned works to upgrade the Suma Park Dam wall to increase the storage capacity. This project was expected to be complete by April 2016.

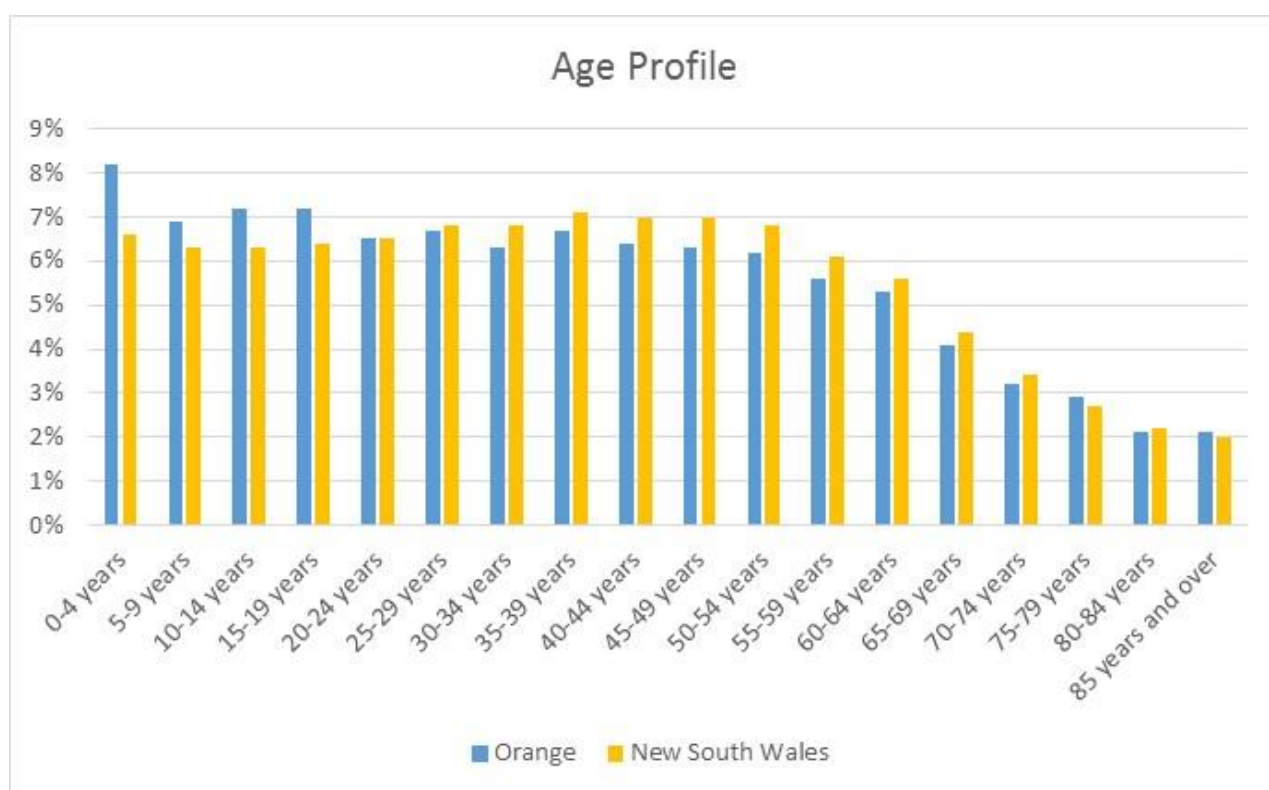


Figure 2: Orange Age Profile

Source: Australian Bureau of Statistics 2016

**Table 3: Overview of City of Orange**

Population (2013)	40, 869
Median Age	35.2
Area	284km <sup>2</sup>
Elevation	860m
Unemployment	4.5%
Towns	Orange, Canobolas (part), Clifton Grove (part), Emu Swamp (part), Guyong (part), Millthorpe (part), Spring Creek, and Springside (part)
Suburbs	March, Lucknow, Spring Hill, Huntley, Shadforth and Spring Terrace
Land use	Predominantly rural (90%). Some commercial and industrial land use and expanding residential areas. Rural land use mainly consists of forestry, crops, cattle and sheep grazing, mining orchards and viticulture.

Source: (Wikipedia, 2016; Orange City Council, undated)

### *Climate*

Orange has a mild temperate climate with rainfall distributed fairly evenly throughout the year (Australian Government, 2016). Compared with most population centres in Australia it has colder winters, especially in terms of its daytime maximum temperatures (Australian Government, 2016). Average maximum temperatures during the summer months range between 23.9-26°C (Australian Government, 2016). The average maximum temperatures during the summer months are lower than in most inland centres due to the region's elevation (Australian Government, 2016). In winter, the average minimum temperatures range between 0.7-1.5 with record minima down to -7.1°C (Australian Government, 2016). It is one of the only cities in Australia to receive regular snow, with moderate to occasionally heavy snowfalls occurring several times each winter. The number of hot days (exceeding 35°C) per year varies significantly across the Central West and Orana Region but the Central Tablelands cities of Orange and Bathurst experience fewer than 10 hot days per year (New South Wales Government, undated-c). Up to a 130 cold nights, where minimum temperatures fall below 2°C, are recorded per year in the Central Tablelands area (New South Wales Government, undated-c). The Central Tablelands typically experience on average between 800-1200mm of rainfall per year (New South Wales Government, undated-c). Table 4 provides an overview of the climate data for the region.



**Table 4 : Climate data for Orange Airport**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
<b>Record high °C (°F)</b>	37.2 (99.3)	37.5 (99.5)	33.0 (91.4)	29.8 (85.6)	22.0 (71.6)	18.5 (65.3)	17.8 (64)	20.4 (68.7)	25.6 (78.1)	30.7 (87.3)	35.6 (96.1)	35.0 (95)	37.5 (99.5)
<b>Average high °C (°F)</b>	26.0 (78.8)	25.2 (77.4)	22.4 (72.3)	18.3 (64.9)	13.9 (57)	10.4 (50.7)	9.3 (48.7)	10.7 (51.3)	13.7 (56.7)	17.3 (63.1)	20.5 (68.9)	23.9 (75)	17.6 (63.7)
<b>Average low °C (°F)</b>	12.2 (54)	12.4 (54.1)	9.7 (49.3)	6.2 (43.2)	3.5 (38.5)	1.5 (34.7)	0.7 (33.3)	1.4 (34.5)	3.3 (37.9)	5.8 (42.4)	7.9 (46.2)	10.1 (50.2)	6.2 (43.2)
<b>Record low °C (°F)</b>	1.7 (35.1)	2.4 (36.3)	-0.5 (31.1)	-3.5 (25.7)	-6.6 (20.1)	-6.5 (20.3)	-7.1 (19.2)	-5.8 (21.6)	-6.0 (21.2)	-3.0 (26.6)	-1.0 (30.2)	-1.0 (30.2)	-7.1 (19.2)
<b>Average precipitation mm (inches)</b>	84.0 (3.307)	82.4 (3.244)	53.7 (2.114)	52.6 (2.071)	62.5 (2.461)	65.3 (2.606)	88.2 (3.472)	93.6 (3.685)	79.0 (3.11)	78.2 (3.079)	76.0 (2.992)	78.8 (3.102)	897.9 (35.24)
<b>Average rainy days</b>	8.7	8.2	7.2	7.2	10.0	12.3	13.7	13.5	11.6	10.8	10.3	9.0	122.5
<b>Average relative humidity (%)</b>	44	49	51	55	63	70	70	65	61	56	53	45	57

Source: Australian Government 2016

### *Climate change projections for the Central West and Orana Region*

The climate change projections below are based on the summary report from the NSW Office of Environment and Heritage for the Central West and Orana Region which includes the major towns of Orange, Bathurst and Dubbo. Simulations were run from twelve climate models to provide detailed future climate information for the region. Simulations were run for near future (2030) and far future (2070) compared to baseline climate (1990-2009) (New South Wales Government, undated-c)

#### Temperature

Both maximum and minimum temperatures are projected to increase by 2030 and by 2070 (New South Wales Government, undated-c). The number of hot days is projected to increase and the number of cold nights is expected to decrease (New South Wales Government, undated-c).

#### Hot Days

The number of hot days (days per year above 35°C) is projected to increase by 2030 and 2070 (New South Wales Government, undated-c). The projected increases are expected to occur mainly in the spring and summer months.

### Cold Nights

The number of cold nights is expected to decrease by 2030 and 2070 (New South Wales Government, undated-c). The Central Tablelands area is expected to experience a decrease of 10-20 fewer cold nights by 2030 and 20-30 by 2070 (New South Wales Government, undated-c).

### Rainfall

Rainfall is projected to decrease in spring and increase in autumn across the Central West and Orana Region (New South Wales Government, undated-c).

