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A GLOBAL AND REGIONAL STUDY ON WINEGROWERS' PERCEPTIONS AND ADAPTATIONS TO CLIMATE CHANGE

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Abstract

Aim: The aim of this study was to explore the current and future state of the wine sector in the context of climate change, where the goal was to obtain greater understanding on winegrowers' perceptions and adaptations to a changing climate and its associated impacts. The study sought to provide both a global and regional perspective on these issues.

Methods and Results: Translated in 10 different languages, a survey was elaborated and address to winegrowers in 18 wine producing countries. The survey had a structure of 27 quantitative and qualitative questions based on past, present and future growing conditions. With 3625 questionnaires collected, results were compiled to provide a general context for each targeted country, while for the second database specific for France, results were analysed to consider the regional specificities to increase understanding on this subject. At international and regional level, the majority of winegrowers are observing a changing climate, recognising the shifts in temperatures and rainfall patterns. The level of awareness was higher than 80% for most countries. The observed impacts, especially in Europe, relate typically to an earlier onset in phenological stages and deviations in berry composition. However, impacts on vine yield and diseases are highly variable and less significant. Overall, countries such as Spain highlight the detrimental effects on wine quality, compared to countries such as UK perceiving the beneficial influences. These dissimilarities are also illustrated for French wine growing regions. At international and regional level, winegrowers display a strong awareness that continued climate changes are likely. As most are expecting climate changes to continue, winegrowers assigned various adaptation priorities to ensure the sustainability of grape growing and wine production. The latter depending on many contextual factors that shape winegrowers' vulnerability to climate variations.

Conclusions: Using survey data collected from 18 wine producing countries, study findings have provided important insights on winegrowers' perceptions and adaptations to a changing climate. Our study contributes to the sustainable development of well-targeted adaptation measures and strategies in the wine sector.

Significance and Impact of the Study: This study has a strong international dimension, allowing the entire wine industry to gain understanding on these issues on a large geographical scale. Such knowledge can offer key information for policy and research to better assist winegrowers in planning adaptation responses to uncertain long-term climate changes.

Keywords: Climate change, winegrowers' perceptions, global wine industry

Introduction

Cultivated and shaped by human uses for many centuries, the grapevine has a rich geographical spread. Across and within these wine producing areas, the winegrower has always acted on the surrounding environment in order to develop a wine with a strong identity, where its quality and sensory attributes reflect the natural and human factors of its local terroir (van Leeuwen and Seguin, 2006). Indeed, the close relationship between climate and grapevine behaviour has constantly led winegrowers to adjusting their strategies (Neethling *et al.,* 2017). Faced with an unprecedented climate change, there is today an increasing urgency to reconsider viticultural and enology practices and techniques. Climate change impacts are a strong reality, affecting the quality and volume of wines produced, even questioning the economic viability of traditional wine growing regions (Ollat *et al.,* 2016; van Leeuwen and Darriet 2016).

Since the early 2000s, and especially over the past decade, a great deal of scientific work has been done on viticulture in a changing global climate. Stakeholders are exposed to a greater understanding of possible mitigation and adaptation strategies in the face of expected impacts. For example, changes in cultural practices related to vigour and soil management (Parker *et al.,* 2015), use of more drought and heat tolerant plant material or more drastically, expansion of viticulture to non-traditional wine growing regions (Barbeau *et al.,* 2014). Still, very little information exists on winegrowers' perceptions and adaptions to such expected climate changes and impacts at an international scale.

Within this perspective, the aim of this study is to obtain specific information on the perception of winegrowers on climate change and its associated impacts, as well as their attitudes and priorities in terms of adaptation measures. Understanding and identifying the needs and intentions of winegrowers will help to identify and act effectively, from the national to the local level, recognizing that the resilience of wine systems to climate change requires the implementation of local and context-specific actions.

