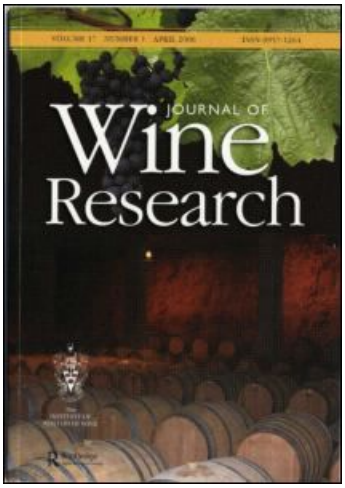

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Climate Change, Viticulture, and Wine: Challenges and Opportunities

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Climate Change, Viticulture, and Wine: Challenges and Opportunities

GREGORY V. JONES and LEANNE B. WEBB

Throughout human existence weather and climate have played a decisive role in where and how cultures have developed. Agricultural systems that could support early civilizations were crucial to their success. Nomadic tribes have always moved to find better growing conditions for their crops or to feed their animals. During the age of worldwide exploration the suitability of a given location to certain crops helped to determine whether a colony could be established there or not. Today, as in the past, climate is clearly a pervasive factor in the success of all agricultural systems, influencing whether a crop is suitable to a given region, largely controlling crop production and quality, and ultimately driving economic sustainability. Maybe more so than at any time in human history, our agricultural systems today are at risk from rapidly changing climates that affect the suitability and sustainability of crops worldwide.

Climate's influence on agribusiness is at its most evident with viticulture and wine production where it is arguably the most critical aspect in ripening fruit to its optimum to produce a desired wine style. As in the past, today's wine production occurs over relatively narrow geographical and climatic ranges, most often in mid-latitude regions that are prone to high climatic variability. Furthermore, individual winegrape varieties have even narrower climate ranges, which further limit the areas suitable for their cultivation. These narrow niches for optimum quality and production put the cultivation of winegrapes at greater risk from both short-term climate variability and long-term climate changes than other crops. And while winegrapes as a crop are not crucial to human survival, the vine's extraordinary sensitivity to climate makes the industry a strong early-warning system for problems that all food crops may confront as climates continue to change.

This special issue of the *Journal of Wine Research*, along with further supplemental papers in the next issue, is devoted to examining the significance of climate change to growing grapes for wine production. Articles in the two issues provide perspectives on the physical basis for climate's influence, vulnerabilities of differing sectors of the industry, and available mitigative and adaptive strategies. In this issue, Schultz and Jones detail how climate change has altered grape composition and wine styles and show that the geography of wine regions globally is changing and will likely continue to change in the future. Examining climate in Australia and China, Pagay and Pullman in the next issue detail how both regions have experienced increased heat extremes and below average precipitation that has lead to more frequent and severe droughts. Other research in Australia has coupled these observations with projections

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for future climates that indicate further changes in grapevine growth characteristics (Webb *et al*., 2007) and wine quality (Webb *et al*., 2008). The Pagay and Pullman research in the next issue also highlights the fact that climate change is not uniform over time and space, both in observations from the past and future projections (IPCC, 2007). For a review of the range of observed changes and future projections in wine regions worldwide see Jones *et al*. (2005) and Jones (2007).

As an example of the sensitivity of winegrapes to climate, in the next issue Shaw examines numerous pinot noir climates worldwide and compares them to the historical home of the variety, Burgundy. The author finds that regions growing high quality pinot noir have many similarities in climate, but significant regional differences that drive wine styles variations. Shaw and others also note that pinot noir is arguably one of the most climatically sensitive varieties grown worldwide, providing strong insights into the effects of observed and projected changes in climate. Other research has shown that pinot noir has an approximate 2°C climate niche (Jones, 2007), and given that changes, both observed and projected, in climate have been near or above this value, the suitability of some regions continuing to produce pinot noir in the future is in doubt.

Two articles on Burgundy and *terroir* highlight the delicate balance between nature, nurture, and economics in the face of a changing climate and market place. In this issue, Whalen discusses the move afoot to reinvent the much hallowed French term *terroir* into *climats*. Used locally for hundreds and possibly thousands of years, *climats* attempts to redefine the role of nature and humans in the pursuit of a regional product such as wine. It appears that the creation of an Association des Climats du Vignoble de Bourgogne (Association of Burgundian Wine Climates) has the support of many in the region who are disenchanted with the French AOC system. Burgundians hope that the move to *climats* and being recognized by UNESCO as a world heritage site of 'exceptional and universal value' will provide a 'fixed reputation with enhanced opportunities for innovation, variance, diversity, etc.' In the next issue, Atkinson gives further perspectives on the role climate change has on Burgundian *terroir* noting that change is inevitable but difficult in the face of controls placed upon growers. Given the observed and projected changes in climate in the region, along with the sensitivity of its marquee variety, pinot noir, the suggestions by Whalen are a good move. As White *et al*. (2009:) have argued "competition from the New World, a changing climate and technological advances have threatened the Burgundian notion that the quality of wine depends on regional geography and culture. Only flexibility can keep the concept of *terroir*, [or now *climats*] alive" (p. 82).

