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Industrial Transformation in response to climate change | NSW VITICULTURE SECTOR

PREPARED FOR:
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About the authors

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AdaptNSW

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Climate change adaptation in NSW Viticulture sector

Introduction

The purpose of this case study is to investigate business innovation activity in response to impacts associated with a changing climate in the viticulture industry. Two case study sites in New South Wales were selected. The sites; Orange, in the Central West Tablelands and the Riverina region, in Western NSW, are in two different climatic zones. Climate changes expected in each of these regions include temperature changes (daily and night time minimum and maximum temperatures), changes in rainfall patterns and changes in the frequency and intensity of weather events such as heat waves, severe storms, rain events and bushfires.

The viticulture sector, as with the horticultural and wider agricultural sectors are highly experienced in dealing with climate variability and the impacts this has on the productivity of business operations. This case study examines the current range and application of adaptive measures that growers and winemakers are undertaking to manage for current climate variability, and understanding how these measures may be amplified, augmented or limited in the future under greater climate change.

The report highlights a range of adaptive response measures that are being implemented in the sector not only with climate, but also market and customer preference changes. There is diversity in the measures available and selected by each business is dependent on business size, market opportunity, market position, as well as the internal capacities of the business, such as the experience and knowledge of the business owners and key staff members.

There is also diversity in the characteristics and knowledge intensity within these geographically-based sectors or clusters. Cluster is a term in economic geography used to describe geographical concentrations of an industry sector that has developed sophisticated specialisations of knowledge, product and service offerings and labour markets (represented in specialist skills). In clusters the sum of knowledge stocks available to individual firms is amplified by the benefits of geographical concentration. This is evidenced in the degree and strength of communications and knowledge sharing across firms with the Cluster. These systems are unique in each region, with different characteristics of membership in knowledge networks, types and form of knowledge flowing through the network.

Methodology

The case study methodology includes a three-step research design. First, background information, literature and studies were reviewed to provide context to the case study. Climate change impacts and adaptation have been investigated in a number of previous studies in Australia (Hannah et al., 2013). Previous case study work has included the McLaren Vale region in South Australia (Fleming, Dowd, Gaillard, Park, & Howden, 2015; Galbreath, 2014, 2016a, 2016b; Galbreath, Charles, & Oczkowski, 2016), and the Margaret River region in Western Australia (Galbreath, 2014). There were no studies identified in recent literature that focused on New South Wales wine regions.

The second stage of the research design was interviews with various industry stakeholders within the viticulture sector in the two locations; Orange and the Riverina in NSW.

Stakeholders included; winegrowers, winemakers in businesses of various size in each region, local wine and viticulture associations, local economic development officers, viticulture education institutions, Regional Development Australia staff, business chambers of commerce, and other stakeholders identified through a snowballing interview process.

In Orange ten interviews were conducted. In the Riverina five interviews were conducted. The Orange interviews were conducted in person during fieldwork in April 2018. The Riverina interviews were conducted in person during fieldwork in December 2018.

The interviewees represent a diverse range of stakeholders from the viticulture sector in each location, and are similar in coverage to previous studies (Galbreath 2011, 2014). Interviews were structured around 9 open-ended questions, that guided discussions. Interviews lasted on average for an hour. The interview guide is shown in Appendix 1.

The viticulture industry in NSW

Australia is now one of the world’s largest wine producers, with rapid industry grow over the last 3-4 decades. Australia is the fifth largest wine producer in the world, and the largest in the Southern Hemisphere, with total vineyard production of around 135,000 hectares (Wine Australia 2019).

New South Wales makes up 30% of the Australian production, and includes four main wine regions: the Hunter, Orange, Cowra, and the Riverina. There are also a number of smaller and newly established wine regions, some immediately adjacent to the four main wine regions, including the Canberra district and the Shoalhaven region.