### Fire Weather

Both the 'average' and 'severe' fire weather is projected to increase in summer, spring and winter across the Central West and Orana Region by 2030 and 2070 (New South Wales Government, undated-c).

### 3 Findings from the quantitative SNA

#### Accessing climate information

In total, the 31 participants interviewed in this study noted that they obtained climate change information from 212 nodes (including the participants themselves). Of these sources, 1 was an international entity, 4 were Australian Government, 32 NSW Government, 12 local government, 17 non-government organisations (NGOs), 27 community based organisations (CBOs), 33 mass media (tv, radio, newspaper), 22 mass communication channels (e.g. internet or mobile), 9 social media (e.g. twitter), 30 research organisations, 5 individuals, 1 was a political party and 19 other.

Figure 4 is a visualisation of the climate information access network. The nodes are coded for affiliation by colour, and for degree by size.

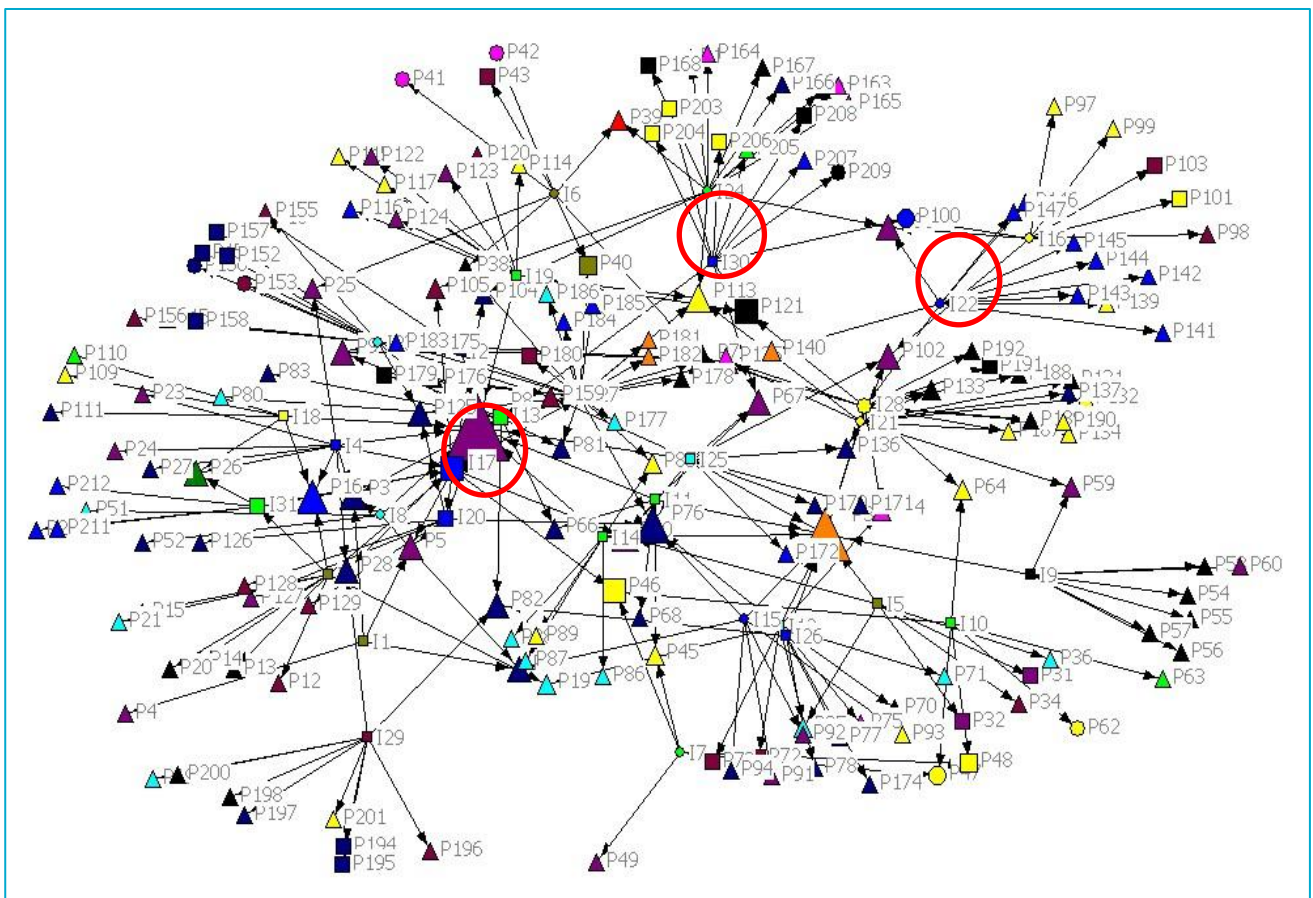















Figure 3: Orange network: Where do you access your climate information?

<b>Legend</b>		
<i>Node shape denotes gender:</i>		
<i>Female = Circle</i> ○	<i>Male = Square</i> □	<i>Not applicable = Triangle.</i> △
<i>Node size denotes popularity or the number of times the node was mentioned by other participants:</i>		
<i>Small node = less mentioned</i>	<i>Large node = most mentioned.</i>	
<i>Node colour denotes the type of organisation:</i>		
<i>International = red</i> 	<i>Federal Government = orange</i> 	<i>State Government = yellow</i> 
<i>Local Government = green</i> 	<i>NGO = light blue</i> 	<i>Community Based Organisation = blue</i> 
<i>Mass Media (tv, radio) = indigo</i> 	<i>Mass Communication Channels (internet, mobile sms) = violet</i> 	<i>Social Media = magenta</i> 
<i>Research Centre = black</i> 	<i>Individual = khaki</i> 	<i>Other = deep burgundy</i> 
<i>Political Party = forest green</i> 		

When analysing the cohesion of this network, the average degree of each node was 1.3, with an average distance or reach for each node of 1.5. This means that on average, each node had ties to 1.3 alternate nodes, and through these connections could reach up to a further 1.5 nodes. The network was highly fragmented with 212 components and 0.99 degrees of fragmentation; however, this network also had a diameter of 3 (diameter meaning that it took only three nodes to make a path through the network) with a degree of closure of 0.1 (for full cohesion measures please see Table 5).

**Table 5: Full Cohesion measures Orange network: Where do you access your climate information?**

Average Degree	1.316
Density	0.006
Components	212
Component Ratio	1
Fragmentation	0.990
Closure	0.106
Average Distance	1.513
Diameter	3

Further exploration of the data through Keyplayer demonstrated there were three key nodes in each scenario as outlined in Tables 6 and 8. The key nodes were #I17 – (CBO), #I22 – (State Government), and #I30 (State Government). This analysis indicates that although individuals may gather information from other sources such as personal weather stations, websites, reports, and other mass media devices, these three key nodes, #I17, I22 and I30, could reach approximately 35% of the network.

**Table 6: Keyplayer findings: Where do you access your climate information?**

I17	CBO
I22	State Government
I30	State Government
Percentage of nodes reached	34.928%

### *Disseminating climate information*

In total, the 31 participants interviewed in this study noted that they shared climate change information with 205 nodes (including the participants themselves). Of these, there were no international entities, 2 federal government, 51 state government, 31 local government, 28 non-government organisations (NGOs), 42 community based organisations (CBOs), 5 mass media (tv, radio, newspaper), 3 mass communication channels (e.g. internet or mobile), 1 social media (e.g. twitter), 18 research organisations, 6 individuals and 18 others.

Figure 4 is a visualisation of this climate information share network. The nodes are coded for affiliation by colour, and for degree by size.