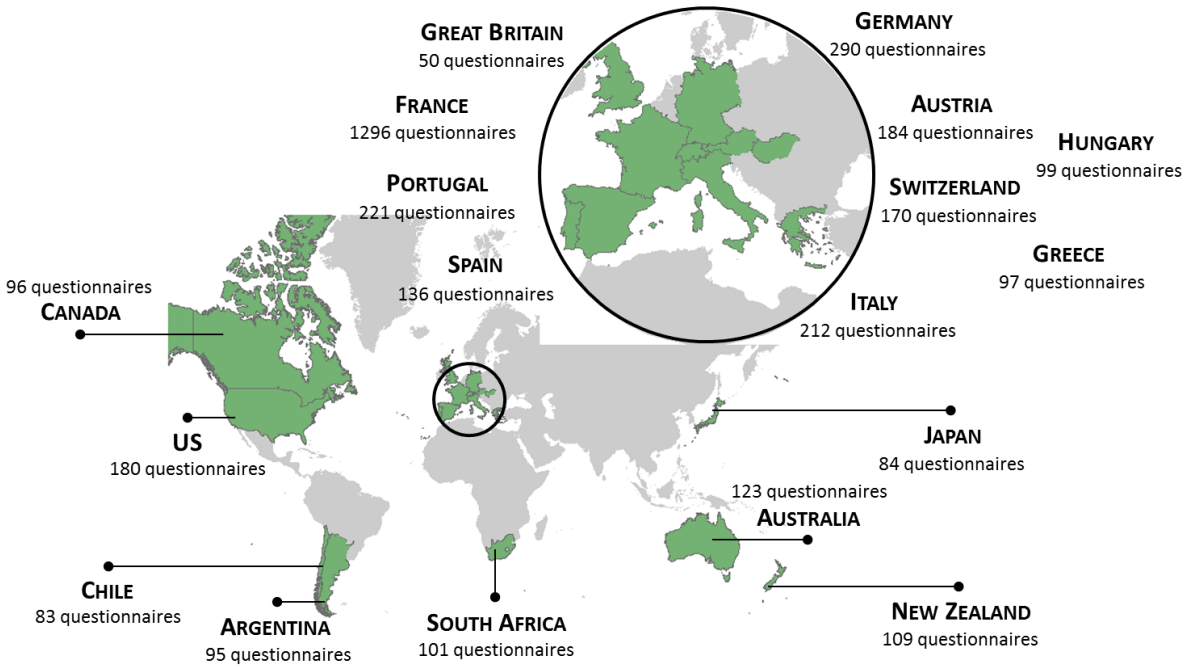

Figure 1: Targeted wine producing countries with the number of questionnaire responses collected.

Materials and Methods

A questionnaire was elaborated and set up using Google Forms, distributed to winegrowers of 18 different wine producing countries (Figure 1). It had a structure of various quantitative and qualitative questions based on past, present and future growing conditions. To facilitate the understanding of the questions, the questionnaire was translated into the main language(s) of each country (i.e. into 10 different languages) and sent individually and randomly to winery contacts, or with the help of public organisations and associations, circulated in regional newsletters. The collected data were then organised by question in an Excel spreadsheet and analysed through descriptive and inferential statistics. Since sample sizes were uneven, the weighted and unweighted averages

were compared when expressing the central tendency of the international dataset, i.e. when considering all countries. Study findings were therefore compiled to provide a general context for each targeted wine producing country, while for the second database specific for France, results were analysed to also consider the regional specificities, allowing to increase the understanding on winegrowers' perceptions and adaptations to climate change.

Results and Discussion

Between May 2019 and April 2020, a total of 3625 responses were collected (Figure 1) from 18 wine producing countries (Argentina, Australia, Austria, Canada, Chile, France, Germany, Great Britain, Greece, Hungary, Italy, Japan, New Zealand, Portugal, South Africa, Spain, Switzerland and United States).

Question: Have you noticed any changes in climatic conditions in your region over the last two or more decades?
The majority of winegrowers questioned have noticed a climate change over the past few decades. Across the studied population, the weighted average show that 84% of winegrowers are aware of a changing climate, with only 4% not noticing any changes. The level of climate change awareness varies between countries, from 68% for Great Britain (GB) up to 94% for Germany (DE). In France (FR), 84% of winegrowers surveyed noticed a climate change, where the level of awareness differs regionally from 76% for Bordeaux to 89% for Loire Valley.