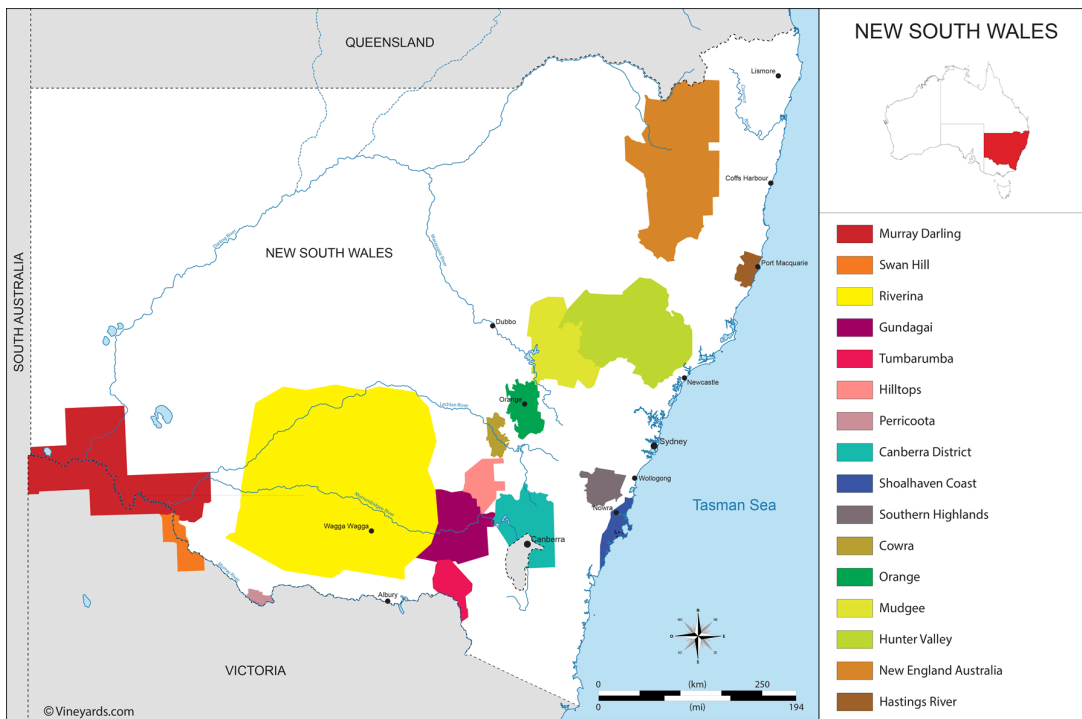


Figure 1: Map of NSW wine regions Source: Wine Australia

Summary industry data is provided in Table 1 for the two regions. In comparison, the two regions offer different climatic conditions, concentrations of grape varieties, grape quality and price points for wines, and maturity and composition of industry participants. The Riverina area is of a magnitude larger than any other area in NSW, making up over half of the total production in NSW of wine. The price points for Riverina wines are lower, but crush and total export volumes (if not in percentage terms) are much higher. The two regions have very similar varieties, with the same four varieties making up four of the top five in each region.

Table 1: Regional Characteristics

Characteristics	Orange			Riverina		
Plantings						
Total vineyard area (hectares)	1,127			18,765		
% of national vineyards	1%			14%		
% of NSW vineyards	3%			55%		
Crush						
Estimated tonnes crushed in 2018	4,042			333,682		
Average yield (tonnes/ha)	3.6			17.8		
Change in crush from 2017	-41%			-6%		
Exports						
Export volume (,000 litres)	705			21,908		
% crush exported	25%			9%		
Varietals						
Top 5 varieties, %, and \$ per tonne	Shiraz	28%	\$914	Chardonnay	23%	\$352
	Chardonnay	19%	\$1,088	Shiraz	19%	\$465
	Cabernet Sauvignon	15%	\$904	Cabernet Sauvignon	9%	\$480
	Merlot	12%	\$959	Semillon	8%	\$302
	Pinot Gris	7%	\$1,282	Pinot Gris	6%	\$490
Climate data						
1961-1990 Mean January temperature, annual rainfall	20.5 C	813mm		24.6 C	420mm	
1991-2017	21.9 C	736mm		25.8 C	401mm	
2017-18 season	23.5 C	500mm		28.0 C	317mm	

Source: Wine Australia Statistics

Analysis of previous studies

Global level studies

Climate change and the viticulture industry has been the subject of significant study in the past two decades at the global level. This has concentrated on the main wine producing regions of the world, Europe, the west coast of America, South America, and more recently China. Australia has been represented in this work, but as with much work on the physical impacts of climate change studies at a global level, it is not that informative for local level decision making. For example in Santillan et al's (2019) global assessment of the adaptation needs in grape producing regions under climate change, results for the Oceania region (including Australia and New Zealand) highlight the need for mandatory irrigation needs in wine regions in the southern areas of Australia, and that regions in Queensland and the Northern Territory (both sites with very small wine cultivation regions) may benefit from a reduction of precipitation in the growing season. Other studies have highlighted the potential for a reduction in wine grape production of up to 74% by 2050 due to climate change in Australia (Hannah et al 2013). In both cases, the findings from these studies highlight the significant impacts of climate change on the wine industry in Australia, but do not provide enough

information for wine regions and/ or individual wine businesses to properly understand their risks.

Studies using Australian cases

There have been a number of studies examining the physical impacts of climate change, and some analysis of adaptation responses from viticulturalists and wineries in Australia. Past studies have focused on the South Australian wine regions and the Margaret River region. None have specifically focused on NSW wine growing regions.

These studies reveal a number of important findings that are relevant to this case study. First, across all the studies there is a mismatch in growers understanding of the reality of climate change, and the experience of the impacts of that climate change. This mismatch has led many viticulturalists to question the veracity of climate change impact forecasts, or at least the severity of them. In some cases, for instance in the Margaret River region wine growers perceive that climate change could be beneficial for wine production into the future (Galbreath 2014).

Water availability and water security for agriculture is one of the primary physical impacts of climate change. Across the studies there was also a disconnect between the future availability of water and climate change. Water efficiency measures were identified as one of the main adaptation responses by wineries, but these measures are being implemented due to the increasing price of water rather than concerns about current or future water availability.

Climate change responses as innovations

In Galbreath (2014) responses to climate change were considered as firm innovations, in a similar way to the *Regional Innovation Systems theme* in the OEH Adaptive Communities Hub. Galbreath (2011, 2014) is one of a few identified sectoral studies to use such an innovation approach, and is therefore highly relevant to this work.

Innovation is broadly defined as knowledge converted into new products, processes or services and can take the form of new ideas, but also new combinations of existing activities (Edquist, 1997; Expósito-Langa, Molina-Morales, & Capó-Vicedo, 2011). Galbreath (2014) notes that innovations can encompass changes in current activities and not only new practices, products and processes. In Galbreath et al.'s work these innovations are segmented into either mitigation (carbon reduction) or adaptation (dealing with threats and opportunities from physical risks).

