

**Is climate change really a threat to business? Exploratory evidence from the wine industry**

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## **Is climate change really a threat to business? Exploratory evidence from the wine industry**

**ABSTRACT:** This study explores the climate change issue with a sample of wine firms in Australia. Using a qualitative, inductive approach, the results challenge the extent to which climate change is a salient stakeholder, while demonstrating that the phenomenon may, in fact, be beneficial. The study further finds that firms engage in actions that both mitigate and adapt, although response is not always specifically directed towards climate change. Implications of the findings are discussed and propositions put forth.

**Keywords:** Australia, climate change, greenhouse gases, interviews, strategy, qualitative, wine

Given intense public debate and government interest, are firms overly concerned about climate change?

This question is increasingly relevant to management research as climate change has become one of the most high profile social issues in the world (Enkvist & Vanthournout 2008). According to the strategic issues perspective (Mahon & Waddock 1992), a high profile social issue such as climate change can affect the ability of a firm to meet its objectives. Research does suggest that firm strategies are being shaped by the climate change issue; specifically, the dominant stream of literature has focused on the impact of and response to climate change through investigating carbon footprints, with emphasis on regulation, reductions in greenhouse gas (GHG) emissions, and market-based mechanisms such as carbon trading (Hoffman 2005; Jeswani, Wehrmeyer & Mulugetta 2008; Kolk & Levy 2001; Kolk & Pinske 2004, 2005, 2007; Martin & Rice 2010; Okereke 2007; Weinhofer & Hoffmann 2011). Yet current research is limited.

Current management research on climate change is limited for three reasons. First, most studies rely on high polluting (e.g. energy) or high profile (e.g. oil and gas) industries. Such industries are at the forefront of regulation on the climate change matter in many parts of the world, and as such GHG emissions are the exclusive focus of study. This biases findings to 'inside out' approaches to climate change rather than 'outside in' approaches that can offer deeper or more expansive insight (Winn & Kirchgeorg 2005; Winn, Kirchgeorg, Griffiths, Linnenlueke & Günther 2010). Second, Kolk and Pinske (2004) and Okereke (2007) find that one of the key challenges to addressing climate change is the regulatory challenge. However, do industries who are unregulated with respect to GHG emissions, or who are relatively low GHG emitters, view the climate change challenge differently? Little research has directly explored climate change challenges which leads to a third limitation of previous research:

stakeholder salience. To have saliency, a stakeholder must demonstrate power, legitimacy, urgency and, in the case of climate change, proximity (Haigh & Griffiths 2009; Mitchell, Agle & Wood 1997). To my knowledge, no research has studied climate change from a saliency perspective, which is necessary to test the tenets of stakeholder theory (Weber & Marley 2010). The present paper therefore seeks to advance the study of climate change by addressing previous research limitations through the use of a unique research sample (Bamberger & Pratt 2010); namely, a sample from the wine industry.

The research approach is based on a qualitative, inductive method. The advantage of using the inductive method is that it allows research findings to emerge from the frequent, dominant, or significant themes inherent in raw data, without the restraints imposed by structured methodologies or specified hypotheses. Thus, the approach allows for a more open picture of how firms perceive climate change, view its challenges, and respond to its potential demands. The findings illustrate an assessment of the extent to which 12 wine firms, in one of the world's top wine producing regions, perceive climate change as a concern and the extent to which they are responding to the matter.

### **LITERATURE REVIEW AND SENSITIZING CONCEPTS**

Clarkson (1995) proposes that stakeholders are groups or individuals who voluntarily or involuntarily face a risk because of a firm. Those stakeholders who voluntarily run a risk are those who invest in the firm, whatever the form of investment (e.g. material, human, financial). Alternatively, those who involuntarily run a risk are groups or individuals who are placed in a situation of vulnerability because of a firm's activities. The stakeholder definition of Clarkson (1995) suggests that one must construct a broader reflection relative to the interactions between a firm and society, bearing in mind both equity shareholders and other actors. This broader reflection has led to an examination of the natural environment as stakeholder.

Following Mitchell et al. (1997) and Driscoll and Starik (2004), Haigh and Griffiths (2009) posit that the natural environment is a primary stakeholder because of climate change. Their argument rests on two key premises, which includes the concept of stakeholder salience. For the first premise, firms *depend* on the natural environment. Virtually all business activity depends on the resource and economic inputs

the natural environment provides (Dyllick & Hockerts 2002). If the resources and inputs nature provides are disrupted, run out, or are otherwise put at risk through climate change, economic activity could be severely constrained. By virtue of this fact, the natural environment could be considered the “ultimate” stakeholder (Stead & Stead 2004). Similarly, Haigh and Griffiths (2009) suggest that, following Freeman’s (1984) definition of a stakeholder, the natural environment can affect, or can be affected by, business activity. For example, industrial disasters have affected the natural environment (Stead & Stead 2000). On the other hand, scholars argue that extreme weather events as a result of climate change have “the potential to significantly affect business” (Kolk & Pinske 2007: 371).

