XIIIth International Terroir Congress
17–18 November 2020
Virtual Congress | Adelaide, Australia

HAVE THE BEST BORDEAUX WINES BEEN DRUNK ALREADY? A REFLECTION ON THE TRANSIENT NATURE OF TERROIR, USING CASE STUDY AUSTRALIA

Richard Smart*

Smart Viticulture, Greenvale, Victoria, Australia

*Corresponding author: vinedoctor@smartvit.com.au

Abstract

Aim: The aim of this paper is to demonstrate that the meaning of t*erroir* should be regarded as transient. This is because climate, one of the principal components of *terroir,* is changing with time, and can no longer be assumed to be constant with fluctuations about a mean. This is due to the climate crisis.

Methods and Results: The paper reviewed a very recent climate modelling study of Australian grape growing regions (GI's) especially for temperature. It included Mean Growing Season Temperatures (MSGT) for the present period (1997-2017) and two in the future, (2041-2061) and (2081-2100). The results were in line with several previous projections indicating warming and drying trends over the period. Present hot inland regions will be the most affected. Literature references indicated similar trends elsewhere in the world including traditional vineyard regions of Europe.

Conclusions: Results of the climate modelling for Australia and the rest of the world suggest the need for adaptive responses as the *terroir* changes. This will require changes to variety or of the region. The transition will be easier for presently cool regions than for presently hot ones, as more potential varieties are available. Some currently hot regions may become unsuitable for wine production. There is evidence that the optimum temperature conditions for present varieties in regions like Bordeaux have already been surpassed by climate change.

Significance and Impact of the Study: There is limited evidence to date that global wine firms recognise the scale of this problem and are planning to adapt. A good outcome would be that the world wine map might be redrawn, to feature some new regions and new varieties in existing regions. A bad outcome would be associated with failure to acknowledge or address the impending crisis.

Keywords: Climate change, terroir, temperature

Introduction

Terroir can be defined as a stamp (or mark) of place and time on a wine and its attributes (chemical and sensory). The closest English synonym to the French term is provenance. This paper discusses the *terroir* concept and its application to the global wine sector at a time of recognized global climate change due to warming. Climate change has led to responses such hastened phenology, and growing season and vintage compression.

The viticultural and oenological interpretation of the word *terroir* has a sense of permanence. The components of *terroir* are to do with the "place" (location) and also the "time" (vintage year of harvest, reflecting as it does the growing conditions leading up to that harvest). This acknowledges the importance of weather during the growing season as a significant component of *terroir*. Traditionally we have regarded the weather in terms of variation about average values, which we term the climate of the region. That average value of climate has been previously stable over time. Since the soil and climate conditions of the site are relatively constant over time, then one might accept that the *terroir* of a vineyard is a constant entity. However, is this the case for today? This review will endeavour to demonstrate that global climate change challenges the very essence of the constant nature of *terroir.* This paper does not rely on original research but uses recent research by others and literature reviews.

Why the title regarding Bordeaux? If the climate of Bordeaux is changing as will be demonstrated, what was the climate when the wine quality reputation of Bordeaux was formed? And how have the climate and *terroir* changed, especially since 1950, when global warming has become more apparent? Might the best wines have been already consumed? This is a provocative idea to put a transient *terroir* into perspective.

This issue was raised in 1989 at the 69e OIV General Assembly in Luxembourg (Smart, 1989). The issue of appellation and *terroir* along with global climate change was addressed, warning that the varietal composition of Bordeaux vineyards may change in the future, an idea met with mirth from the French delegation.

We begin with a case study, that of projected climate change of Australian wine regions, considering *terroir* at a regional level. Australia is a mid-latitude and very large and very flat island land mass. Few Australian grape growing regions are maritime, the majority are inland with continental climates. Climate change for global wine regions is subsequently considered, including Bordeaux.

Materials and Methods

Climate warming has recently been comprehensively studied (Remenyi *et al.*, 2020) for all 68 Australian wine regions (Geographical Indications, GI's). This work compared recent present conditions (1997-2017) with future projections for the short-term, beginning 20 years in the future (2041-2060) and for a longer-term period, 70 years in the future (2081-2100). It was based on the RCP 8.5 emission model (which may overestimate heating after 2050 if global mitigation strategies are more effective) and spatial modelling over the GI region. The Atlas study used the index Mean Growing Season Temperature (MGST).