Further, Galbreath (2009, 2014, 2016) tested whether internal firm resources (absorptive capacity using a resource-based view of the firm) or geographical cluster/ network effects were more important in learning about and implementing climate change innovations in the wine industry in South and Western Australia. Galbreath (2016, 2014) found that there were significant differences between the two regions studied. In the South Australian wine cluster, firms with higher levels of absorptive capacity were engaging in more climate change innovations, but that these innovative activities were related to and stimulated by knowledge exchanges within the cluster. So in the case of South Australia, both internal and external capacity were relevant.

In the WA case, the external knowledge exchange activities were more important. Additional factors contributing to these differences include the maturity, extent and sophistication of the two clusters (with SA being more developed, and including key sector institutions and research organisations). The research highlighted that further studies are required to define the interaction between internal and external capabilities, within different clusters.

These findings have an important policy implication in informing where and how policy would intervene to enable increased business preparedness for climate change – at the individual firm level through increased absorptive capacity, or the business sector/ cluster level through increased support for knowledge networks, or a combination of both. A further complexity is policy responses also need to take into consideration pre-existing characteristics and compositions of the industry in each place.

The overall lack of investment in climate change responses in the viticulture sector can be attributed to the scale of investments required, and the uncertainty around returns and timelines of returns on these investments. This is a common theme in research examining business response to climate change. Investments in climate change innovations have many “unknown risks, lack clear-cut cost-benefits, require an intertemporal perspective that generally cuts against the grain of a business culture of short-term thinking, and must simultaneously account for environmental, managerial, regulatory, social, and technological issues” (Galbreath et al. 2016, pp226).

Whilst many of the specific dynamics of business innovation relating to climate change are unknown, one conclusion that can be drawn from this work (especially Galbreath et al.) is that “the better informed and knowledgeable a firm is about climate change, the more likely there will be the possibility of engaging in innovations to mitigate and adapt to it” (Galbreath et al., 2016).

Comparisons between firm and individual capacities for adaptation responses

Research by Fleming, Dowd et al (2015) highlight further limiting factors preventing firms from responding to climate change (other than lack of absorptive capacity, and/or weakness in cluster knowledge networks). These factors relate to farmers stress and health status. Fleming, Dowd et al (2015) explore farmers adaptive capacity levels and the impacts of stress and mental health on these levels.

This work highlights the different ways in which researchers can approach climate change responses in primary producer businesses – whereas in Galbreath’s work factors relating to response were derived at the firm level – firm’s internal capacities, and the meso-level activities of a cluster or sector. Fleming, Dowd et al (2015) look at individuals, as farmers – in this case grape growers, and their individual responses, perceptions and capacities. They suggest that grape growers coping with high levels of stress (physical, mental, financial) were unable to adequately address, or even consider climate change as a relevant issue for their activities, because they are focusing on coping with their current (stressful) situation. This was also with the acknowledgement that climate change in the current and near future would exacerbate these stressors further.

Again this highlights the complexity of understanding climate change responses in regions and across different sectors. The geographical unevenness of climate change impacts, sector composition, and the ability of firms and individuals to respond (differing levels of absorptive capacity at the firm level, knowledge network strength at the sector/ cluster level, and adaptive capacity at individual business owner and employee level) makes this a highly dynamic environment for policy. However, as the impacts of climate change on the industry will be so significant (up to 74% loss of production by 2050 (Hannah et al., 2013)) policy interventions are required.

Orange case study

Regional geography and context

The City of Orange is a large regional city in the Central West and Orana region of NSW. It is situated within the traditional lands of the Wiradjuri Nation (Orange City Council). The Orange region had a population of 59,000 people in 2017, with over 5,000 businesses in a land area of approximately 6,200km² (ABS, 2016). Agriculture has been the primary industry in the region with wheat the primary crop, followed by fruit growing. Wine grapes are a significant crop, alongside apples, pears and a variety of stone fruits. Apart from agriculture, Orange has a history of mining which has experienced a downturn in recent years.

Thematic analysis

Industry structure and business characteristics

The Orange wine region is relatively young, starting in the early 1990s (Harman et al., 2016), and coinciding with a time period with significant tax incentives for wine grape planting. Most of the wineries in the area can trace their history back to this time. Prior to this Orange's primary agricultural products were autumn/ winter apples and cherries. The wide spread development and use of cold storage technology (especially by supermarkets) changed the dynamics and price points associated with apple production, and led to many orchardists leaving the industry, and orchards being replaced with vines. Cold storage facilities in apple and cherry orchards were seen as an advantage for many wineries, offering temperature controlled storage.

The majority of the 40 wineries in the Orange region are classified as small wineries, and many are family owned. Stakeholders pointed out that family ownership allowed decision making favouring longer term investment (such that might not occur in a shareholder based model) but also tended to be conservative and risk averse. This has the effect of delaying innovations and changes in vineyard and winery management, production processes and other market development opportunities (such as exports, planting different varieties, cellar door activities).

"...Family companies dominate here, they only have to justify decisions to themselves..."

"...Business case not always needed, but need to have consensus within the family and the capacity for change..."

Generational change is identified as an opportunity for innovation. As a large proportion of the sector are family-owned wineries and many of these businesses are approaching 20-30 years of operation, generational change is a common feature. This was seen by some stakeholders as a period of change in relation to how wineries positioned themselves in regard to business sustainability and responses to climate change.

"Sometimes the older generation holds back on the innovations, but then the wine industry itself is slow to change, we will wait until there is no alternative"

Perceived climate change impacts

All stakeholders acknowledged the reality of climate change, although, as has been the case in other studies as part of the *Adaptive Communities Node* business research, and in the wider literature, there is disagreement, or reluctance to acknowledge projections for climate change impacts.