Table 1: Respondents awareness to past and future climate changes.

Frequency (%)	**AR**	**AU**	**AT**	**CA**	**CL**	**FR**	**DE**	**GB**	**GR**	**HU**	**IT**	**JP**	**NZ**	**PT**	**ZA**	**ES**	**CH**	**US**
Past climate change awareness																		
No	3%	7%	1%	9%	0%	2%	1%	4%	5%	1%	3%	6%	11%	4%	4%	4%	0%	10%
Not sure	18%	10%	10%	12%	10%	14%	4%	28%	12%	14%	9%	2%	17%	11%	10%	11%	14%	15%
Yes	**79%**	**84%**	**89%**	**78%**	**90%**	**84%**	**94%**	**68%**	**83%**	**85%**	**88%**	**92%**	**72%**	**85%**	**86%**	**85%**	**86%**	**75%**
Future climate change awareness																		
Not likely	6%	5%	1%	7%	0%	1%	2%	2%	0%	1%	3%	10%	10%	3%	3%	2%	4%	9%
Not sure	15%	12%	5%	12%	6%	12%	7%	4%	14%	8%	24%	10%	13%	7%	25%	6%	11%	20%
Yes likely	**79%**	**83%**	**94%**	**80%**	**94%**	**87%**	**92%**	**94%**	**86%**	**91%**	**73%**	**81%**	**77%**	**89%**	**72%**	**92%**	**85%**	**71%**

In bold, values with higher than 50% consensus

Question: Please indicate if the following climate related variables have increased, stayed the same or decreased over the course of your farming career.
In order to understand these questions related to climate change perceptions, as well as observed impacts, only "yes" responses for climate change awareness were considered.

The most noticeable climate changes for respondents aware of climate change are increasing winter temperatures, increasing summer temperatures, increasing droughts and decreasing winter rainfall. Country specific climate changes are expressed by winegrowers, for instance, increasing frost events for Austria (AT) and Switzerland (CH), increasing hailstorms for Hungary (HU) and Italy (IT), increasing winter rainfall for Canada (CA) and Great Britain (GB) and increasing summer rainfall for Japan (JP). Region specific climate changes in France illustrate increasing frost events for Loire Valley and Bordeaux, while increasing hailstorms for Bordeaux and Provence.

Question: Did these changes in climatic conditions affect the grapevine phenomena, and, if so, how?
With a changing climate, winegrowers are observing its impacts on grapevine behaviour and performance. Aside from Canada, the majority of country respondents have observed an earlier onset in phenological stages, especially in traditional European wine producing countries. Climate changes also have resulted in reduced yields, which is particularly the case in countries such as Chile (CL) and South Africa (ZA). However, countries such as Great Britain (GB) illustrate the opposite, with climate change resulting in increasing yields. For the regional study of France, the results are very different from one region to another. Findings show that French wine regions such as Provence and Languedoc-Roussillon are the most impacted by a decrease in yield. According to winegrowers, sugar accumulation is the most effected berry component by climate changes during berry ripening. However, the effect on increasing sugar content is much more substantial for traditional wine producing countries, compared to new world wine countries. Concerning grapevine diseases, the results are much more diverse. Countries such as Hungary (HU), Japan (JP) and New Zealand (NZ) are highlighting an increase in grapevine diseases, while as for countries such as France (FR), winegrowers tend to agree that there is no climate change effect on the presence of diseases.