These results are summarized for 39 representative major GI's in Table 1, all producing more than 1,000 t in 2019, which represent 91% of the reported wine grape production for 2019 (Wine Australia reports, www.wineaustralia.com), and which embrace the present temperature range of Australian wine regions. Note that the southern island state Tasmania is a single GI, but for convenience the data is presented for two areas to indicate the present temperature range of Australian grape growing regions. A temperature classification with eight, one-degree centigrade (1^{o}C MGST) divisions, along with verbal descriptions is introduced. These are: with MGST less than 16.0 ^{o}C as VERY COOL, 16.0-16.9 ^{o}C as COOL, 17.0-17.9 ^{o}C as SLIGHTLY COOL, 18.0-18.9 ^{o}C as WARM, 19.0-19.9 ^{o}C as HOT, 20.0-20.9 as VERY HOT, and => 22.0 ^{o}C as EXTREMELY HOT.

An explanatory note is required to explain Australia's rather unique method of regional appellation by GI's. The system is new, begun in 1993. Importantly, the allocation of GI boundaries is arbitrary from a viticultural perspective. Existing vineyards are included, but the borders contain much larger areas often with contiguous borders between GI's, leading to large GI's by international standards. The southern island state of Tasmania (surface area 6.8 Mha) is a single GI, but with only 1,700 ha of vineyards; the enormous GI Riverina in central NSW has area around 78,000 km^2 and is 110% the size of Ireland!

Results and Discussion

The majority (72%) of Australia's wine grapes are grown in only three GI's, the hot and arid inland "Irrigation Areas" of low rainfall and substantial irrigation. Located near inland rivers, these are the Murray Darling, Riverina and Riverland. Table 1 shows the MGST values for each of the GI discussed, along with a colour coding and key. The projected warming is graphically represented; from the first (1997-2017) to the second period (2041-2060) all but three regions change their thermal classification. For the second period 2041-2060, 16 of the 40 regions are classified as hot or above, being 87 % of the present production levels; for the third period 2081-2100, 34 of the 46 regions are classified as hot or above, representing 98 % of the present production levels. The projected rate of warming at 0.400 ^{o}C/decade between the second and third periods is greater than between the first two at 0.264 ^{o}C/decade. Present hot regions show the largest temperature increases over the period.

Table 1 graphically presents a sobering forecast for the future of the Australian grape and wine sector, with an average temperature increase over the 103 year period predicted at 3.0 ^{o}C. The present 'very hot' regions, the source of the majority of Australia's present wine grape production are most at risk of becoming unsuitable for wine production. Higher temperatures will substantially compromise grape ripening and wine quality for present 'warm', 'hot' and 'very hot' regions. These regions are generally very sunny; plant temperatures can be increased up 15 ^{o}C above ambient air temperature with solar heating, especially if the vine is water stressed. As was experienced during the 2019-20 summer, high temperatures are associated with increased wild fire risk, causing physical damage to vineyards and wineries and remote-from source smoke taint damage to grapes and wine.

Table 1: MGST (1997-2017), and colour grades and descriptors for 3 periods after Remenyi *et al.* (2020).

	MGST (^{o}C)			
GI REGION	***1997-2017***	***1997-2017***	***2041-2060***	***2081-2100***
SOUTH BURNETT	22.4			
MURRAY DARLING	21.9			
SWAN DISTRICT	21.8			
RIVERINA	21.8			
RIVERLAND	21.1			
COWRA	20.6			
HUNTER	20.2			
GUNDAGAI	19.8			
RUTHERGLEN	19.7			
MUDGEE	19.5			
HILLTOPS	19.5			
LANGHORNE CREEK	19.2			
CLARE VALLEY	19.1			
BAROSSA	19			
MARGARET RIVER	18.9			
GRANITE BELT	18.7			
MCLAREN VALE	18.6			
CURRENCY CREEK	18.5			
HEATHCOTE	18.5			
EDEN VALLEY	18.4			
ORANGE	18.1			
SOUTHERN FLEURIEU	18			
PYRENEES	18			
GREAT SOUTHERN	18			
ADELAIDE HILLS	17.9			
PADTHAWAY	17.8			
STRATHBOGIE RANGES	17.6			
KING VALLEY	17.6			
WRATTONBULLY	17.5			
MORNINGTON PENINSULA	17.4			
COONAWARRA	17.3			
GEELONG	17.2			
MOUNT BENSON	17.1			
GRAMPIANS	17.1			
ROBE	17			
UPPER GOULBURN	16.9			
ALPINE VALLEYS	16.9			
YARRA VALLEY	16.3			
CENTRAL NORTH $	14.5			
UPPER DERWENT	12.7			
	18.6			