Many stakeholders cite they have noticed small changes in trends such as earlier harvests, higher temperatures and lower levels of rainfall. Some stakeholders talked of the “new normal” in terms of temperature and rainfall.

“Harvesting is changing, we have an earlier harvest, up to 2-3 weeks earlier, used to be March to May, now more likely February to April.”

“...people are talking about the “old normal” and the “new normal”, the “new normal” is more variable...”

“...Noticed that it has been warmer over the last 5 years, rain patterns have changed...”

“We have noticed with the Pinot Noir ripens 1-2 weeks earlier, we have also changed our pruning method in one of the top blocks [to accommodate for higher temperatures].”

“Vintage has not changed that much – Shiraz and Cabernet, 7-10 days earlier than before, usually around the last week of March”.

Climate change adaptation and responses

Climate change adaptations in the Orange region have primarily been through vineyard management; changes in treatment of canopy (less pruning to allow for leaf cover for sun protection, making trade-off with mould risk), and increased irrigation (where previously none).

“We have made changes to how we manage canopy – we leave more on to shield the grapes from the hot.”

“...the main impact of climate change for us is heat, you can’t counteract heat..”

“We never used to irrigate during the growing season, but now we have to...”

None of the stakeholders had made changes to the varieties in response to climate, although a number had been thinking about different varieties. This was not a specific response to climate change alone, but rather a combination of market demand and customer trend expectations and a desire to make high quality wines (and at a higher price point), as well as climate. The enormity of investment in changing varieties was highlighted by many stakeholders, as evidenced below.

“Vines are perennial, you plant them, and then you have to wait a minimum of three years, so it will be five years before you can think about making a return on your investment – the level of capital investment required to adapt is not available, and at the moment it is not seen as a priority.”

“...It is difficult introducing new varieties into the market, you don’t have the weight of numbers, no critical mass, it is a case of everyone waiting and seeing who will go first. You can look to the big companies for leadership, but I doubt it, they don’t want to risk it...”

“It is a big decision to change varieties, do you graft, you could have grapes in 2 years, if it works, if you plant again looking at 3-5 years, and then you have to make the wine – you would need to be certain and patient.”

“It is such a significant investment to change, almost like starting over again, maybe for new entrants, they might make different decisions...”

“...I don’t think so much about climate change, I think about the variety and the vineyard suitability, and terroir...”

As Orange is a relatively small and boutique wine region (in terms of total vineyard area and crush) and many wineries have diversified their business operations to encompass a wider range of activities including cellar doors, sales of other agricultural product (e.g. figs, olives), restaurants, cafes, bars and accommodation activities. The evolution of this type of business diversification strategy is evidenced in the below quote, and is the experience of many small wineries in the area.

“Our vineyard was planted in 1992/93, 15 acres, we initially sold grapes, then we started making wine and selling wholesale, then we had the cellar door open a few times a year, now we have a permanent cellar door”

Orange markets itself as a food and wine cluster and a destination for tourists in Central West NSW. This is supported by activities by the local Council and other organisations (including the annual Orange Food Week). All of these activities support the brand of Orange and assist in market development for wineries of their wine, but also their other associated food and accommodation service activities.

Supporting innovation

Stakeholders noted that the wine industry is generally very conservative and slow to change. Although two stakeholders spoke of the speed of adoption of screw cap sealing for wine bottles, with the majority of wineries switching to the new system in less than three years. In this case, an industry leader took the initial “first mover” risk, and then the rest of the industry followed. There was also a clear cost of not changing – cork taint, which was affecting up to 10-20% of vintages. Stakeholders said currently they didn’t have the same financial impetus for change, and the lack of leadership on responding to climate change at the political and sectoral level was acknowledged as a further barrier.

“...there are no institutional signals to change, no short term business incentive to take on climate change or sustainability issues”.

The high capital costs of replacing varieties and adding new infrastructure into the vineyard (such as irrigation) are not the only resources needed for change. Stakeholders identified there was a need for new knowledge resources in how to grow and make wine from these new and different varieties.

“Viticulture is dominated by 10 varieties – but there are over 5,000 available, there are varieties that are more suited to hot, dry climate, we just need to find them and learn how to make wine with them”

Two stakeholders mentioned the New Zealand wine industry sustainability program which includes incentives and marketing, with the overall approach of taking an industry wide perspective on the issue. This de-risks involvement for individual businesses while providing a way to share information and experiences. The McLaren Vale sustainability program was also mentioned. The significance of this program is in the influence and impact of knowledge sharing activities by industry leaders and pioneers in sustainability and biodynamic processes, as well as codifying these processes and sharing knowledge with the broader industry.

Technology is seen as an opportunity by stakeholders with opportunities available right through the value chain; from growing grapes, making wine, to building brands and selling directly to customers.

“I see a role for new technology in all stages of growing, from identifying disease, pest management and water management. On the production side I see technology advances in sharing and contracting winemaking facilitates”

“...I think all these digital platforms offer us a lot of opportunity to develop relationships with customers, we need to learn to be much more savvy in how we use them...”

The viticulture network in Orange was noted to be very collaborative, however issues of climate were not points of conversation. Stakeholders identified that whilst the network within Orange was strong, external connections to knowledge sources outside the region but within the sector were not as strong.

Riverina Case study

Regional geography and context

The Riverina Murray region is in the south-western corner of NSW, covering an area of approximately 152,700km² and a population of ~300,000 (NSW Government, 2013). The region has a number of major urban centres such as Albury, Griffith and Wagga Wagga surrounded by smaller communities and townships. The Riverina region also includes a variety of landscapes from mountains to arid areas in the west, however the majority of the region are the floodplains of the Murray, Darling, and Murrumbidgee rivers (NSW Government, 2013). This region is a significant agricultural producer; with irrigated agriculture in particular having an input of over \$900 million into the regional economy in 2006-2007 (ABS 2007).