The second key premise that Haigh and Griffiths (2009) put forth is that climate change has *salience* as a stakeholder. Salience was posited by Mitchell et al. (1997) as a means to determine which stakeholders managers should give due attention. Following Mitchell et al. (1997) and Driscoll and Starik (2004), Haigh and Griffiths (2009) argue that climate change has salience because of *power* over business through impacts brought about by droughts, hurricanes, and other severe weather events. Climate change has *legitimacy*, as scientific evidence appears to demonstrate that human activity is leading to a warming planet (Australian Academy of Science 2010; IPCC 2007; National Academy of Sciences 2008). Climate change also demonstrates *urgency*, as climatic events (e.g. prolonged droughts) are already affecting business operations (Fenner 2009; Wahlquist 2009), and are predicted to accelerate in the future (Hätel & Pearman 2010).

Lastly, Haigh and Griffiths (2009) point out that recently a fourth dimension of stakeholder salience has been identified. *Proximity* (Driscoll & Starik 2004) is necessary as a salience dimension because some stakeholders in a firm’s network (and, in fact, the focal firm itself), or value chain, are closer than others to areas that are susceptible to extreme climatic events heightened by climate change. Proximate stakeholders are therefore spatially dependent—and they are vulnerable to disruption brought about by climate change. Hence, according to Haigh and Griffiths (2009), under the tenets of stakeholder salience (Driscoll & Starik 2004; Mitchell et al. 1997), managers have a strategic obligation to address climate change given its power, legitimacy, urgency, and proximity.

## RESEARCH GAP AND QUESTIONS

The study and science behind climate change is not complete. There remains disagreement amongst scientists and analysts (Farley 2008). For example, scientific controversy remains over the accuracy of the temperature record and the interpretations of the evidence of natural climate variations (The Royal Society 2010). Others have questioned the peer review process that the IPCC follows (Feder 1996; Shaw & Robinson 2004). Analysts with legitimate credentials in their own right have suggested that the IPCC's predictions of an anthropogenic global warming have been greatly exaggerated (Feder 1996). Such is the recent controversy that calls have been made for the IPCC's complete reorganization (Dayton 2010; Ridley 2010). This level of scrutiny has been exacerbated by the fact that the United States has withdrawn its funding of the IPCC, claiming the organization has evolved into espousing a political agenda rather than a scientific position. Regardless of any controversy, firms are left to interpret the findings of organizations such as the IPCC and make judgments of their own. Thus, the first research question addresses how the wine industry views climate change:

*Research Question 1: How does the wine industry view the climate change challenge?*

The second research question seeks to explore firm response to climate change. More specifically, a systematic review of business response to climate change reveals a few clear patterns. First, current management literature relates climate change response to reductions in GHG emissions (Hoffman 2005; Jeswani et al. 2008; Kolk & Levy 2001; Kolk & Pinske 2004, 2005, 2007; Martin & Rice 2010; Okereke 2007; Weinhofer & Hoffmann 2010). This level of study may in part be driven by the development of the Kyoto Protocol in the 1997, the recent rhetoric of Copenhagen and Cancun, and governmental efforts focused on carbon emissions (e.g. EU-ETS targets). Institutional pressure and regulation (both currently enacted and perceived future action by governments) are requiring firms to address GHG emissions. However, scholars acknowledge that the effects of climate change could be profound (Hätel & Pearman 2010). Efforts on the part of business therefore require not only means to reverse or mitigate rising temperatures, but to assert deliberate attention to preparing for and responding to climate change effects, or the so-called 'outside in' effect (Winn et al. 2011).

Considering the narrow scope of the study of response to climate change, the starting point is a focus on an industry that is considered minimal impact with respect to GHG emissions. According to Colman and Päster (2009), the wine industry's contribution to total global emissions of greenhouse gases is considered on the low-end of a spectrum of all industries. Studying the wine industry therefore might seem counter-intuitive from a GHG emissions perspective. However, the wine industry is especially vulnerable to the effects of climate change, no matter how minimal those effects are (Cahill & Field 2008; Keller 2010; Tate 2001). The argument therefore is made that studying the wine industry can reveal findings that will expand previous studies of high profile, high carbon emitting industries, and follows recent calls for unconventional research contexts and samples (Bamberger & Pratt 2010). Hence, the second research question focuses on the extent to which firms are addressing the matter with a narrow or broad range of actions:

*Research Question 2: How is the wine industry responding to climate change?*

## **METHOD**

### **Sample**

Margaret River, Western Australia, is the setting of this study. Fifteen companies were invited by email requesting their participation; hence, this study incorporated purposive sampling. Selection was based on companies in Margaret River who participated in a training and certification exercise for the EntWine program in 2009-2010, an environmental management program established for the wine industry by the Winemakers' Federation of Australia. In all, participants representing 12 companies accepted the invitation to engage in the study (Table 1). Participants held a variety of management positions, including executive, operational, and technical positions.

### **Data collection**

To assess the research questions and due to the exploratory nature of the study, the study relied on semi-structured, open-ended interviews. The interviews were recorded, transcribed verbatim, and then imported into QSR NVivo 8.0 (QSR NVivo, 2008) for data analysis. To supplement interview data, information about the companies' approach to climate change was collected from their websites, where available.

Although the data from websites were not extensively used, the information gave additional perspectives on key issues.