Grade	Colour	MGST Range (C)	Word Descriptor
1		<16.0	VERY COOL
2		16.0-16.9	COOL
3		17.0-17.9	SLIGHTLY COOL
4		18.0-18.9	WARM
5		19.0-19.9	MODERATELY HOT
6		20.0-20.9	HOT
7		21.0-21.9	VERY HOT
8		>=22.0	EXTREMELY HOT

Australia has no shortage of suitable land for viticulture, but water resources for irrigation are generally limiting. Finding regions with less hot climates means moving production away from the river water sources of inland Australia! Cooler climate regions are available to the south in Victoria and Tasmania; both states also have higher rainfall. Such relocation would allow the continuing use of so-called "international varieties" which have market dominance at the moment, both nationally and internationally.

So much for Australia. We can see that the projected climate change, especially for temperature will cause a very transient *terroir.* What are the projections for global wine regions, and especially for acknowledged premium areas of Europe? In fact, they appear very similar. We considered analyses of global wine regions viz. Jones **et al.** (2005), Schulz and Jones (2010) and Moriondo *et al.* (2013). These studies all indicate similar degrees of warming and drying for European regions as for Australia. Further, these studies emphasise the central places of variety and temperature in discussions of wine quality impact. The present strict appellation laws of France (which are common in Europe) control variety choice, and vineyard management by way of planting density, pruning level, permitted yield and banning of irrigation, effectively preserving the *terroir.* But there is no protection against a changing climate, that very important component of *terroir.* It cannot be made illegal, although some officials may wish that.

The Jones *et al.* (2005) study considers Bordeaux along with other wine regions, including some in Australia. Bordeaux has warmed over the period 1950-1999, and especially since the 1990s. Further, using analyses of vintage ratings as surrogates for quality over the period 1950-1999, they found evidence that the warming which had already occurred in the 1990s had exceeded the predicted optimum temperatures. Examples were given for wines from the following regions, and their predicted optimum temperatures: Alsace, white wines, 13.7 ^{o}C; Loire Valley, sweet white wines. 16.7 ^{o}C; Bordeaux, red wines, 17.3 ^{o}C and Barolo, red wines, 18.6 ^{o}C, see their Figure 4).

Further, climate modelling into the future (2000-2049) suggests that temperatures will further increase by an average MGST of increase of 1.31 ^{o}C in the northern hemisphere, and 0.93 ^{o}C in the southern hemisphere. This increase in temperature may then exceed MGST at the temperature optimum for the variety currently being grown. Australia's Barossa Valley was one such region identified. The range of varieties now suited to a prior cool regions is likely to expand with warming. However, and seriously, opportunities for variety replacement in present hot regions are many fewer; perhaps grape growing for wine may be replaced by growing table grapes, as occurs presently in hotter vineyard regions of the world. Projected warming studies of Moriondo *et al.* (2013) up to 2050 indicated similar results. The landscape for winegrape production in Europe will change "dramatically" due to climate change. Those present warmer southern European regions were shown to be most at risk from increasing temperature and water deficit.

The primary means of adaptation to climate change is suggested by Smart and Lockshin (2020) for the Australian wine sector is succinctly stated "*either change varieties or change regions".* This sentiment is reflected in the three references cited above. All authors make the point of the need to change varieties as the climate warms, however recognizing the market impact on regional reputation. The change of varieties is presently forbidden under some European appellation laws.

Conclusion

Climate is an integral component of *terroir*, and is transient; and so then is *terroir*. Climate change will be the overwhelming concept for the future of the Australian and global wine industries. These concepts are well documented, yet there is little present evidence of timely adaptive response.

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