The Griffith region has been inhabited by the Wiradjuri people for hundreds of years. Since the 1900s there has been a strong agricultural history with the town being designed by Sir Walter Burley Griffin in 1914 (Griffith Council, 2016) and the population growing to 27,000 in 2018 (ABS, 2018). Both the Murrumbidgee and Murray-Darling have sophisticated irrigation systems. Griffith has some of the oldest irrigation channels in the country with the Murrumbidgee Irrigation Scheme established by the NSW Government in 1906 (Griffith Council, 2016).

The Riverina is the largest wine producing region in Australia with 55% of all grapes in NSW coming from this region; famously one in every four glasses of wine produced in Australia comes from the Riverina. The Griffith region is renowned for its citrus and grape growing and famous for the botrytis and other fortified wines and port. In addition, Griffith and the surrounding areas are home to a range of wineries when it comes to scale; from small family owned and operated wineries to large international brands.



Figure 2: Vineyard rows in Griffith with uncles grass levels between the row



Figure 3: Vineyard rows in Griffith with untrained vines

Thematic analysis

Industry structure and business characteristics

The Riverina region contains a greater mix of wine businesses than in Orange. The sector ranges from some of the largest wine growers in the country, through to small, family owned boutique wineries. However the region is not supported by the same strong 'food and wine trail' marketing as in Orange.

The size of the industry in the Riverina means there is a greater disaggregation in the supply chain, with specific grape growers, wine makers, businesses that do both, and a range of support service businesses, such as equipment manufacturers, chemical companies, irrigation and land information services.

"We are intentionally small, we want to focus on quality..."

The Riverina region is a much larger wine producing region than Orange, these economies of scale change the characteristics of the sector. The sector is much more capital intensive than in Orange, with pruning and picking all mechanised. The large total vineyard area also creates different dynamics around key times of the year, such as picking, crushing and bottling; with capacity constraints much more of an issue in the Riverina.

Irrigation and water use

Irrigation and the deep interactions with the water market and water policy are additional dynamics to the viticulture industry in the region, one that is not similarly experienced in other wine regions. The Riverina area is part of the Murrumbidgee Irrigation Scheme. Historically, vineyards would have been located on land with high security water licences. The changes to the water system, including the creation of property rights in water allocations have significantly shifted how and when water is accessed, and the amount of resources and money that are directed at water resources.

There are now significant agricultural activities in the Riverina that are occurring in areas with general security water licences. The difference between general security and high security water is significant, as high security water costs more, but the holder of those water rights are more likely to receive their water allocation. Those with only general water are less likely to have access to water, particularly in drought; for example in December 2018, those in the Murrumbidgee irrigation channel that held general water security only received 7% of their allocation.

Agricultural activities, including recent perennial almond tree plantations, that operate on general water security, then have to bid into the water market for additional water. Whilst these activities may not necessarily affect the water availability of vineyards, it can shape how they make decisions about expansion (i.e. can I buy water at a viable price) or selling un-used water allocations (and then the decision becomes when to sell). The high cost of water makes these high-impact and strategic decisions for the businesses involved. Water trading is currently the norm, in particular for large growers. The market volatility is a problem for those without the capital to manage fluctuation in water price.

“There are massive capital costs involved in viticulture now, water prices are high, but you cannot grow anything without it”

“Water has become a big factor, it limits growth, half the value of the vineyard is in the buying of water, there is competition between commodities, it is just treated like an investment market, it really affects the whole community”

Drip irrigation is used to optimise water use in the majority of farms and on-farm storage such as dams or tanks are also used. However water is used only as needed as the water price is the same for off-site water as on-site water.

Solar panels on pump stations are implemented where possible; this is dependent on the layout of the vineyard rows as there is the need for the tractors to be able to turn around at the end of the row. Solar pumping offsets the cost of electric pumps where gravity fed irrigation isn't possible. Increased electricity prices has resulted in some negative adaptations related to water use. In some instances, farms that have had drip irrigation with pumps have returned to flood irrigation due to the cost of pumping water from water source to crop. This has significant negative impacts on water use in the region.

Perceived climate change impacts

Similar attitudes exist in the Riverina, as Orange, in terms of grape growers and wineries perceptions of climate change. Most acknowledge climate change as an issue, but comment they have had little experience of direct impacts as yet. Stakeholders comment that the region

has always been 'hotter' than other grape growing regions, and they are used to this. Again, many stakeholders talk of the challenge of dealing with climate variability (day to day, and year on year) in the agricultural sector, but don't specifically link this to climate change. There is minimal to no linkage between water and water availability and climate change impacts.

"Growing hasn't really changed, always no two years are the same..."

"...it is more the markets that are changing than impacts of climate change, changes in style, changes in what customers want, who the customers are..."

Through the course of the annual grape growing and wine making season, businesses need to make a number of operational decisions and weigh different trade-offs for volume and quality of wine output. These decisions are very sensitive to weather and climate. Many stakeholders discussed how they are highly attuned to respond weather signals in their activities. In summary there are four main interactions between time, yield and quality. It is likely as climate change impacts increase that tensions between these factors will increase, with negative results for viticulture businesses in terms of yield and quality:

- a smaller yield will ripen earlier;
- a warmer year ripens earlier;
- a larger yield will take longer to ripen;
- a cooler year will ripen later.