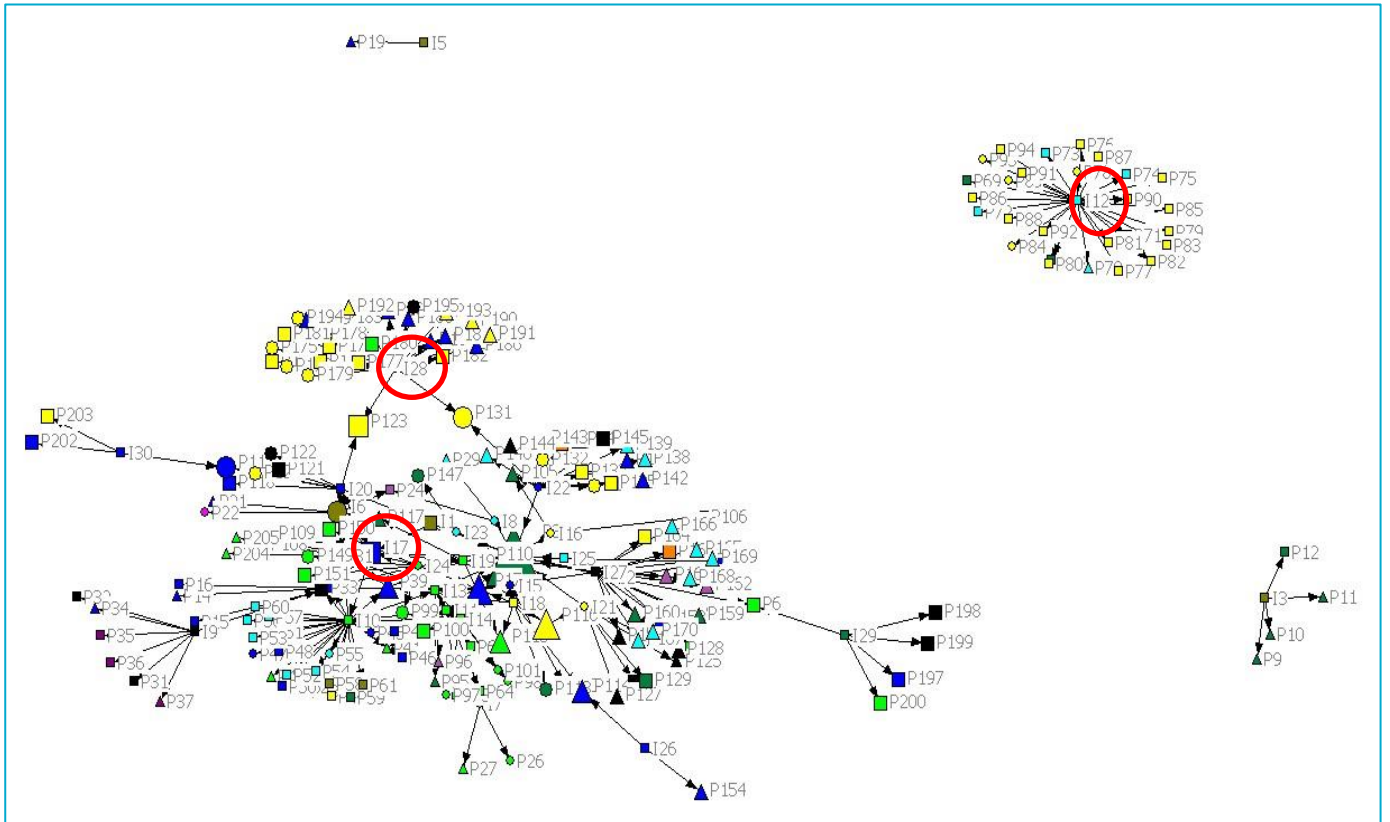















Figure 4: Orange network: Who do you share climate information with?

<b>Legend</b>		
Node shape denotes gender:		
Female = Circle ○	Male = Square □	Not applicable = Triangle. △
Node size denotes popularity or the number of times the node was mentioned by other participants:		
Small node = less mentioned	Large node = most mentioned.	
Node colour denotes the type of organisation:		
International = red 	Federal Government = orange 	State Government = yellow 
Local Government = green 	NGO = light blue 	Community Based Organisation = blue 
Mass Media (tv, radio) = indigo 	Mass Communication Channels (internet, mobile sms) = violet 	Social Media = magenta 
Research Centre = black 	Individual = kaki 	Other = deep burgundy 
Political Party = forest green 		

When analysing the cohesion of this network, the average degree of each node was 1.1, with an average distance or reach for each node of 2.6. This network was more fractious compared to the information access network (Figure 3) having 205 components with a fragmentation factor of 0.9. The main component of the network had a diameter of 8 (meaning it would take 8 steps to make a path through this network) with a degree of closure of 0.1 (for full cohesion measures please see Table 7). Within this network, there are instances where interviewees shared with nodes that were not connected to other parts of the network, creating small components within the network.

**Table 7: Full Cohesion measures Orange network: Who do you share climate information with?**

Average Degree	1.185
Density	0.006
Components	198
Fragmentation	0.978
Average Distance	2.664
Diameter	8

Keyplayer analysis demonstrated 3 key nodes were the most effective in disseminating climate information: #128 – (State Government), #112 – (NGO), and node #117 (CBO). These three key nodes reached approximately 50% of the share network. See table 8.

**Table 8: Keyplayer findings: Where do you share your climate information?**

I28	State Government
I12	NGO
I17	CBO
Percentage of nodes reached	49.010%

## 4 Observations from interviews

While the preceding section of this report identified the knowledge networks in Orange in relation to climate change adaptation, this section represents an analysis of the main themes or issues that emerged as a result of coding the data from the 31 interview transcripts. In particular, this section represents the views and experiences of the key participants in relation to their major concerns and information needs in the context of climate change adaptation. This section complements the quantitative results by adding further insight into how participants in the Orange community perceive and respond to climate change. The research team's interpretation of the implications of these themes along with the SNA is presented in section 5.

### 4.1 Global climate change and local adaptation

Participants were asked to comment on their perspectives of climate change and adaptation. Most of the 31 interviewees believed in climate change and felt that global temperature change was in fact accelerated by human activity. Not all however, were convinced about the science or the communication of risk more broadly given the range of vested interests and values that are mobilised around global warming and the burning of fossil fuels. As one local farmer commented:

*I'm very critical of the outrageous and ludicrous statements that some people make. The notoriety or to push a message for financial and political gain. It serves no purpose whatsoever bar to confuse the general community... The classic example is we make up a bit over one per cent of the carbon emissions of the world. But then someone says [...] on a per capita basis we're the highest in the world. Everyone is using language to push their own agenda... You can make statistics do anything you want. It's just disappointing that people who want to push their agenda they use the worst case scenario or the fact that suits their argument the best.*

Many interviewees that did support climate change, whether they understood and supported the science or not, felt that society needed to get on with the job and move forward from the scientific debate and respond to the problem in a timely manner. The ones that were unsure about the scientific evidence based their argument on philosophical grounds and broader principles of environmental sustainability. As one interviewee stated:

*Say the science comes along [...] in five years' time and goes, sorry guys, we were wrong. There actually is no climate change. It doesn't matter, because if it's made us more aware of our*



*surroundings and more aware of water use and living a bit more of a - well, for want of a better word - a sustainable life. I don't think it matters. I just think it should be just part of our daily lives, climate change.*

When participants were asked about climate change and adaptation most respondents commented on issues involving the 'mitigation' of global greenhouse gas emissions. For example, participants spoke about the need for political action to prevent further burning of fossil fuels and the release of carbon into the atmosphere. Interviewees seemed very conscious of the broader climate change debate and the challenges and opportunities of addressing global emissions through mitigation strategies. Many commented on the need for significant incentives and investment in renewable energy and sustainable infrastructure to reduce carbon emissions. The three most prominent examples included electric vehicles, solar PV (photovoltaic solar cells) and wind farms. Although many participants commented on the adoption of solar PV at the local scale as examples of adapting to climate change, there were concerns about both social inequity and the actual impact on global emissions. In terms of social inequity, there was a belief that many in the community could not afford to pay for the solar and therefore may be disadvantaged from accessing this particular technology and also potential increases in energy costs as a result of reduced demand from the grid. Given the extent of discussion on global emissions there were strong suggestions that the focus should be on mitigation and not adaptation although both were considered important components of addressing the climate change challenge. The interviewees that suggested the focus should be on mitigation, held strong views that the more effort and resources being spent on adaptation will lead to business as usual practices, as one retired community member commented:

*My interest in climate change is certainly not in adaptation, because the more time being put to adaptation, the less time and money you have to spend on mitigation. So it's a matter of balancing the two. To me, mitigation is number one and then you adapt where you have to, but the more you mitigate, the less you have to adapt really.*

Not all participants were active supporters of climate change and considered themselves to be somewhat sceptical. These participants indicated that they preferred to use the words 'climate variability' rather than 'climate change' given the belief that the climate has always been changing over thousands of years. This view was most common across the farming sector and within the local council, as one local government representative stated:

*My perspective is there's climate variation occurring. I'm not really an advocate to say that climate change is occurring. I suppose when you look historically over time, the world's climate has been changing over thousands of years. So I'm understanding more that yes, there is a need to adapt to*

*the differences that occur. Both naturally plants and animals adapt and we've got a role in adapting to climate as well. I suppose the key things - we've gone through - if I go by my career here at council we've gone to - when I first came here the weather patterns were very precise I suppose just seasonably. Then we went through the drought period of the 2000s...*