### **Data analysis**

Thematic analysis based on an interpretive approach was used for the analysis of the interview data (Boyatzis 1998; Braun & Clarke 2006). Thematic analysis involves encoding qualitative data in the search for patterns and themes that help explain social phenomena (Boyatzis 1998). The interpretive approach to thematic analysis attempts to theorize the significance of the themes and their broader meanings and implications (Patton 1990). Although the intent of this study was not strictly theory *building*, nonetheless an attempt is made to reflect implications of the findings to theoretical discourse, particularly with respect to stakeholder theories of the natural environment and climate change.

After a process of inductive coding (Bryman & Burgess 1994; Dey 1993), ‘emerging themes’ were counted as themes in this study when interview data addressed the guiding research questions. The validity of the final themes was tested throughout the study via constant reference to the interview data and the triangulation of the interview data with information derived from company websites. Each theme contained selected interview fragments, which were left intact as much as possible so as to minimise author intervention. Select interview data shown in this paper are presented in tables (Tables 2, 3, 4, 5) to reflect how participants told their stories. Figure one presents the final data structure and themes.

## **FINDINGS**

In this section, themes emerging from the data are discussed and viewpoints described as they relate to the guiding research questions.

*Theme 1.* Results suggest climate change is likely to be beneficial. Some firms did acknowledge that climate change is a societal concern in general and one that is important specifically to the wine industry in Australia (Table 2) and the three areas that received the most attention were increased temperatures, decreases in rainfall, and more extreme weather events. With respect to the wine industry, all three of these weather-related factors are potentially problematic. For example, because specific grape varieties require narrow ranges of temperature to achieve optimal quality, any increases beyond a given

threshold can reduce both quality and yield. On the other hand, increases in extreme heat days can destroy crop, resulting in reduced yields and income.

At first sight, a conclusion could be made that climate change is a matter of concern in this sample and it is, but with a caveat: while participants perceive climate change as an issue to pay attention to, they are much less concerned over the impact that climate change will actually have. Specifically, participants suggest that one effect of climate change, increased temperatures, is a positive for viticulture in the region, which is consistent with the literature (Jones, White, Cooper & Storchmann 2005; Schultz & Stoll 2010). However, at least one participant (Company H) was keen to point out that rising temperatures may or may not be beneficial: temperature depends on region, micro-climate, and grape variety (Table 2). This was followed up by Company F's observation regarding rising temperatures due to climate change, suggesting that hotter temperatures are actually better for the overall process of wine making (Table 2).

*Theme 2.* The second theme is that while there were many expressed challenges in adapting to climate change, an economic challenge emerged as dominant. For example, Company A noted that response to climate change is "driven by economics" and that they would not engage in response unless there was evidence of a profit (Table 3). Company I expressed a similar sentiment, in that responding to the challenge of climate change may be a means to actually lower input costs and therefore directly affect the bottom line. Beyond the directly noted economic challenges, other key challenges demonstrate an indirect economic link to climate change. One such prominent example includes market acceptance of new varieties. For example, Company J made the point that changing varieties is quite expensive, but the market might not accept a new variety (e.g. hotter climate varieties) from Margaret River—*planted for the sake of climate change adaptation*. The data therefore suggest that response to climate change is substantially influenced by an economic challenge, which offers some level of confirmation of previous findings (Okereke 2007).

*Theme 3.* What was clear from the analysis is that sample firms are engaging in (or are considering engagement in) a variety of actions that would be considered appropriate as response to climate change (Tables 4 and 5). Of interest, however, is that the actions are broader than reductions in GHG emissions

(Table 5). Some participants reported more extreme heat days that are causing sunburn on grapes. As a means to adapt, firms reported carrying a bit more leaf to protect grapes as well as using UV spray protectants. Canopy management techniques in the vineyard were cited most often and suggestions that flexibility, depending on how climatic conditions evolve, is the key adaptive strategy. Further, many participants reported actions designed to conserve on water use. For example, those that irrigate use drip irrigation, which minimizes water use. Along with drip irrigation, most companies reported that soil probes and sensors are used to detect when, and where, water is needed, another conservation strategy. Similarly, some companies use pinpoint spraying, through technology such as recirculating sprayers, so that water is not wasted during application. Lastly, some techniques have been put in place to ensure that annual rainfall is put to maximum use. For example, Company F has specific techniques to treat waste water, which has reduced their water use by 50 percent (Table 5).

### DISCUSSION

Our results to some extent challenge the notion that climate change, as a distinct phenomenon of the natural environment, is a salient stakeholder. First, in Australia, the government has not imposed GHG reduction targets on business and even if they do, primary industries, including the wine industry, will be exempt. As for climate change and physical force, with the exception of a few reports of extreme heat days depending on location in the appellation, none of the participants expressed concern over observed extreme or disruptive weather events. Hence, climate change does not appear to have *power* in the context of this study.

Second, Driscoll and Starik (2004) argue that climate change has gained legitimacy from the world's scientific community, where human carbon emissions have been linked to changes in the climate. However, to what extent does scientific endorsement of an issue mean that the issue has legitimacy in the eyes of actors outside of the academy? For example, while participants in the sample acknowledged climate change as a general societal issue, there was far less concern as to its real impact on the Margaret River wine region. This appears to be because of lack of scientific evidence demonstrating any significant climatic change effects in the region. Thus, firms in the sample do not appear to see climate change as

having any *significant* impact on their operations currently (or in the future), while some believe that an increase in CO<sub>2</sub> might actually benefit grape production. Hence, climate change, as a distinct phenomenon, appears to have little *legitimacy* in the Driscoll and Starik (2004) sense.