The interaction of fruit quality/ timing and weather are when capacity constraints emerge. For many growers and winemakers, picking, crushing and bottling are scheduled activities. Only the largest vineyards will own their own equipment, and even then will rely on contracted transport to move grapes around. The situation can arise, where fruit is ready to pick (to achieve right quality needed) but not scheduled to be picked for another week. This can have a significant impact on the price the grapes achieve for the grower, and the quality of the wine that can be produced from these grapes.

Desired alcohol content is also shaped by fruit ripening/ weather / time dynamics. Historically there has been trends towards higher alcohol percentages (e.g. shiraz up to 15% alcohol) however current trends in wine market are to lower alcohol content (especially demand from Chinese customers). As the alcohol content of the wine is largely due to the sugar content of the grape and levels of ripening, this shift in alcohol also contributes to a change in timings on farm.

Depending on the size of the farm the ability to modify timings for different activities may shift. e.g., for a small farm with one property, it may be possible to pick grapes that are ripening quickly, and then come back in a day, or in a few weeks when the next batch are ready. For larger operations, these are decisions that are made at a larger scale, for example the earlier you prune the earlier the bud breaks; the last vines you prune will be the last to ripen. However once picking starts at a large organisation it will continue until the process is complete.

In December, large vineyards will "precautionary spray" for mould every two weeks, even if there is no rainfall, because they cannot run the risk of rain on vines that have not been sprayed. Smaller vineyards may wait later and inspect their vines' growth, assess available water allocation and total desired yield, before taking the decision to spray or applying fertilizers.

Climate change adaptation and responses

Adaptations within the viticulture sector in the Riverina varied, and are dependent on both the scale of the operation (small, medium, large) and also the market (local, national, international) that businesses are serving. These adaptations are largely autonomous, and in response to managing specific weather risks, rather than necessarily representing climate change responses.

For larger wineries, owning and operating multiple growing sites was one response. This minimises the risk of a local extreme event, wiping out an entire crop, and therefore vintage.

“...In 2012, Griffith flooded and lost all its Shiraz. But the Clare Valley and Barossa didn’t flood, so we could get Shiraz supply from there....In 2018, South Australia had frost, but New South Wales could help through their variability of supply.”

For smaller businesses, response strategies are more on-farm and include diversification of business operations to include direct sales, cellar door, and other agricultural product sales.

Wineries also employ a number of changes in growing and harvesting techniques, and the timings of these. Some vineyards are opting to grow the canopy in a different arrangement in order to protect the grapes from heat.

“...first you grow for canopy, then grapes, we call it urban sprawl, we don’t train the vines up on wires...”

Some viticulturists select to use a clay based “sunscreen” on the grapes to protect them from the most severe heat waves. Some growers reported that they did not spray under the vines in mid-row, rather put mulch there to improve organic matter. Others saw the mid-row to be a potential threat as with increased grass levels, disease and/or mould spores may thrive and ultimately ruin the vine.

Some growers are starting to look at varieties that are more tolerant of heat, for example Vermentino and Fiano, but these growers admit to knowledge gaps in how these varieties perform as irrigated vines, and how to make the best wine from them.

“On the science and research side, what we have is really dated, from CSIRO and DPI comes from back 20-30 years...we want to know which varieties perform best, which tolerate drought, and what are their characteristics...what can we learn from others who are growing these varieties”

There was acknowledgement that younger and new entrant growers and wine makers were more innovative in their selection of varieties and making different types of wine. Although stakeholders commented that the barriers to entry in terms of the increased size a vineyard now needs to be for viability, was a significant limitation for new entrants, this combined with cost and availability of water licenses.

“Younger generations are more willing to give things a try”

“The average size of a farm has increased, you could get by on 10 – 15 hectares but now you have to have 70 -100 hectares to make things work.”

Supporting innovations

There was consensus among stakeholders that if new grape varieties were required to adapt to climate change impacts, then there were clear knowledge deficits in the sector; deficits about how new varieties performed in the Riverina, how they performed in an irrigated system, how to make wine from these new varieties and how to educate customers about these wines.

Stakeholders commented that the region had significant research programs dedicated to creating outputs for the area (e.g., CSIRO site previously in Griffith). However, much of this research funding is finished and therefore the research presence in the region is significantly diminished. This has created a knowledge gap regarding climate change impacts for the region moving forward.

“We have a real gap in knowledge about irrigated wine varieties – what is the annual cropping and yield of different varieties, we need to bring together all the data and interrogate it”

“Relationships with growers groups are important, everyone wants to share information because everyone is running on a tight budget”

“There is a high price for failure, so yes we are resistant to new varieties..”

Growers are also adopting new technology; this diffusion has been driven by younger farmers in the region. Some of this technology relates directly to operations on farm (e.g., smart irrigation, soil temperature etc), while other innovation relates to winery operations (e.g., improved centrifuge to treat solids, cross-flow filtration development). Although there has been a shift in technology, with more sensors, a greater reliance on water trading and water management, there is still a strong connection to the landscape and the vines.

“You can’t farm from the office”

Finance is identified as a barrier to innovation, with stakeholders commenting on the lack of appropriate low interest loans available for some on farm infrastructure (e.g., drip irrigation). This alone does not completely explain the financial barrier, there is also a lack of desire within wine businesses to obtain debt finance when margins for viticulture are not clear or without certain incentives. The opportunity to sell water on the temporary market, in some case provides additional finance for drip irrigation system or to offset energy costs.