In determining the ultimate outcomes of climate change for the wine industry there are, in fact, two main factors that humans can influence. The first is mitigation: the more we mitigate our emissions of greenhouse gases the more we can limit the magnitude of climate change risk to which we are exposed. The second factor is adaptation: by building the capacity to adjust climate-sensitive activities we can limit our vulnerability to the climate change that does occur. The two are linked in that the more effort that is applied up-front to mitigation efforts, the less effort will be required for adapting to climate changes (Stokes and Howden, 2010).

Awareness of our individual 'carbon-footprint' will serve to highlight potential mitigation options. In this issue López-Valeiras Sampedro and his colleagues suggest that companies in the wine industry must consider their actions to be potential causes of environmental pollution and should therefore incorporate environmental variables as a critical success factor in their management control systems. From the same line of reason, Reich-Weiser *et al*. in this issue have evaluated the importance of

transportation to the total greenhouse gas (GHG) footprint of wine and discuss the variability of transportation emissions depending on the specific type of transportation utilized.

The adaptive capacity of the wine industry to a changing climate is influenced by a number of factors. One of these factors is the operating context within which responses occur. This concept is demonstrated by Monica Hadarits, Barry Smit and Harry Diaz who, in this issue, examine the vulnerability of grape and wine producers to climate change in the context of other stresses via a case study in the Maule Region of Chile. Through interviews, producers revealed that the stakeholders' key sensitivity was income, which is influenced by a variety of factors, including climate and weather, market and currency fluctuations, institutional arrangements and labor availability. In the next issue Pagay and Pullman also highlight the fact that various economic, institutional and social circumstances also affect producers, who are managing all these risks simultaneously. Their work suggests that differences in available resources, technology, and economics in Australia and China will drive the climate change adaptation strategies available to growers.

Adaptive capacity is also influenced by the availability of effective adaptation options, as evaluated and provided by research and other sources of knowledge and technology; and while there is a recognition of this in the wine and climate change scholarship, Tara Holland and Barry Smit in this issue describe the need for further exploration in this area. Here they also raise the concept of the 'human factor'; the capacity of individuals to access support and implement adaptation options. The ultimate vulnerability of communities and enterprises to climate change is strongly dependent not just on potential biophysical impacts but also on the way people respond and their potential to moderate those impacts. Webb and colleagues in this issue examine the variation in response of growers to a severe heatwave experienced across south-eastern Australia in the summer of 2009. The results demonstrate that losses were not always related to the amount of heat above a certain threshold but to the management practices employed in the lead-up and through the event. Furthermore, these observations point to the importance of capturing information from the diverse knowledge-base of managers as a very effective way to reveal potential adaptive capacity to a changing climate.

Adaptive capacity can be enhanced by managing climate risk and uncertainty; in assessing the Niagara region of Canada, Cyr, Kusy and Shaw in this issue provide an example of how weather derivatives can be employed to hedge the financial risk of a critical weather-risk factor common in viticulture, that of excessive rainfall during the harvest season. By developing the capacity for individual evaluation of climate risks through access to climate information some potential impacts can be avoided.

While the exact spatial changes in the magnitude and rate of climate in the future are speculative at this point, what is absolutely clear from historical observations and modeling is that the climates of the future, both over the short term and over the long term, will be different from those today. These changes are likely to bring about numerous potential impacts for the wine industry, including: added pressure on increasingly scarce water supplies, additional changes in grapevine phenological timing, further disruption or alteration of balanced composition in grapes and wine, regionally specific needs to change the types of varieties grown, necessary shifts in regional wine styles, and spatial changes in viable grape growing regions. In *vino veritas*, the Romans said: *In wine there is truth*. The truth now is that the Earth's climate is changing much faster than the wine business, and virtually every other business on Earth, is prepared

for. While uncertainty exists in the rate and magnitude of climate change in the future, it would be advantageous for the wine industry to be proactive in assessing the impacts, to invest in appropriate plant breeding and genetic research, to be ready to adopt suitable adaptation strategies, to be willing to alter varieties and management practices or controls, or to minimize wine quality differences by developing new technologies. We hope that the articles in this issue encourage additional research into this topic and provide insights for those wishing to be ahead of the curve in terms of mitigation and adaptation.

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