Interestingly, while many interviewees within the local government sector preferred to use the term variability as opposed to climate change, the Orange City Council has acknowledged that climate change poses a significant threat to their local environment and has identified this within their environmental sustainability action plan – a joint initiative between Orange, Dubbo and Bathurst Councils. Key areas of concern identified within the plan include: environment and public infrastructure, society, economy, and council governance. Many of Orange City Councils existing plans and policies support a move towards climate change management, in particular their policies relating to water and energy. Water resource management and water security were big concerns raised by interviewees, particularly local government representatives. Given that the region has limited water storage capability and has experienced past drought conditions, the council have been proactive in management of water resources. Perhaps the two most significant and somewhat novel projects include the Macquarie River Pipeline and the stormwater harvesting project where potable water supplies are augmented via these alternate water supply options under certain environmental conditions. According to one local government representative:

*Water is always a worry, so we've done [some] big drought proofing projects, including the Macquarie pipeline. We're pumping from the Macquarie River now in times of drought...*

And

*...one of our big adaptation projects is stormwater harvesting, we actually drink our stormwater. All of the city streets that wash in go into a collected system with our creeks and [...] then they go into our big dam and then we treat it properly.*

Local government representatives also commented on the council's commitment to reducing energy demand and emissions through adopting solar PV and implementing a program to replace all street lighting within the city with energy efficient bulbs. Although council perceived themselves as being somewhat innovators and leaders in the energy and water space, many interviewees outside of the council indicated that the local council were often not practicing what they preached in terms of environmental sustainability. As one local community member suggested:

*Yes, if you come down to a local scale there's things that councils can be doing. If you have a look at all the new subdivisions there's no footpaths, there's no cycle ways, there's no sign that, if Australia*

*is to change in the future, then we're going to ride more pushbikes or we're going to walk more to work or whatever, we - our current planning is still looking in the rear vision mirror and not looking forward.*

There were some suggestions that climate adaptation was occurring in other ways within the community outside of the solar and water debate, such as through the inclusion of more shade shelters in parks and at public swimming pools. At an individual scale, many interviewees had indicated that for a large proportion of the broader community adapting to climate change was challenging on a number of fronts. In particular, there was a sense that people don't really know what they can do and often feel disempowered in that whatever they do it's not going to have a big impact. As one senior academic suggested:

*I think the first is that people feel precisely that, they feel as though their actions won't change anything. It's just too big a problem. They listen too much to the arguments of the Coalition to say that unless the Chinese and the Indians get their shit together why should we bother? So there's that. I also think they just don't know what to do. How can I make a difference? If these companies continue to pollute, what can I do?*

Some suggested that people were often motivated by self-interest and indicated that people would take action only if there were obvious and justifiable socio-economic benefits from their actions. The adoption of solar PV technology was frequently cited by participants as an example of transparent economic benefit to individuals (i.e. reduced electricity bills) where people could be seen to be 'doing their bit' for the environment. There was a strong sense that people needed more information and guidance on what they can do at the individual scale despite having sound knowledge of the scientific debate and supporting the need for action.

In terms of farm scale adaptation, there were suggestions that some growers within the viticulture industry were factoring in climate change within their management regimes, as one local grower stated:

*Well over the wine industry it's certainly becoming a major fact of life, and grape growers are now changing varieties to try and match the heat or the change in climate, which I think is good. So I think people are now realising they've got to do something about it, which is basically pulling out of viticulture and going to somewhere cooler. The cool areas have become much better known and cool climate wines are generally a better quality and nicer to drink rather than the hot ones.*

Another grape grower had commented on the fact that they have changed their soil management, irrigation practices and canopy management. However, they indicated that this was not directly

related to climate change but perhaps more about efficiency and adopting best practices to improve the quality of the fruit. This type of approach was considered a 'win-win'. In general, farmers were typically seen as being slow to react to changes but nevertheless very capable to make adjustments on farm to deal with a number of socio-economic and environmental factors. Some believed that farmers have plenty of time to adapt to climate change due to the long term nature of the problem.

Participants were asked if they had observed any notable changes in the climate since living in the region. As seen in Table 2 above approximately two thirds of the participants have been living in the region between five and twenty years or twenty years plus. Some participants indicated that they had experienced significant change in the climate. The participants that shared this view were supporters of climate change science and believed that climate change was influenced by humankind. Others who had lived there for more than 40 years stated that they hadn't noticed any significant change in the climate. Some of these interviewees were the ones who preferred to use the term climate variability as opposed to climate change. According to one local grape grower:

*We are buffered quite well in the Orange region because we are coming from a cool base, as compared to the hot regions which are in a much more precarious position I think, knowing the Riverina well. They're running at 24 degrees, 24 and a half mean temperature, and of course they'll be well over 35 for that critical temperature. That's why a lot of our fruit from here, just [unclear] supplies, Casella Wines, they get our fruit for extra flavour, aromatic flavour.*

Some interviewees indicated that they hadn't lived there long enough to notice any significant changes, acknowledging the long term nature of climatic change. While not all interviewees indicated that they had observed any significant change in the local climate, most had observed an increase in climate variability, seasonal shifts in climate and an increase in extreme events. In addition, a large number commented on a decrease in snow events and snow falls. However, it was also noted that there was a significant snow event last year (2015) but prior to that nothing for about 15-20 years. Some participants observed less rain in winter and more in the summer months. When it did rain it was reported to be more 'torrential' (high intensity events). Overall less rainfall generally and a decrease in water availability were noted. Participants had observed more warm days and hotter temperatures all round. Interviewees commented on the impact of hotter days and an increased frequency of hotter days affecting the horticulture and viticulture industries. Interviewees also noted that there were fewer frosts with frost events ending in October (i.e. no summer frosts), which also impacts on the horticulture and viticulture industries.

There were also concerns about an increase in storm frequency and intensity with winter storms now being observed. References to an increase in pest species (e.g. fruit bat) were also mentioned.

## 4.2 Challenges, concerns and information needs

Participants were asked to comment on what they believed to be the most concerning and challenging factors associated with climate change and how they felt information about climate change should be delivered. For many interviewees, frustrations began at the point where information was first received. The enormous body of climate change information represented a challenge in itself and was described by one state government representative as confusing and difficult for many to interpret:

*I know at the moment everyone's a bit confused because there's so much research and so many findings. It's information overload almost. It's just an overwhelming amount of information that you're trying to get your head around.*

In addition to the volume of information available, concerns were also expressed by one local community member about being “constantly bombarded by opposing messages”. The lack of consensus in regards to the climate change debate meant that making an informed decision regarding their position on climate change was problematic for many participants. For example, another state government participant explained that:

*There are so many mixed messages. I think it's the different messages that are out there and the fact that it's quite difficult for people to understand what's going on. Who do you actually believe?*

Furthermore, embedded in many of these concerns related to conflicting climate information was a sense of distrust in the information source itself. Several participants were suspicious of hidden agendas and the use of climate information to further personal and/or organisational interests. As one local community member stated:

*Everyone is throwing their own opinion in and you don't know whether [they are] looking after themselves, looking after a job, looking after something somewhere. How can you believe what they're talking about? Their agenda items are all a bit of a worry. I mean that's the biggest problem and trying to sift out the rubbish against the real stuff is the biggest and hardest thing.*

These concerns were generally directed towards more formal information sources, in particular, political parties. Competitive politics and political “short-terminism” were perceived to be a considerable barrier to effective action on climate change issues. Considering the scale and nature of the problem, many participants felt that what was necessary was a co-ordinated approach towards climate change issues driven by strong political leadership across all scales of governance:

*We have such a short term of government [and] because we've got such a short term on how we look at the world we tend to [think], let's not worry about it. It's alright, it's not an issue, or someone else is going to solve that problem. But that's it, I think we need good leadership now with good government at all levels to tackle these big questions on how we're going to adjust to climate change. Possibly with our new change in government, hopefully we can see - who knows? But that's the problem government only lasts for three or four years.*

The links that many participants drew between receiving clear and consistent information, having trusted and credible information sources, strong and co-ordinated government leadership and their influence on community acceptance and engagement were perhaps most effectively summarised by one local government interviewee:

*This is one of the big issues and I think it should be looked at far more closely [...]. Wherever the community does not trust leaders they will not change and they do not trust politicians because they give misinformation about carbon tax and carbon emissions and emissions trading schemes, it's going to affect us and it's not going to affect us. So all of a sudden who do we trust, who do we trust, who do we trust? We hear that we must have a coal industry to support our energy needs [...] and we're told our electricity prices are not going to go up, but they do. Who do we trust? So we need to spend far more time looking at being able to get communities to trust policy makers and to trust their community leaders. Too many broken promises that break down in trust leads to an inability to adapt to change. To me, that aspect [...] is fundamental.*

As noted in the findings from theme one, the majority of interviewees held more global rather than local perspectives towards climate change and focused on mitigation efforts rather than adaptation. In like fashion, when asked to comment on their climate concerns, many participants were more attentive to the potential effects of climate change on a global scale and within a ‘big picture’ context rather than in their ‘own backyard’. These concerns regarding large scale issues ranged from species extinction:

*The potential for a catastrophe really [...], getting people to take the problem of extinction of species seriously. Once they're extinct it's over.*

To human induced oceanic warming and glacial melting:

*The fact that our oceans are acidifying [...] and heating and things like that. I find that deeply disturbing. How people can [...] impact on something as mammoth as the Pacific Ocean and change the way that it functions is deeply disturbing. The fact that we resulted in both the Polar Regions significantly shrinking and we [are] losing vast quantities of water into the ocean and the changes to El Nino and everything else that goes with it, is deeply disturbing.*

And also large scale social problems:

*Recognising that climate change will produce, probably, more refugees than we've ever seen before.*

And:

*We know that emissions continue to increase [...]. We know that temperatures, land and sea temperatures, are continuing to rise. We know that the ocean is becoming more polluted. We know that those wonderful things that we love about Australia in terms of the reef are really under threat and showing signs of stress. I worry that there will come a point where there will be this environmental chaos which will wreak economic and social chaos. I think that's almost inevitable. So that to me is a really scary scenario. I sort of think that my kids could be part of that. It probably won't happen in our lifetimes but my kids could be part of that and that could be a really horribly messy period of - you know you could see quite significant social upheaval. People clinging onto the short term economic argument. I mean that will go out of the window the second people don't have enough water to drink and food to eat.*

For these participants, large-scale social and economic concerns were reinforced by the longer term impacts on future generations. While adaptation measures were scarcely mentioned alongside these global and long-term concerns, many participants who spoke about mitigation held this future orientated perspective where links were drawn between our current social and economic path, future climate change predictions and what a lack of mitigation action might mean for their children, as one local community member explained:

*What concerns me is that if we continue on our present trajectory, we're going to end up having a planet which will be uninhabitable, as we know it and it's very, very concerning to me because I have four grandchildren who it's going to hit the world big time for them by the time if serious realistic action is not taken.*

For several participants, these concerns meant that any discussions about climate change action should also consider moral obligations and the legacy we leave for future generations. One participant was deeply concerned that 'we're preventing future generations from enjoying the same benefits that we have', while another added that spreading this message of inter-generational equity may be a way to elicit an emotional response in people and increase public motivation and engagement:

*[The] inter-generational equity theme, is not sold anywhere near enough. I think there's scope to tap into the emotions of people a lot more, and it has been done.*

It was also evident that participants had difficulty in connecting these broad, macro scale perspectives and concerns back to the individual and local scale. Whilst many participants were worried about potential global impacts and the 'big picture' of climate change, many also felt distant and struggled to make a personal connection, as one member of a local community based organisation felt that:

*It's probably at too high a level. It's sort of broad, too longer term, too sort of big a picture in terms of the sort of trends overall and the geographic area that we're talking about. So intellectually it's sort of quite interesting [...] but on what that means for me and my life I find it hard to make that connection.*

The consequence of not being able to make a personal connection between the bigger picture problem and local scale responses means that people are left either 'not really knowing quite what to do' or 'feeling very disempowered that whatever they do, it's not going to have a big impact'.

There were also suggestions that people in general are fairly time poor and often don't have the scope or financial capacity to plan for long term timeframes. It was suggested that timeframes need to be more tangible to improve local community buy-in. For example, according to one local member of a community based organisation:

*...I think if you're going to actually engage with people - well every - most people living their lives and a lot of people sort of living their life day to day they're struggling just to get by in terms of earning money to feed their kids and send their kids to school and blah, blah, blah. They just don't have the capacity. Scope, time and capacity to sort of think about what might happen in 20 years' time. But if we can sort of bring the timeframe - be a bit more specific about the timeframes as well I suppose. So it's all a bit vague. You hear sort of dates like 2020, 2030 or 2050 but if we could sort of say in the next five years, the next 10 years, the next 15 years, it becomes a little bit more immediate for people if it's in that sort of timeframe. I think most people are concerned about their kids and the future for their kids. If we can sort of couch it in the context of well this is the world that your kids are going to inherit if your children choose to stay and live here, this is how it may be different for them when they're having their children and/or grandchildren.*

Others were concerned about the lack of financial incentive to change. There was a strong belief that people are not motivated because there are no incentives for behavioural change:

*But I guess, socially, my biggest concern is that - I don't know. How do I say this? There's not enough incentive to change. Does that make sense? So for the community or for a community member, there's so much talk about climate change and how terrible it is and oh my goodness, there's tsunamis and fires and earthquakes and the whole climate is changing. But what's the government*



*doing - or not only the government, but the change makers and the advisors and all of the people that are working on this massive issue. You're telling us that there's all of this change, but what incentive are you giving to the individual or to the community to make a change?*

As identified in the preceding theme, while some interviewees believed that the climate is already changing and that there are more frequent and extreme weather events, others indicated that there have not been any observed changes other than what has always been experienced in the region. Many commented on the elevation and spatial location of Orange and felt that they were somewhat buffered from any impacts of climate change. As one climate sceptic noted:

*Well we're very lucky here. We never get to 40 degrees here. Our hot day for us is 35. So we're very lucky because Orange is about 800, 850 metres above sea level. We've got a very temperate climate. We get cold in winter but you can live with that. I don't think we've ever hit 40 degrees as long as I can remember. I'd have to have a look at the meteorological charts. Today we're only going to get 28. But Victoria they're going to be pushing 40. We're a bit cooler than Canberra. Canberra is a reasonable guideline to what we get. We never get to 40. I never remember 40 degrees.*

Interestingly, while many supported similar views to the above, it is important to note that not all interview participants believed this to be the case, particularly in the context of temperature and bushfire risk:

*I think we'll still have absolute scorchers. Two years ago we had a week of 40s or whatever or high 30s. No, we're not immune from it, and in a season like this with grass up to your waist. When it dries off I think the grass fires will come into play. It gets windy here too, which is a bitch on a hot day.*

In addition to the wide range of views and perceptions of climate change risks, many participants spoke about the demographic challenges in relation to community engagement and climate change. These challenges relate most strongly to the younger and older demographic. Some participants mentioned that legacy issues of scepticism and lack of motivation to engage are particularly prevalent among the older population especially older farmers. Older farmers who were unlikely to see an immediate benefit from adapting were unlikely to implement measures. One local community member perhaps best expressed these concerns:

*If you're a farmer and you're old and this is your superannuation package, why are you going to take the risk to adopt some new industry that you're not going to see? Say for example, I was going to plant trees on my farm and that's 40 years out. Well, I'm not going to get any benefit out of that, am I? So unless I've got a son that's going to take it over, why am I going to take that decision? So it can be some of that, this is the way we've always done it and we're not going to change. So the longer the industry's been around, the more set in their ways, is my observation. But that's a generalisation.*

There were equal challenges with the younger demographic who were seen as being preoccupied with other existing stresses in life but were also seen as being the most critical and potentially influential in the context of climate change given the long term nature of change and the implications on future generations as previously identified. Indeed, several interviewees expressed the importance of educating the young by making climate change an explicit focus in school curriculum. Some noted that elements of climate mitigation and sustainability more broadly were already part of the school curriculum but this perhaps needed to be unpacked and a deliberate focus on adaptation to be included. The importance of educating young children in terms of climate change was raised by many:

*I think the education in schools - if the schools were focused on climate change and those things then I think the message will get across. It's the education it comes back to. As I said with the schools, education and climate change - or effects on climate change - or even growing vegetables and other things like this...*

Several people mentioned the local impacts of climate change and what it potentially means for the local economy of Orange. In particular, water availability and the possibility of an increased number of hot days were key concerns. Water supply was recognised as being perhaps one of the most significant concerns for both the town and the industries around the town. As a means to manage water supply issues the local government have been proactive in trying to drought proof the region through both water supply and demand projects, including the Macquarie River pipeline and augmenting water supplies through stormwater harvesting and reuse. Although much of the economy is driven by mining, more emphasis was given to the things Orange is famous for and what its promotional identity is as a city, in particular, food and wine, and tourism. The major concerns related to a loss of lifestyle and culture. This concern was perhaps best expressed through one local member of a community based organisation:

*Well for the region that we're in firstly it's still largely an agricultural region...There's significant horticultural industries around Orange, in particular apples, cherries and also viticulture for wine making. Orange has a reputation for fine food and wine. So in terms of this region, the potential for climate change to significantly impact on our ability to grow food to feed ourselves but also to feed other parts of Australia and feed the world, that causes me a great deal of concern. There's probably two main reasons for that, is the potential for decreasing rain or changing rain events that change the pattern of rain that might not be conducive to the growing of crops that we've traditionally grown here and the increase in temperature given that we're a cold climate region and a lot of the crops that we grow here rely on frosts. If temperatures increase and we no longer have frosts or no longer have the extent of frosts that we've had in the past that could impact on the crops, on the food production that we have been able to grow in the past.*

And,

*Oh, if our rainfall dropped, because being an agricultural area, it would affect us a lot. Our average rainfall is usually a good average right across the board. Because our community's evolved around agriculture. That's one of our main incomes for people in the area. If that was to drop off, it affects everything really. It affects the town's sustainability to be able to still run as a town and have the services that people expect to have. I think, plus, if our temperatures dropped too low or go too high, we're using electricity or heating, one way or the other, to cool or warm, so it just seems to add - the cost of everything just goes up.*

There were also concerns about not acting swiftly and efficiently and the potential impact it may have on community liveability. As one state government interviewee stated:

*If they get away, these tipping point problems - can we go back? That's my concern. If you don't act quickly enough on this and seriously enough, we may not be able to return to this sort of life that we enjoy at the moment.*

Other interviewees expressed concern about health (including mental health, particularly within the farming community) and biosecurity issues related to climate change. Participants spoke about possible outbreaks of mosquito borne diseases such as Ross River Fever and Dengue Fever.