Question: Have these modifications in grapevine behaviour been DETRIMENTAL or BENEFICIAL to the overall quality and style of your wine?
Overall, countries such as Spain (ES) highlight the detrimental effects on wine quality, compared to countries such as Great Britain (GB) perceiving the beneficial influences. These dissimilarities are also clearly illustrated for French wine growing regions. A changing climate appear much more beneficial for regions such as Champagne, compared to regions such as Languedoc, where its impacts seem much more detrimental. Still, a large number of winegrowers explain both the detrimental and beneficial impacts of climate change, highlighting the importance of understanding the various processes and factors that define the contextual vulnerability of vine growing and wine producing within their regional environment. For instance, seasonal warming may be beneficial for vine growing and berry ripening in a northern latitude region such as the Loire Valley, France. However, warmer springs also lead to an earlier onset in budburst, which expose the vines to a greater risk to spring frost.

Question: Where would you prioritise changes in viticultural practices and techniques to adapt to climate change?
The majority of winegrowers expect that continued climate changes is likely over the 21st century (Table 1). The weighted average show that 85% of winegrowers are expecting future climate changes, ranging between 71% for United States (US) to 94% for Chile (CL).

In order to understand the questions related to adaptation priorities and attitudes, only "yes likely" responses for future climate change awareness were considered.

Faced therefore with future climate changes, the priority for adapting viticultural practices and techniques varies greatly between countries, and among country participants as displayed by the regional study in France. Winegrowers were asked to rank a number of viticultural practices from highest to lowest priority. A certain number of countries are positioning their urgency on perennial practices, such as the choice of grapevine variety in Portugal (PT) and South Africa (ZA), planting sites in Spain (ES) and United States (US), or irrigation systems in Chile (CL) and Australia (AU). Some countries such as Japan (JP) or New Zealand (NZ) prioritize disease management practices, Hungary, harvest management practices or countries such as France (FR) or Italy (IT), considering soil management practices as the most urgent. These results highlight that several adaptation strategies are possible, where their priority will depend on the diversity and complexity of the local environment.

Conclusions

Using survey data collected from 18 wine producing countries, study findings have provided important insights on winegrowers' perceptions and adaptations to a changing climate. Indeed, the strong relationship between climate and wine imply that winegrowers are dealing constantly with climate variability and change, and therefore, their knowledge and inputs can be of great value in understanding the current and future state of the wine sector to climate change.

Moving forward, traditional European wine producing countries can even draw on the experience of vine growing and wine making in new world wine countries. Traditional European wine grape varieties are largely cultivated in those countries under warmer and dryer climates (such as in South Africa and Australia) than their native vine growing areas. And opposed to Europe, new world wine regions had to develop in the frame of a few decades many sustainable strategies to deal with local climate constraints, where the notions of innovation and geographical relocation are particularly developed to be competitive on the wine market. With a changing climate, those countries are acting as climatic analogues, allowing the European winegrowers to even obtain key technical and scientific knowledge on adapting practices and techniques to climate change, and to improve the resilience of their viticultural systems.

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References

Barbeau, G., Goulet, E., Neethling, E., Ollat, N., Touzard, JM., 2014**.** Les méthodes d'adaptation au changement climatique. In: Quénol, H. (Ed.), *Changement climatique et terroirs viticoles*. Lavoisier Editions Tec & Doc: Paris, France.

Neethling, E., Petitjean, T., Quénol, H., Barbeau, G., 2017**.** Assessing local climate vulnerability and winegrowers' adaptive processes in the context of climate change. Mitigation and Adaptation Strategies for Global Change, 22: 777–803.

Ollat, N., Touzard, JM., van Leeuwen, C., 2016**.** Climate change impacts and adaptations: New challenges for the wine Industry. Journal of Wine Economics, 11: 139-149

Parker, A., Hofmann, R., van Leeuwen, C., McLachlan, A., Trought, M., 2015. Manipulating the leaf area to fruit mass ratio alters the synchrony of total soluble solids accumulation and titratable acidity of grape berries. Australian Journal of Grape and Wine Research, 21: 266-276.

van Leeuwen, C., Seguin, G., 2006. The concept of terroir in viticulture. Journal of Wine Research, 17: 1–10.

van Leeuwen, C., Darriet, P., 2016**.** The impact of climate change on viticulture and wine quality. Journal of Wine Economics, 11(1): 150–167.