Third, climate change does not appear to have *urgency*. There is no doubt that climate change is on the minds of the firms interviewed, but there is little evidence suggesting that climate change is having any immediate impact on the industry. This was especially noted in the fact that several participants believe that the predicted slight increase in temperature for Margaret River over the coming decades will, in general, actually benefit the quality of wine in the region. Further, one participant (Company H) had harvest date records dating back 30 years but has found little variation in those dates over time. If climate change were occurring in a given location, variation in harvest dates would be clearly evident (Keller 2010).

Fourth, the Margaret River wine region is a region that is predicted to be impacted by future climate change; specifically, less rainfall and very moderate increases in temperature (Webb 2010). However, none of the participants expressed concern that the region will undergo dramatic effects—effects over the next several decades that will be extreme enough to marginalize wine production or limit access to natural resources. Hence, *proximity* does not appear to be a salient factor in this study. Taking into account the vast diversity of industries, institutions, and the heterogeneous distribution of climate change effects around the world suggests the following proposition:

*Proposition 1: Climate change has salience as a stakeholder when: (1) government mandated targets are in place to reduce GHG emissions in the given industry (power); (2) scientific evidence pinpoints specific regional or meso-level locations of operation in which climate change effects are resulting in significant variation from long-term trends (legitimacy); (3) evidence exists to demonstrate that climate change effects are persistent enough to disrupt normal business functioning (urgency); and (4) biophysical conditions in the regional or meso-location of operation(s) have been altered to the point that resource availability is interrupted or constrained (proximity).*

The results, contrary to most management studies in the stream, show that response to climate change is broader than reductions in GHG emissions. This is likely due to two factors. First, most studies examine ‘inside out’ response to climate change which focuses on carbon footprints (Winn et al. 2011).

Second, scholars argue that climate change is having, and is predicted to have, detrimental effects to business due to extreme weather events. In such cases, response to climate change requires entirely different strategies than reductions in GHG emissions. Winn et al. (2011) call this 'outside in' response. The most obvious industries under threat of this outside in effect are primary industries (e.g. agriculture). However, this is not necessarily the case. For example, manufacturing or services firms with major operations along coastlines or in locations more vulnerable to climate change effects could be threatened as well (Haigh & Griffiths 2009; Winn et al. 2011). An implication of the present study suggests that climate change response is not a one size fits all approach. This suggests the following proposition:

*Proposition 2: There are no reasons to expect that response to climate change will be limited to actions designed to reduce GHG emissions when industry, location (regional and/or micro location), and weather variables are factored in.*

Some scholars argue that attempts by firms to address matters concerning the natural environment, such as climate change, have an economic basis rather than a genuine ecological concern (Banerjee 2000). Our findings suggest that economic concerns and response to climate change are indeed interdependent. Reality suggests that committing resources to climate change or any other social issue is a cost to business. For example, any tax associated with carbon is sure to raise the costs of private business, having a direct affect on revenues, profits, and ultimately economic growth (at least in the short-term) (Rowlands 1995). There are several examples of firms in the sample describing actions related to climate change that were put in place for economic reasons, or were avoided because the economic benefits were not clearly identifiable. This seemed to be the case for both mitigative and adaptive actions. However, it is acknowledged that the wine industry can perhaps be more selective with respect to the level of response to climate change. This in part is due to the fact that at the time of this study the Australian government has not imposed mandatory carbon emission reductions. Hence:

*Proposition 3: In the absence of regulation of carbon emissions, response to climate change will be demonstrated when economic benefits are clearly identified.*

Lastly, neoclassical economic theory views managers as rational decision-makers and profit maximizers. Morality, ethics, and values tend to be neutralized in economic theories of firms (Kantarelis

2010); however, behavioural theory and the social responsibility literature argues that firms have a moral imperative, not only in terms the economic decisions they make, but also in how they account for the broader environmental and social consequences of their economic activity (Bosse, Phillips & Harrison 2009; Cyert & March 1963; Swanson 1999). Hence, the fact cannot be ignored that firms may take a proactive response towards climate change, in the absence of scientific evidence or regulatory mandate, given personally held values, a moral stance, or a socio-emotional response towards the natural environment.

In this study, although there is not clear evidence that firms in the sample specifically view treatment of the natural environment as a ‘moral’ imperative, they do demonstrate a stewardship approach (Sharma & Henriques 2005). In fact, one company (Company D) is certified biodynamic and states that “[we strive] to keep nature in balance, and to work with nature”. However, the stewardship philosophy appears to be directed more towards a general approach to the natural environment rather than specifically towards climate change, although some actions suggest this is not entirely the case. Hence, contrary to Haigh and Griffiths (2009: 347), climate change, as a standalone aspect of the natural environment, does not appear to be an “easily” identifiable stakeholder in this study. This leads to the last proposition:

*Proposition 4: Firms in the wine industry who demonstrate proactive stewardship towards the natural environment will be both directly and indirectly engaging in actions related to climate change.*