In terms of information needs, farmers and community members with close ties to the farming sector were interested mostly in information relating to temperature change and rainfall prediction. Moreover, participants stated that they would be interested in more information relating to intense storm events, in particular hail storms, as these were seen to be detrimental to many cropping activities. According to one state government representative who has done previous work in this area:

*The main feedback we've got is - the one message that came through again and again was that they want to see a focus on an adaptation strategy. They don't want the doom and gloom of everything is changing and we can't do anything about it sort of thing. They said that they wanted information on specific production systems with details of planning and also focusing on not only just long term change but variability from season to season. They were interested in what sort of energy options are out there, what changes they should be making, planning based on water resources and not only like assets. Also looking at ground cover, how that affects run-off and things like that. Extreme weather events, so not only that they're going to increase or decrease but what they actually mean and how you can prepare and respond. Also some people are concerned about their adaptive capacity change. Then not only NRM and agricultural or biosecurity but looking at the social and community. Also I know from our local government infrastructure is a big consideration as well. Then looking at proactive tools for planning. Then I suppose [the how], they're looking at forums, supporting fact sheets with local examples and case studies that we can work from.*

In addition, some interviewees spoke about the need for more information on weeds and pest species relevant to the region under climate change scenarios. Information on what individuals can do to make a difference was also a common response from interviewees. Given the plethora of climate change information available and the fact that interviewees expressed concern over the ability to digest all the information, there was a suggestion that information needs to be targeted so that it is relevant to the various sectors and industries within the community. It was suggested that information could be supplied in a simple factsheet style communication piece that contained sector specific information (e.g. horticulture, biodiversity, biosecurity, emergency management, pastures, livestock, and cropping). Importantly, these factsheets need to also contain information on what the relevant sectors or individuals can do to adapt to the predicted changes as opposed to just providing information on the various climate predictions over different time scales. It was also apparent that information dissemination needed to be well timed and done on an ongoing basis. For more information of the timing of community engagement see theme 4.4 - *Beyond climate change and the communication of risk*.

### 4.3 Planning, politics and governance

Participants were asked who should be responsible for policy development on climate change and adaptation. Overall, there were mixed responses. The majority of interviewees suggested that climate change was not currently a priority on the political agenda and as such there was a lack of leadership on the issue across all scales of governance. There were suggestions that the economy was a priority over environmental matters and as such there were strong beliefs that 'climate change initiatives needed to be linked to an economic advantage' to gain greater political support and momentum. Another common response was that the political system was too unorganised to enable an efficient response to climate change. Participants commented that the current political system was dysfunctional, unorganised and unable to manage longer term environmental problems such as climate change due to the nature of short term electoral cycles. As one interviewee stated:

*I think it's very disorganised, I mean I know the council's starting - I don't think there's enough done in an organised local government, state government, federal government level, because the whole issue has been screwed around, right, turned into a political debate, so you can't have a debate on climate change without someone accusing you of being political. So the waters have been terribly muddied.*

Many interviewees spoke about the importance of higher level government leadership and support to enable local governments to make bold decisions regarding climate change. There were also suggestions that local government was strategically placed to address climate adaptation given that impacts would be experienced at the local scale. Furthermore, local government was seen as the closest level of government to the community and therefore understood local community needs and aspirations. As one local academic noted:

*...local government plays a pivotal role. So much of the responses to climate change are at a community level and so council needs to see that - as a handful of councils have done is the councils have marvellous opportunities to really engage with local communities and start showing some leadership around climate change. So they could facilitate a great deal on water, on waste, on energy. I mean those three areas alone, if council took leadership positions on those and really lift that sort of [unclear] community solutions for energy generation, looked at how they could make - embrace new technologies, [sewer] water filtration and waste treatment, all of these things. That in itself could be a wonderful thing.*

And,

*...So local government should be a leader and be able to bring about planning changes that reflect adaptation in how suburbs are built, how transport is provided, how energy is provided, if it's not being dictated to you by state and federal government and more often than not that's not the case.*

Yet, several participants expressed frustration towards the lack of leadership shown by the local government despite the fact that many felt they were well placed to address the issue. In parallel with these issues, there were concerns about trust, in particular, the lack of trust towards politicians who were seen to break political promises time and time again. As one local government interviewee noted:

*I believe it's very fundamental to what we have because people don't trust a lot of people; local government, state and federal government, politicians, policy makers because they've seen too many policies and things put forward that are not believable or found are not true or whatever. I think a lot of this relates to renewable energy and people don't trust what they're hearing about the impacts or otherwise of wind farms, for example, et cetera.*

As such, there were suggestions that effort needed to focus on restoring trust within the political system and the need for 'good leaders' who are willing to look beyond the next election. Other interviewees suggested that climate change policy implementation needed to occur across all sectors and scales of governance including the local community. As one state government interviewee noted:

*...Of course local government has a role but that doesn't really answer the question. But I think everyone has a role to play and policy needs to influence everybody. Policy needs to be implemented*

*by everybody. I think all levels of government as well as community. I'd like to think that community can influence government to implement that policy...*

Given the lack of trust towards politicians and government more broadly, there were some suggestions that scientists should play a greater role in policy development. These views were shared across both supporters and climate sceptics who were strong believers that politics and 'big business' have distorted the facts and truths about climate change. Scientists were seen as 'trustworthy' and therefore should play a leading role:

*The scientists. Not the politicians. It should be based on sound consistent science. No political agendas. No whims. Make the hard decisions where necessary based on pure science. Well government makes the final call. But it should be based on scientific evidence. Politicians are only there to implement changes or carry the agenda. That's what they're elected for. But they're not scientists. They've got to take advice from the people who are best suited to make those directives and to a certain extent I think that's happened. It took a [lot]. The politicians trying to dress it up to suit their own agendas.*

While many interviewees argued for higher level government support and leadership, some mentioned the need for an overarching governing body to lead and facilitate policy development on climate change. The examples used were a structure similar to that of the Reserve Bank of Australia or a United Nations type approach. These participants argued that a governing body was essential to overcome the widely acknowledged political and institutional challenges and constraints that are mobilised around complex policy problems such as climate change.

#### 4.4 Beyond climate change and the communication of risk

While varying degrees of knowledge and support for climate change and the science that underpins modelled predictions were acknowledged by participants, it was apparent that not everyone in the community spoke the same language when it comes to climate change and adaptation. For example, there were suggestions that the word 'carbon' should not be used when attempting to engage the agricultural community. Instead, terms such as 'agricultural advice' or 'agricultural transition' were deemed to be more appropriate when talking about longer term risks such as climate change. While there was a strong preference by many to use the term climate variability over climate change:

*I know a lot of people don't like the word climate change; they're afraid of climate change. We're actually quite careful with how we promote our events. I know if you see something on climate change lots of people shy away from that but we're looking at climate variability, using adaptation*

*and looking at viability of farming, Natural Risk Management or whatever it might be. People are a bit more responsive to that.*

This was not a view supported by all interviewees as one local government participant expressed:

*I think climate variability is a weasel because I think it's a weasel word. I think whether you call it global warming. Whether you call it human impact on the climate system. Whether you talk about long term shifts, your climate patterns driven by human activity. I think you need to be really clear. Climate variability there has always been variation in the climate. That's why variability doesn't work.*

Despite the different opinions most interviewees understood the broader risks associated with changes in the climate but few had little understanding of the potential consequences of climate change on them personally or what action they could take to better prepare and respond.