Energy costs have been an issue over the past five years. As the energy prices have increased, some farmers moved away from drip irrigation back to flood. Other are using a diesel/ solar mix, however this is not widespread due to limitations in inverting solar energy into three phase power systems.

The Riverina region is generally known for ‘bulk’ wine grapes, although there are many efforts to change this. The Riverina’s distance from major population centres curtails the opportunity for food and wine tourism activities and therefore the demand for relevant cellar door, food and accommodation services in the region. In some areas there are yield restrictions set by wineries that growers must follow. For example in Griffith there is a 6 tonne per hectare restriction with an indicative price set for grapes (\$200/T). Both these factors could act as a disincentive to growers to wineries to innovate further sustainable practices on farm.

Networks

From the interviews it appears there are a number of local knowledge networks operating concurrently in the region, and not necessarily connected. Those in larger organisations tend to talk to those at similar sized organisations working in similar roles.

“...the community is not particularly close knit...”

“There is a difference between the large and the small producers, we are different businesses... I talk with the other small ones”

“Everyone just thinks we are bulk wines, we are not really taken seriously, not represented in national bodies...”

“Good networks across the industry, if not within Griffith”

For smaller organisations there tends to be no problem sharing information with other organisations, although some information related to competitive advantage may be held back. The significant barrier to knowledge sharing is time; having so many things to do in order to keep the business going often there is no time for networking.

Conclusions

The two regions analysed in this report highlight the level of climate change adaptation knowledge and responses within the NSW wine industry. In both cases adaptation knowledge is limited and so are adaptation activities. These results are broadly similar to the wine regions within Australia that have been studied in the past decade (Margaret River region in Western Australia and McLaren Vale region in South Australia).

In each of the cases, and in the previous literature, there is consensus within the industry that climate change is a reality. There is however in each case, a difficulty in matching this reality with individual wineries perceived experience of climate change impacts. Then for the business and/ or regional sector to have the insight to translate what the projections might mean for the local industry in terms of specific impacts, and identifying what are the range of adaption options available, and how to decide and implement adaptation strategies. In both the case studies there is little linkage of water, water availability and future climate impacts.

The viticulture sector, as with the horticultural and wider agricultural sectors are highly experienced in dealing with climate variability and how this impacts the productivity of business operations. In both the regions, stakeholders identified changes in their vineyard management practices related to recent climate variability, including hotter temperatures, declining rainfall (during growing seasons), and earlier harvests.

Previous literature, especially by Galbreath (2011, 2014) uses an innovation lens to examine climate change responses – either as mitigative (emission reduction) or adaptive (addressing physical impacts of climate change) innovations. In each of the regions there were examples of mitigative innovations, firms using renewable energy for on-site power needs as well as water management activities. Adaptive innovations were also evident in each case, but largely autonomous, and using techniques of vine management, such as growing and retaining wine canopy (for heat), irrigating, and changing timing of pruning, and harvesting. In both regions, more significant changes, such as changing varietals, have not occurred, although some stakeholders have considered them.

Barriers to more significant adaptations are financial, market, knowledge, and human capital limitations. All stakeholders spoke of the enormous cost that changing varietals would incur; significant capital investment, and the 5+ years to become income-positive from these investments, and how these are too great a financial risk for many small, and even large businesses in the sector.

Even if financial limitations could be overcome, the ability to re-establish a brand in the market place with new varietals is difficult, and places existing brand reputation at risk. Stakeholders in both regions highlighted their knowledge deficits about new varietals, that although these new varietals are more suited to a changing climate, that there was little experience and knowledge of growing and making wine from these varieties, and to change this would require significant learning activities (and costs).

Fleming, Dowd et al (2015) highlight an interesting comparison with other previous literature – in how different capacities for change are identified and developed. Most of the business and management literature look at capacities at the firm level – with absorptive capacity (the ability of the firm to take in and make use of new knowledge) as a key driver for innovation. Fleming, Dowd et al (2015) look at individuals (farmers) and their stocks of adaptive capacity. Their work highlights the impact of stress on an individual's adaptive capacity, concluding that

grape growers are so stressed by a range of other factors (including the ongoing financial viability of their operations) that they have no capacity to deal with climate change.

A further layer of analysis is provided by economic geographic and agglomeration effects, where specific positive, cumulative impacts accrue to a cluster or region when a concentration of a particular sector exists in a particular geography. The effects are known as spillovers, and can include specialists knowledge, service providers and networks, that give a specific region a competitive advantage.

From the two regions profiles in this report, there are clear limitation to individual firms absorptive capacity as it relates to climate change adaptation. In each of the regions, there is evidence of cluster spillover effects; knowledge networks and specialist service providers, but as the levels of knowledge on adaptation are so low, these clusters are also not an effective conduit for adaptation knowledge.

Forecasts of the impacts of climate change on the Australian viticulture industry are severe, production losses of up to 74% by 2050 (Hannah et al 2013), with minimal awareness of the issue, let alone ability to innovate in response, it is likely significant policy interventions will be required for the industry to successfully adapt.