## CONCLUSION

The current management literature on climate change focuses nearly exclusively on GHG reductions. Given the current regulatory environment and institutional pressure to manage the carbon footprint, that firms would attempt to reduce their GHG emissions is not surprising. Yet, a fundamental question arises as to the extent to which climate change can be considered a *primary* stakeholder (Haigh & Griffiths 2009). Based on the findings of the present study, a major theoretical contribution of this research challenges the extent to which climate change has power, legitimacy, urgency, or proximity. In the Margaret River wine region of Western Australia, climate change does not appear to be altering micro-climates to the extent that wine production will not be able to be viable for decades to come. There is little

indication that resources are being constrained or disrupted due to climate change. In fact, firms in this study indicate that an increase in temperature (within limits) and CO<sub>2</sub> (within limits) will actually *benefit* the region in terms of quality. Further, there are no mandatory reduction targets for GHG emissions in primary industries in Australia, so firms in the wine industry are not being coerced into managing their carbon footprints. Hence, a conclusion that climate change is a legitimate stakeholder in the context of this study cannot be made. But, this conclusion comes with a condition.

Climate change effects are heterogeneously distributed around the world (Hätel & Pearman 2010; Winn et al. 2011). Further, regulatory mandates targeting climate change are also heterogeneously distributed around the world (Ferrey 2010; Olson 2010). An implication of these facets suggests that depending on region or country—and the physical location within regions and countries—climate change could be a legitimate stakeholder in the Haigh and Griffiths (2009) sense but researchers need to be much more precise than their arguments. The theoretical framework proposed in this paper (see Proposition 1) addresses this matter. For researchers, an implication is that precision is required in climate change studies. Climate change is highly context specific, including location and industry. A continuation of studies that only examine reductions in GHG emissions, or that rely on high carbon emitting industries, while important, will do little to advance understanding of how and why firms focus attention on climate change and what actions are taken in response. Further, climate change as a field of study is somewhat unique in that effects can take decades to unfold. In spite of research difficulties, longitudinal studies are therefore required, with perhaps unconventional samples (Bamberger & Pratt 2010).

Lastly, there is an economic imperative to climate change. As with any strategic use of resources, the data in this study suggest that cost-benefit analysis is a necessary part of determining whether or not to respond to climate change. This may be particularly heightened by the fact that firms in the sample are small, and therefore the availability of slack resources to broadly and deeply respond to climate change limited. At the same time, this study has practical implications for large firms, particularly MNCs. Because MNCs operate in multiple countries, under various regulatory regimes, and under varied climatic conditions, response to climate change could potentially look quite different depending on where

operations are in the world. There is evidence to suggest that large firms are responding to climate change more broadly than current results demonstrate (Galbreath 2011), and that location and greater availability of resources are the likely drivers. Hence, MNCs require strong capabilities in collecting, processing, and communicating climate-related information, while resource and coordination flexibility is necessary to adapt to climate change impacts given far-flung operating environments that require specialized—if not unique—response depending on location.

This research is not without limitation. First, while 12 firms is a relatively small sample, saturation point was reached and that further sampling in this study was not necessary. Interviewing participants until saturation point is a common approach and therefore deemed valid (Bryman & Burgess 1994; Dey 1993). Future studies could explore larger samples to account for quantitative analysis, for example. Second, only a single industry was studied. The use of a single industry does limit the ability to generalize the results. However, studying a single industry affords the opportunity to offer a significant contribution to existing knowledge through the deepening or widening of current understanding (Oxley, Rivkin & Ryall 2010), especially with respect to the peculiarities and determinants of a phenomenon at an early stage of knowledge (Siggelkow 2007). We suggest single industry studies continue and that future research examine a variety of different industries, particularly those that are not high-profile GHG emitters. Lastly, the study was limited to the Margaret River wine region based in the southwest of Western Australia. There is evidence to suggest that climate change impacts are different in other wine producing regions in Australia (Webb 2010). Because of the heterogeneous effects of climate change, future research opportunities exist in other location specific regions of Australia and the world.

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## TABLES

Company	Participant Role	Tonne Crush*	Cases Sold*	Key Wine Varieties	Key Export Markets
A	Viticulturist	1300	120K	Cabernet Sauvignon, Chardonnay, Merlot, Sauvignon Blanc, Shiraz, Zinfandel	Hong Kong, Japan, Singapore, UK, US
B	Vineyard Manager	980-1000	40K	Cabernet Sauvignon, Chardonnay, Merlot, Sauvignon Blanc, Semillon, Shiraz	Hong Kong, Mainland China, Singapore, UK,
C	Winemaker	350-550	30K	Cabernet Sauvignon, Chardonnay, Merlot, Sauvignon Blanc, Semillon, Shiraz, Zinfandel	Hong Kong, Mainland China, Singapore
D	Managing Director	250-499	20-50K	Cabernet Sauvignon, Chardonnay, Merlot, Pinot Noir, Sauvignon Blanc, Semillon	Canada, France, Germany, Hong Kong, Portugal, Singapore, UK, US
E	Viticulturist	300	20K	Cabernet Sauvignon, Chardonnay, Merlot, Sauvignon Blanc, Semillon, Shiraz	Hong Kong, Mainland China
F	Winemaker	650-700	18K	Cabernet Sauvignon, Chardonnay, Merlot, Sauvignon Blanc, Semillon, Shiraz	Hong Kong, Japan, Mainland China
G	Managing Director	(not disclosed)	(not disclosed)	Cabernet Sauvignon, Chardonnay, Merlot, Pinot Noir, Riesling, Sauvignon Blanc, Semillon, Shiraz	Canada, Mainland China, New Zealand, UK, US
H	Managing Director	200	15K	Cabernet Sauvignon, Chardonnay, Merlot, Pinot Noir, Sauvignon Blanc, Semillon	Canada, Hong Kong, Japan, Mainland China, New Zealand, Scandinavia, Singapore, UK, US
I	Vineyard Manager	800-1500	100-120K	Cabernet Sauvignon, Chardonnay, Merlot, Riesling, Sauvignon Blanc, Semillon, Shiraz	Canada, Dubai, Middle East, Sri Lanka
J	General Manager	600-700	38-40K	Cabernet Sauvignon, Chardonnay, Merlot, Sauvignon Blanc, Semillon, Shiraz	Hong Kong, UK
K	Vineyard Manager	1200	100K	Cabernet Sauvignon, Chardonnay, Merlot, Sauvignon Blanc, Semillon, Shiraz, Zinfandel	Canada, Mainland China, Germany, Hong Kong, Singapore, UK, US
L	Marketing Manager	60	4K	Cabernet Sauvignon, Chardonnay, Sauvignon Blanc, Semillon, Shiraz	Hong Kong, Mainland China