Interestingly, the importance of language and the framing of climate change dominated much of the discussion despite the fact that there were no explicit questions asked to participants in relation to this topic. While most interviewees expressed concern over using certain words when talking about climate change and adaptation (e.g. risk management, prepare not adapt, weather not climate, variability not climate change), there were also suggestions that the timing of community engagement was critical to maximise the level of participation. According to one state government representative community engagement in the context of climate change should be timed with weather related events, such as periods of drought or sudden extreme events:

*Yeah, it's funny - one of the guys here was running some farm dam workshops. He said he has actually had to really rethink when he runs those workshops. Because when we got all of that really good rain earlier in the year, no one was coming. Because all of the dams were full, all this water, why would we be worried? Then they had some a bit later, when there was no rain, and they got heaps.*

There were similar sentiments from one local government representative who spoke about both the timing of community engagement and the framing of climate change adaptation:

*I think in about a month when it gets really hot, a time like that would be the time where yeah I reckon you'd get a lot of interest. An event saying this is what your city's doing to prepare, is the word, not adapt, to prepare for. We'd have things like the aquatic centre's hours are being extended, and old people are welcome in the library.*

As previously mentioned, there was an overwhelming sense that information needs to be personalised or tailored to increase the level of participation and discussion on the issue and to provide greater clarity as to what it means for different sectors, businesses or individuals and what can be done to manage risk and adapt to climate change. According to one local government

interviewee:

*We need to do more in getting this message out. You read on the - you're sitting in Orange and you're reading in the Sydney Morning Herald that the sea level's going to rise and Rose Bay's going to disappear, and you go well whatever, it would be nice to have a beach in Orange. But what the average person in Orange doesn't know, which we need to get out, which I'm hoping to do, is how will it affect Orange?... So I don't think we've really got that message out.*

Others suggested that the message should focus on the socio-economic consequences of not adapting to promote greater levels of awareness and participation within the community. This issue was perhaps best described by one member of a community based organisation:

*I think it needs to be personalised. I think it needs to be simplified. Because a lot of it is based on modelling and long term predictions people are very - scientists are very reticent to say this is what's going to happen. They'll say this is where the trends are going and this is what could happen if the modelling is right. Or this model indicates this and this model indicates that so we've probably got a variability between one to two degrees increase in heat in average temperatures over the next 20 years. But what does that actually mean for people? Does that mean that they're going to be spending an additional \$200 a year on electricity to run their air-conditioners? What does that mean in terms of the crops that we grow in this area? Does the grocery bill go up? Are certain sorts of businesses going to go out of, you know, no longer going to be able to operate because they won't be able to grow the products? They won't have the conditions to grow what they traditionally have grown. So I think it needs to be personalised and it needs to be simplified. It needs to be put into sort of context of what impact it might have on the ordinary person on the street. Just in sort of talking now I can sort of see something really like a one pager with half a dozen points about the impact of, you know, the local predictions about what's going to happen. Five dot points and then what that actually means in terms of industry or individuals. [Information is] often at sort of such a big picture level and often it doesn't connect back to what that means for me in living my life in 10 years' time, what that might mean for me and for my kids. Sorry it's probably - yeah, it's probably at too high a level. It's sort of broad, too long a term, too sort of big a picture in terms of the sort of trends overall and the geographic area that we're talking about. So intellectually it's sort of quite interesting, I find it really interesting, but on what that means for me and my life I find it hard to make that connection*

In parallel, there were also suggestions that the message needed to be framed around 'business risk' and 'insurance risk' to enhance the level of engagement from big businesses within the Orange community. As such, there were sentiments that big businesses were well placed to manage the impacts of climate change provided that the message was framed in relation to the possible 'economic impacts' or even 'economic opportunities'. It was suggested that 'money talks' across all sectors of the community:

*Of course people will engage when you find things that resonate with them and in Orange you've really got to focus on the immediate [benefits], like in all things where you have to customise your message. Your message would need to be about the economic opportunity of climate change, the opportunity to enhance our local environment and community but that's it.*



In terms of adaptation options, there was a sense that these needed to be simple, achievable and effective. As one member of a local community organisation stated:

*If people can do things simply and they get information, they will make some simple changes. But some of the changes they're asking people to make in terms of climate change are significant. If it's easy for them to do, yeah, they will adopt.*

However, one of the greatest challenges of 'selling adaptation' relates to issue of tangibility. It is far easier to make clear cause-effect links when implementing mitigation measures than implementing adaptation measures particularly when they are proactive rather than reactive responses. As such, many interviewees expressed the need to frame adaptation as being a response to a longer term problem that would have significant benefits for future generations.

## 5 Key insights and policy implications

In this study we find that participants *access* climate information from a variety of sources, including social media, mass media (e.g. Radio National and Sydney Morning Herald), Federal Government (e.g. BOM), State Government and research centres (e.g. CSIRO). While a variety of sources are used to access climate information, Keyplayer revealed that the three key nodes #I17, #I22 and #I30 could reach approximately 35% of the network. Interestingly, although two out of the three key nodes represented State Government (formal network) they had strong links to the local community through their formal and informal roles and responsibilities. Both the access and share networks were fragmented, however the share network was far more fragmented. The analysis of the share network revealed that although individuals may share to varying degrees both in person and via email lists, websites and social media, three nodes #I28, #I12 and #I17 could reach approximately 50% of the network. Interestingly, two of these three Keyplayers (#I28 and #I17) are active members of community-based organisations and are intensely embedded within their community, with one having a formal role in a state organisation (Local Land Services, LLS). The vulnerability of this network is that if the nodes #I28 and #I17 were removed (e.g. moved away, or ceased to perform their roles), this network may fragment even further.

The analysis of the share network also suggests that key industry groups (e.g. viticulture) tend to operate in isolates and share within their local geographic area and industry based interests groups. These can be seen in Figure 5. As such, they are currently not well connected to the broader community or core share network. The analysis also revealed that node #I17 is pivotal to both the access and share network, again highlighting the importance of embedded roles within community based organisations in the context of knowledge flow. Indeed, local professionals who are active in rallying community based support for environmental matters such as climate change can also act as champions within knowledge networks providing critical links between informal and formal network actors. Key to this case study is the flow of information through both formal and informal channels, though both networks highlight the importance of local community actors (informal) who are strong believers and active participants in sustainability agendas such as climate change. Equally, the analysis also highlighted the importance of indigenous knowledge in more formal roles providing critical links between the informal and formal parts of the network. Both community leaders, who are active in sustainability matters, along with key industry

professionals and state government departments (i.e. Local Land Services and Family and Community Services) provide important avenues for disseminating information about climate change. In sum, while the analysis of the quantitative SNA revealed the underlying importance of actors linked at the community scale, particularly informal actors with strong links to sustainability agendas and formal actors with roles intended to support both local and industry professionals (i.e. LLS), the relatively low percentage of reach throughout the community across both networks suggests that multiple modes and channels of communication are required to improve knowledge flow across the Orange community in the context of climate adaptation (e.g. social media, mass media, mass communications, state and local government). The fractious nature of both networks reiterate this point. Figure 5 depicts a simplified illustration of information flow in Orange.