References

- ABS. (2016), 2011.0 - Census of Population and Housing: Reflecting Australia - Stories from the Census, 2016, Vol. 2017.
- ABS, (2007), NSW Regional Statistics. Canberra: Commonwealth of Australia.
- ABS, (2018), Data by Region Griffith Region SA2 NSW. Canberra: Australian Bureau of Statistics.
- Edquist, C. (1997). *Systems of Innovation*. <https://doi.org/10.4324/9780203357620>
- Expósito-Langa, M., Molina-Morales, F. X., & Capó-Vicedo, J. (2011). New Product Development and Absorptive Capacity in Industrial Districts: A Multidimensional Approach. *Regional Studies*, 45(3), 319–331. <https://doi.org/10.1080/00343400903241535>
- Fleming, A., Dowd, A.-M., Gaillard, E., Park, S., & Howden, M. (2015). “Climate change is the least of my worries”: stress limitations on adaptive capacity. *Rural Society*, 24(1), 24–41. <https://doi.org/10.1080/10371656.2014.1001481>
- Galbreath, J. (2014). Climate Change Response: Evidence from the Margaret River Wine Region of Australia. *Business Strategy and the Environment*, 23(2), 89–104. <https://doi.org/10.1002/bse.1762>
- Galbreath, J. (2016a). Exploratory Study of Climate Change Innovations in Wine Regions in Australia. *Regional Studies*, 50(11), 1903–1918. <https://doi.org/10.1080/00343404.2015.1073849>
- Galbreath, J. (2016b). Exploratory Study of Climate Change Innovations in Wine Regions in Australia. *Regional Studies*, 50(11), 1903–1918. <https://doi.org/10.1080/00343404.2015.1073849>
- Galbreath, J., Charles, D., & Oczkowski, E. (2016). The Drivers of Climate Change Innovations: Evidence from the Australian Wine Industry. *Journal of Business Ethics*, 135(2), 217–231. <https://doi.org/10.1007/s10551-014-2461-8>
- Griffith, City of. 2016. 2916 Centenary of Griffith, Vol. 2019.
- Hannah, L., Roehrdanz, P. R., Ikegami, M., Shepard, A. V, Shaw, M. R., Tabor, G., ... Hijmans, R. J. (2013). Climate change, wine, and conservation. *Proceedings of the National Academy of Sciences of the United States of America*, 110(17), 6907–6912. <https://doi.org/10.1073/pnas.1210127110>
- Harman, B., Rylandce, K., Brown, P., Cunningham, R., Jacobs, B., & Measham, T. (2016). Engaging local communities in climate adaptation: a social network perspective from Orange Valley, New South Wales, Australia. Australia: CSIRO.
- New South Wales Government, (Office of Environment and Heritage) (2017), Western Enabling Regional Adaptation: Central West and Orana region report
- NSW Government, (Office of Environment and Heritage) (2013), Integrated Regional Vulnerability Assessment: Riverina Murray, Vol. 1: Regional vulnerabilities: 52.
- Orange City Council, (2019). Living in Orange, Vol. 2019. NSW: Orange City Council.

BUSINESS INNOVATION IN RESPONSE TO CLIMATE CHANGE: INFORMATION SHEET

This research project, *Business innovation in response to climate change* is being conducted by the Institute for Sustainable Futures at the University of Technology Sydney as part of the research program for the Adaptive Communities Node. The Node is part of The NSW Office of Environment and Heritage funded NSW Climate Change Adaptation Research Hub.

The purpose of the research is to investigate business innovative activity in response impacts associated with a changing climate. This includes temperature changes, changes in the frequency and intensity of weather events such as heat waves, severe storms and rain events and bushfires. The research investigating knowledge sources, and the enablers and barriers to innovative activity in these circumstances. Innovative activities can include: changes in business practices and operations, development of new products and services, development of new knowledge and information sources, and establishment of new partnerships and collaborations. These changes can be of both a short or long-term nature, and at the individual business level, or industry and sector level.

The research team is conducting a number of interviews with key stakeholders on this issue, and you have been identified as one of these stakeholders. Your contribution to this research will involve participating in an interview. The interview will take approximately 45 minutes and will be based on a set of interview questions that you can receive a few days before the interview.

The results from all the interviews will be analysed and included in a research report for this project. All material collected during the interview will be kept confidential and research data gathered from this project will be published in a form that does not identify you in any way. All research participants are acknowledged with thanks in the appendices of the research report. You are free to decline this acknowledgement and also withdraw your participation from this research project at any time without giving a reason.

If you have any concerns or questions about the research you can contact **Dr Samantha Sharpe** at the Institute for Sustainable Futures, UTS on **0425 333 759** or samantha.sharpe@uts.edu.au.

Research ethics for projects conducted at University of Technology Sydney The University of Technology Sydney, Human Research Ethics Committee, has given in principle approval to research studies undertaken by the Institute for Sustainable Futures. If you have any complaints or reservations about any aspect of your participation in this research you may contact the ISF Ethics Coordinator, Dr Keren Winterford (02 9514 4972) or the ISF Deputy Director, Professor Cynthia Mitchell (02 9514 4953). You may also contact the UTS Ethics Committee through the Research Ethics Officer (02 9514 9615). Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome

Appendix B

INDUSTRY TRANSFORMATION: VITICULTURE INTERVIEW QUESTIONS

About the business and business formation

1. Can you tell me about your business? How was the business established?

Innovation and market opportunity

2. What has changed in your business operation over the last 5-10 years compared to what you do now? Eg different markets, direct/ online sales/ value added and diversified revenue streams?
3. What are the plans for the next 5-10 years?
4. Where do you get new information, knowledge and inspiration from? External versus internal sources? How are these activities funded/ supported?

Climate impacts and sustainability

5. How does climate variability impact your business? How do you manage these impacts/ risks?
6. How did you make these decisions – information sources, advice etc.
7. How is sustainability defined/ embodied in your business model? Process to arrive at this?

Networks and their importance

8. How networked/ connected would you say is the business community – in the central west, and also beyond?
9. What networks are important to you and your business? What do they contribute to your work? What do you contribute to them?