\* Some wine firms reported an exact figure based on 2009 results; others provided a general, historical range.

Table 1. Company profiles

<i>Theme 1</i>	<i>Interview Quotes</i>
Climate change is likely to be beneficial	<p>I think from a broader Australian industry perspective it's certainly a significant issue. Probably here in Margaret River a little less so I think. Although certainly from the studies that I've seen, the climate change influence here is going to be more a rainfall related issue...there could be an advantageous impact from climate change in this region, and if that means that there's less rainfall during the harvest period, and potentially a more regular high quality vintage, then it could be an advantage for us. (Company A)</p> <p>I suppose we haven't really seen too many indicators that climate change is occurring. The last four or five vintages have been completely different, from 2006 being the coldest season we've ever had, through to '07 was quite dry. Last year was cold up until January, and then we had that Indian summer. We don't see any pattern emerging to indicate anything really. (Company C)</p> <p>Well technically, hotter temperatures makes wine making easier, to be perfectly honest. If you've got a moderate amount of water available, growing grapes and making wine to a certain level of quality in warm to hot conditions is very easy. Everything grows, it grows fast, fruit ripens, sugar accumulates. You get it off when you want to get it off, well before winter rains start, disease pressure is low. So a slight increase in temperature, technically, makes for probably easier management, better planning, less likely impact of disease. (Company F)</p> <p>So if the overall climate changes by .2° to 1° [C] over the next century—or sorry, the temperature changes—I can't really see a very significant issue for viticulture whatsoever in this region. And because it's going up, I see that as mostly positive. Our key variety, Cabernet Sauvignon, is still a bit marginal in this climate here. So if it gets a little warmer, the Cabernet wines will probably be better, because our lesser vintages are the cooler vintages by and large. So as a very general statement, I don't necessarily see negatives for this reason from increased CO<sub>2</sub>. The other side of it is...I'm not really sure that a higher concentration of carbon dioxide in the atmosphere isn't of significant benefit to us for productivity and other reasons. So I'm not terribly concerned, even if the IPCC forecast proves to be correct. I'm happy to assume that viticulture will be viable for at least the next hundred years, based on that data. So I don't see the climate change issue as a threat. (Company H)</p> <p>We would perhaps suffer the extremes a bit more. So we might have a 2006 vintage again, which was really cool, and then we could have a 2007, which was really warm. Overall, those extremes would have to get much worse for it still to drive Margaret River into a marginal status, on current Cabernet Sauvignon styles. Maybe Sauvignon Blanc, which relies on better fruit, prettier slightly greener fruit aromas, maybe that style might become a bit of a problem. Semillon, on the other hand, probably won't suffer. Chardonnay probably won't suffer. So it's a mixed bag. (Company H)</p> <p>I guess everyone's a bit apprehensive about climate change. We look at the mix of varieties that we grow, and we worry if climate changes, that our mix of varieties might not be quite right. If it gets too hot, then we might not be a Chardonnay growing area, or the style of Chardonnay produced in the area might change. So they're the questions in our own head from a wine point of view. Will our wine styles change? (Company I)</p>