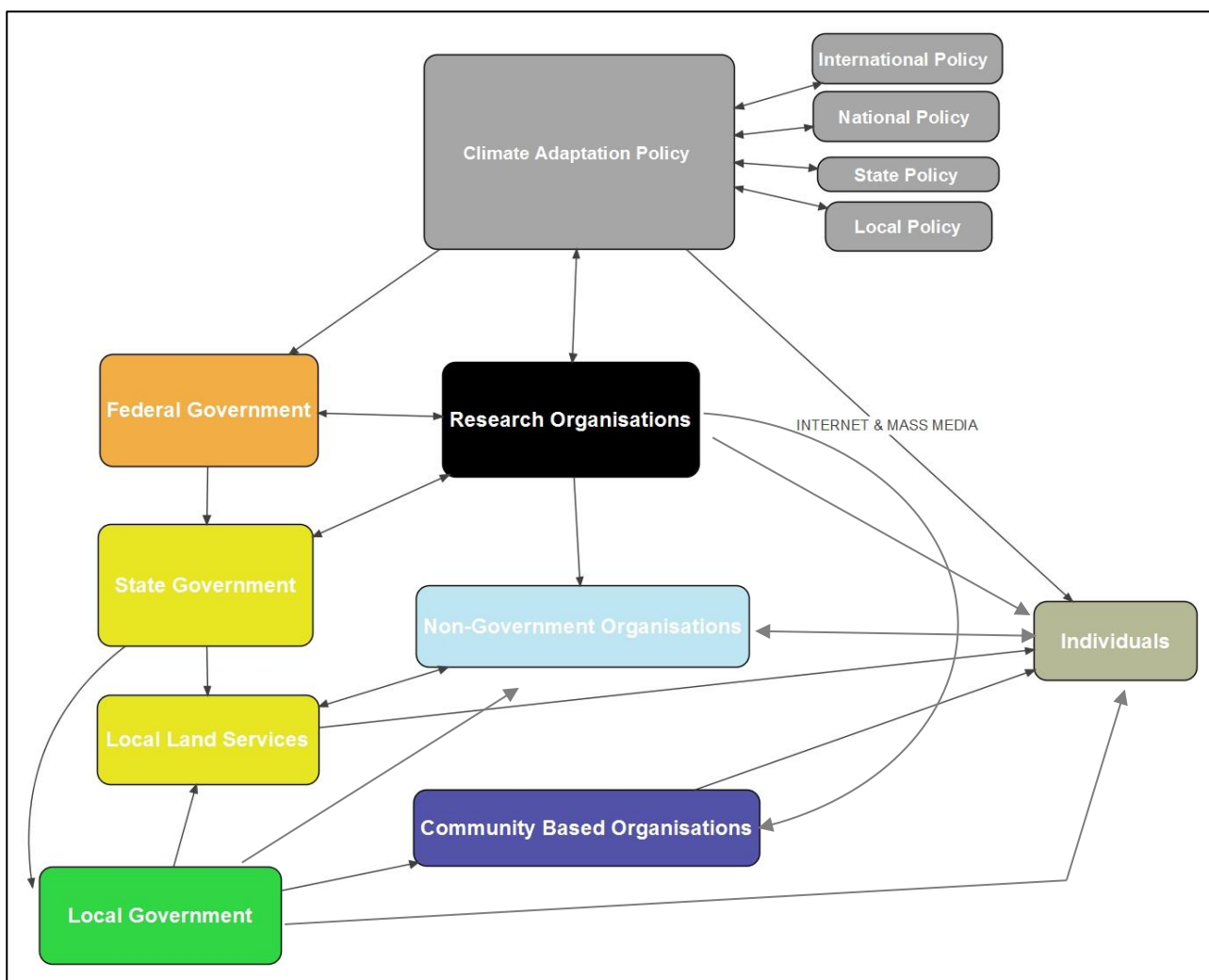


Figure 5: Simplified knowledge flow in Orange

In terms of the qualitative analysis, participants in Orange are broadly aware of climate change and active supporters of the need for different measures to combat not only the causes of climate change through mitigation, but also manage the inherent impacts of changing climate through adaptation measures. While some participants understood the term adaptation, most were familiar with mitigation and as such used examples of adaptation action that involved measures to reduce greenhouse gas emission or their carbon footprint. Some interviewees were sceptical however, and suggested that the 'jury is still out' and more needed to be done to balance the conflicting arguments. There was consensus, however, that information needed to be more targeted and less scientific in terms of the breadth of coverage. Many community stakeholders felt that there was too much information, often conflicting, which could lead to confusion and erosion of trust. Participants with young families were mostly concerned about the impacts of climate change on future generations. Again, the focus tended to be on mitigation rather than adaptation and therefore their arguments tended to be pitched at the global scale rather than local.

From a terminology perspective there were differing views about how to frame climate change. For some, particularly the farming sector, climate variability was the preferred means of language and communication. For others, it was more about managing business risk or insurance risk. Some participants are actively changing their business management practices to mitigate any potential impacts, current or future, as a result of a changing climate. These changed management practices however, are not always directly linked to climate change but nevertheless have significant social and economic benefits in the short to medium term. From an industry perspective, these changes create win-win outcomes. The need for such outcomes was a sentiment expressed by the majority of those interviewed. Many suggested that more information needed to target individuals within the community with a focus on how any proposed changes (e.g. lifestyle adjustments) could generate short term social and economic gains. In other words, more people would participate in adaptation or climate change initiatives more broadly, if there was not a burden but a socio-economic gain from undertaking such action. The adoption of solar panels was frequently used as an example on how individuals could make changes whilst generating a financial saving on their investment through a reduction in energy bills. It was equally apparent that measures needed to be realistic and easily achievable to ensure a large percentage of the community would participate. For many participants, particularly the ones who were passionate about sustainability, there was a sense of 'just tell us what we can do and we will do it'. As such, greater clarity is needed in terms of what individuals can do that will make a difference. Incremental adjustments

were more favourable over transformational changes to existing practices. Indeed, there is scholarly evidence to suggest that habitual practices can be adapted if the proposed changes result in incremental adjustments to existing practices rather than transformational change (Binder and Boltero 2012). The findings from Binder and Boltero (2012) are consistent with all stakeholder groups whether they be formal or informal. Adaptations need to be simple, achievable and effective. Framing adaptation as being a response to longer term risk that would have significant benefits for future generations was also perceived as being important in the communication of climate change risk. However, the issue around local action and global impact was something that was raised frequently during the interview process and something that needs to be addressed in any future communication with this community.

There was no direct correlation between an individual attitude to climate change and the perception of changes in the climate. For example, some participants had lived in Orange their entire lives but had not noticed any significant changes in the climate, while others had lived there for shorter periods and suggested that the climate has significantly changed. However, what was consistent was the perception that there was a decrease in cold snaps in the region and therefore snow events had decreased. For many interviewees, there was a sense that Orange, due to its location and elevation, was fairly well 'buffered' from any climatic extremes. This led to the belief that the region maintained a consistent climate and was at an advantage compared to many neighbouring regions. However, this was not a view held by all participants and many were concerned about changes in temperature, rainfall, pest species and extreme weather events in the region. The issue of a reliable water source was a concern for many, including the local government who have been active in drought proofing the city through a number of initiatives. Community education and awareness, particularly the younger demographic, was considered an important component of the communication challenge. Importantly, community engagement efforts and information dissemination needs to be well timed (e.g. around an extreme event) and information simplified, localised and personalised to ensure broader participation and uptake of adaptation policy. There is a unique opportunity for local government to fulfil this role more broadly given the scale of governance and their ability to understand community concerns and aspirations. However, this opportunity only exists if they are seen to be proactive and visible in the climate change debate. This level of commitment however may not proceed in the absence of higher level governmental support and leadership.

## 6 Conclusions and future research

Community engagement, particularly in the context of complex policy problems such as climate change, is an important yet a challenging task for planners and policy makers. It is particularly challenging because communities are not homogeneous and perceptions of risk and actual vulnerability, vary between and within communities (Cunningham et al. 2015). Recent research has emphasised the differences in people's perceptions of climate change adaptation and risk in Australia (Higginbotham et al., 2014, Boronyak and Jacobs in press). The authors also found that climate adaptation can be 'advanced through targeted place based information that make the most sense to those living locally (Higginbotham et al., 2014, p. 710). Understanding a particular community's needs and preferences is critical to informing the design of climate adaptation policy. By using social network analysis (SNA) and semi-structured interviews we explored the social structures and community perceptions around this particular topic. The findings from this research highlight the importance of local actors (both formal and informal) that not only promote awareness of sustainability issues, such as climate change, but are well connected within the community. The research also highlights the important role that Local Land Services play as boundary spanners that connect key sectors and segments of the community. While the networks are particularly fragmented and therefore vulnerable to changes (i.e. removal of key individuals or actors), there are opportunities to increase the density by bridging some of the communication and knowledge flow gaps within the community. This can be achieved by using a number of different communication strategies and mediums to promote greater awareness and linkages across the community.

The research also identified that framing adaptation is particularly important given that not everyone in the region communicates climate change in the same way. Given the dominance of community based actors in raising awareness of climate change and sustainability issues more broadly in informal settings, there is scope for formal channels to play a greater role in communicating climate change adaptation. This role could be fulfilled by local government given that they are closest level of government to the community but would need to show greater leadership and transparency in the context of climate adaptation (Deem et al. 2015). This may only ever fully transpire when state governments provide the necessary institutional support for local government to confidently act in times of environmental uncertainty. Activating more formal

channels would increase network density and vastly improve knowledge flow within the community. Further, additional connectivity between formal and informal nodes would assist in the transfer of knowledge. The relative influence of individuals versus specific roles in knowledge dissemination networks and the broader implications of fragmentation in the context of climate adaptation policy remain largely untested. This research reiterated the fragility of many communities wherein key players within the community held both formal and informal roles within the community, however if these individuals were to be removed, or were to leave these roles or indeed the area, there would be a gap in the ability to transmit climate adaptation between members of this community. Future research should focus on ways of scaling up SNA through more cost/time-effective ways to collect data. Further, additional research efforts into creating interventions wherein both members of formal and informal networks may come together to co-produce knowledge (e.g., citizen science, and town meetings in central locations such as shopping centres / schools) may be a productive way to accelerate the cohesion of these community networks. There may also be scope to investigate the relative influence or importance of roles versus individuals in knowledge networks by using a longitudinal case study approach. This is important because key actors mapped in local communities may change over time which may significantly influence and shape the knowledge flow. Some of these strategies will be explored through the development of a toolkit that is being developed for NSW Office of Environment and Heritage.

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