Table 2. Select interview thoughts on climate change concerns

<i>Theme 2</i>	<i>Interview Quotes</i>
Climate change challenge is an economic one	<p>A lot of this stuff is driven by economics eventually (...) Can we justify doubling our power bills [by purchasing expensive green energy]? What benefit would we get from it? We're not going to be going down a full life cycle analysis and calling our products carbon neutral, and hoping that we can get a premium in the marketplace for it. So in the end, it's a profit/loss driven exercise I think. (Company A)</p> <p>If you're going to plant a variety that relies on warm temperatures, but we've got a lot of variability from season to season, then you might find that at the moment it might be a bit much of a risk, from a sales perspective, to have one in three years where that variety really shines, at the moment. (Company B)</p> <p>If I were perhaps an owner of a vineyard, and I were about to put a new vineyard in, I'd certainly be considering at least looking at changing varieties that might do better in a warmer climate. It's that long term structure of the vineyard. You put in a vineyard, and the trellising, and planting, you're looking at really a minimum 25-30 years, and longer, on these things. It's a long term exercise. (Company E)</p> <p>At the end of the day, wine businesses need to make money like everyone else, and if you can lower your fuel usage, you can lower some of your input costs. We might use less fertiliser if we can get our balance right. So they're the sort of things that we're looking at. (Company I)</p> <p>So yes, I think for [company name withheld], as a business, for Margaret River as a wine growing region, there are significant challenges that would result from climate change. We would have to... adapting to fit that new environment would be costly, and a big leap of faith at a certain point. There would come a point where we'll have to rip out a whole vineyard and replant it with something else, and that will cost a lot of money, and no guarantee that anyone will believe in the product that you make from it. You spend all your time building your profile for a certain style of wine, and a certain variety, and suddenly you've got to start a whole lot of new messages around that. I don't look forward to that being the case. (Company J)</p> <p>Well the predominant planting in our vineyard is white grapes, which of course don't do as well in the heat, and need a lot more water than red grapes do in the heat. That's the first thing that just makes me go 'Oooh, we made the wrong decision there'. We've actually just grafted over to some white varieties, because they sell. That was an economic decision. That, for me, is the big dilemma, is that what sells isn't necessarily what's best if the climate changes. So what do we do? (Company L)</p>

Table 3. Select interview thoughts on climate change challenges

<i>Theme 3</i>	<i>Interview Quotes</i>
<p>Action both mitigates and adapts*</p>	<p>We have computer controlled temperature regulation on tanks. Simple things like we've insulated all the brine lines so we're not losing energy, sending coolant to a tank, or sending it back in the other direction to be cooled again. Tank insulation is a simple way that I can see significant energy savings. (Company A)</p> <p>Yeah, probably 80 percent of our production will be under these new lean green bottles. I'm not sure how much lighter they are, but it's significant (...) they're also two-thirds the price. So they're cheaper for us. (Company C)</p> <p>The recycling sprayer that we've got does two rows at a time. We can get the vines to the point of run-off, and almost get no drips on the ground. Which is just remarkable. So we can have amazingly precise spray, and directed spray, quite easily, yeah. That forms a very important part of what we do, yeah. (Company C)</p> <p>I think the biodynamics is a part of that, the whole offsetting of our emissions. It's something which everyone should be doing anyway. (Company D)</p> <p>We're doing fewer sprays if we can get away with it. Under vine management and things like that are areas where we can save a lot of tractor time, and therefore a lot of energy. (Company E)</p> <p>Definitely moving into the lighter weight glass, the thinner glass bottles, particularly for our large production wines where they're more price point driven. (Company F)</p> <p>Well we moved to almost all of our small motors are on variable speed drives. (Company F)</p> <p>Yep. We use container ships. The exporting is done virtually exclusively by sea, in containers. (Company H)</p> <p>We insulate everything that we can, and all that sort of stuff. Wherever we can reduce our energy use, we're happy to do so. (Company H)</p> <p>I guess from a company perspective, we're trying to minimise our passes through the vineyard, so we're trying to cut down on our fuel usage. We've minimised our herbicide usage as much as is possible. (Company I)</p> <p>Well we buy 100 percent green power from Synergy. (Company J)</p> <p>We've done a lot of planting. We would have planted 5,000 – 10,000 trees in the last four years. (Company J)</p> <p>With EntWine I am wanting to try and get some environmental certification. Purely to be a bit more responsible ourselves, but also realizing that that is something that's going to be desirable. (Company L)</p>

\*I note that a second-order theme emerged from the data reflecting that not all actions are driven by climate change concerns but rather by a general stewardship approach to the natural environment.

Table 4. Representative data on climate change action (mitgative)

<i>Theme 3</i>	<i>Interview Quotes</i>
Action both mitigates and adapts*	<p>Well all our vineyards are drip irrigated, apart from a little that's unirrigated. We have a couple of different soil moisture monitoring systems, as well as visual observations. (Company A)</p> <p>Inter-rows, trying to grow a good healthy cover crop so we're incorporating a lot of organic matter, having organic matter build up in the soils so we've got soils of high moisture hold capacity going forward (...) We're looking at the longer term, trying to build levels of soil carbon, no cultivation, so that we're getting a naturally more retentive soil, higher infiltration rate. So what rainfall we do get, we're able to take advantage of. (Company A)</p> <p>We have soil moisture probes throughout the vineyard, and we respond to that rather than just chucking on whatever we think. Certainly it becomes a bit visual during the critical times of the year as well, we all back that up. We closely monitor our irrigations. (Company B)</p> <p>Okay. Specifically related to climate change, I can think of activities we've undertaken related to water conservation. I guess in a way they're tied in, and there's pressure along that same line, and that's in terms of the way we treat waste water here. Instead of treating it to a certain point, and then letting it go back into the water courses, after cleaning the water, we're actually circulating the water. Treating it, and putting it back in our holding dam, and using it back for general cleaning purposes. So we've reduced our water use—we would estimate over the vintage period—by perhaps 50 percent, just because of the money we've spent in waste water treatment. (Company F)</p> <p>We're trying to – from an environmental point of view – trying to look after our water storage and our waterways, those sorts of things. (Company I)</p> <p>We're using drip irrigation. We monitor our water usage. We monitor our soil moisture. Other than going to sub-surface drip irrigation, or looking possibly at RDI, but if we don't need to water, we don't water. (Company I)</p> <p>It's all drip irrigation. All the clips which have been plastic are progressively being replaced with stainless steel because they're more reliable, less blow-outs. So we think it's pretty efficient, and we don't think that's unique to us either, but I think vineyard irrigation's pretty efficient. Minimal evaporation generally. (Company J)</p> <p>The other thing that I do – it's probably a bit different – I think that other people do it as well, is I let my cover crops on the mid rows get to... I cut them like a hay crop. So when I cut them, we've got mulchers and slashers, so the slashers cut things long, mulchers cut things short. So we go through and cut, and drop that in the mid rows as well. So you kind of get a mulch layer of probably about an inch, depending on how things are growing. That definitely does reduce the amount of water that you lose. (Company K)</p> <p>We've trialed...a product...which protects against sunburn. We used that on a Merlot block, up the back there. Every year, regardless of what I do, I get sunburn. Did it eliminate sunburn? No. Did it reduce the cases of it? Yep. (Company K)</p>

\*I note that a second-order theme emerged from the data reflecting that not all actions are driven by climate change concerns but rather by a general stewardship approach to the natural environment.

Table 5. Representative data on climate change action (adaptive)

## FIGURES

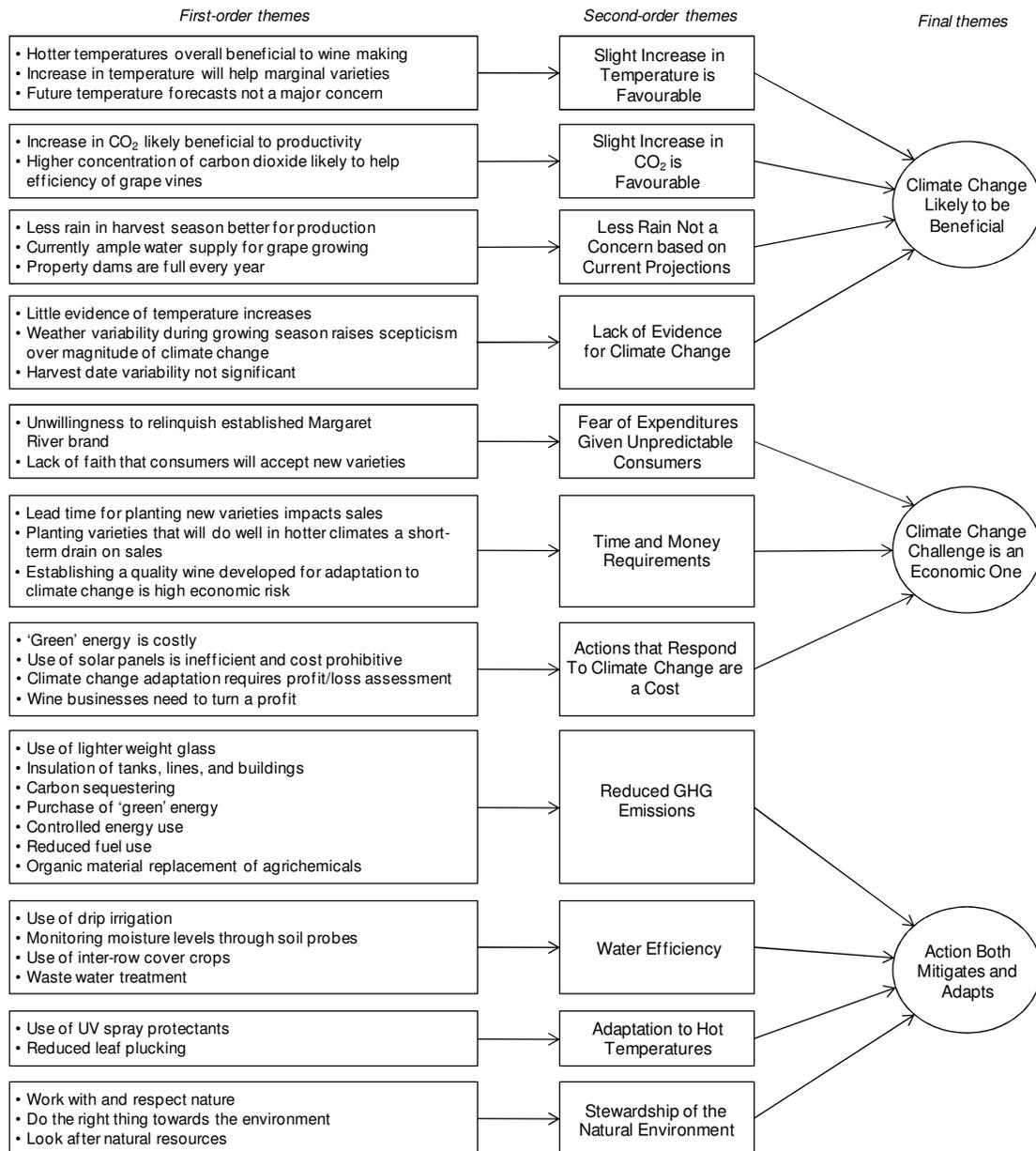


Figure 1. Data structure and emergent themes