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IMPACTS AND ADAPTATION TO CLIMATE CHANGE : NEW CHALLENGES FOR THE FRENCH WINE INDUSTRY

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Abstract

Climate change will impact vine growing in France and the quality of wines in any regions. We summarized here the main information provided throughout the different contributions to this special issue. We attempted to draw some general conclusions in terms of adaptation strategies and to show how the interactions developed between scientists and actors as part of the LACCAGE project can contribute to fulfill the expectations of the French wine industry for the future.

Key words : climate change, grape growing, wine making, adaptation, perception, impact studies

Résumé

Le changement climatique aura des effets sur la culture de la vigne en France et affectera la qualité des vins produits dans toutes les régions. Nous synthétisons ici les enseignements des différentes contributions à ce numéro spécial. Nous tentons également de tracer des directions en termes de stratégies d'adaptation et essayons de montrer comment les interactions développées entre scientifiques et acteurs dans le cadre du projet LACCAGE peuvent contribuer à répondre aux attentes de la filière viti-vinicole française pour l'avenir.

Mots clés : changement climatique, viticulture, œnologie, adaptation, perception, études d'impact

According to the Vth Intergovernmental Panel on Climate Change report, recently released, climate change over the last decades is unequivocal and will continue for the following century (IPCC, 2013). In Northern hemisphere, the last 30 years were the warmest of the last 1400 years. Human activities have largely contributed to this global warming. The increase in average surface temperature by the end of the XXIst century is predicted to be likely over 1,5 °C in all the scenarios and up to 4,8 °C in the most extreme scenario 8.5 (atmospheric [CO₂] of about 1700 ppm). The Arctic regions and lands will warm up quicker than other regions and oceans. Precipitations will be affected with a larger range between dry and wet regions and dry and wet seasons. Sea level will likely increase from 0.26 to 1 m in the most extreme scenario.

As stated by all the contributors to this special issue of the *Journal International des Sciences de la Vigne et du Vin* (JISVV), these changes will impact vine growing in France and the quality of wines produced in any regions. Consequently, adaptation defined as “*the set of organization, localization and technical changes that societies will have to implement to limit the negative effects of climate change and to maximize the beneficial ones*” is a necessity (Hallegatte *et al.*, 2011). The main goal of adaptation strategies, as expressed by representatives of the wine industry, is to maintain yield potential and wine typicity at a regional level. To reach this goal, most actors of the wine industry, including scientists, first think of “technical solutions”, such as oenological methods, cultural practices or plant material. Because of the diversity in growing conditions and wine making processes around the world, many of these potential innovations are already used elsewhere. They only need to be exchanged between actors, then experimented and adapted to French vineyards (Tonietto *et al.*, 2014). Consequently, technical changes may not be a major challenge in the medium-term future. In France, the production, exchange and consumption of wine is heavily regulated by standards, rules and institutions, which monitor the technical innovations in the value chain as well as the location of the vineyards. Thus, institutional changes emerge as very important levers for adaptation to climate change. Economic aspects as well as evolution of consumer preferences will also have significant influences. Scientists and representatives of the wine industry also underline that local and regional levels are crucial for adaptation: on one hand, climate is diverse at interregional and intraregional scales

(Quénol and Bonnardot, 2014), making climate change impacts more or less restrictive from one region to another; on the other hand, production systems and wine characteristics also differ depending on the region and could be more or less sensitive and resilient. Northern regions have relatively more freedom with respect to adaptation in comparison to southern regions where, in the long term, bifurcation towards new systems may be more likely (Viguié *et al.*, 2014). We must also consider that each wine region fosters specific relations between research centers, technical institutes, professional organizations and wine producers, leading to different cooperative strategies, and probably different abilities to adapt.

There is a general agreement that temperature change will increase the earliness of all developmental stages of grapevine by 2-3 weeks to 40 days in the worse scenario. Yield is under the control of several climatic drivers such as atmospheric [CO₂], temperature and water supply. It is likely that yield will be reduced when water will become a limiting factor (Pieri and Lebon, 2014). Fruit composition has and will be further modified with a tendency towards higher sugar content, lower acidity, and modified polyphenol and aroma content. According to the observed correlation between bioclimatic indices and wine attributes, climate warming will probably affect wine quality (Tonietto *et al.*, 2014). The imbalance between primary and secondary metabolisms may increase, which will make the decision about harvest dates more difficult (Zamora, 2014). However, experimental data about the individual effect of climatic drivers on berry secondary metabolism are still scarce and difficult to collect. For example, experiments easily mimic heat waves, but warming over several seasons is much more difficult to assess. Information about the combined effects of climate drivers is almost inexistent. These scientific challenges need to consider not only responses to environmental constraints, but also adaptation mechanisms.

Climate change will not only affect grapevine development but the entire ecosystem and socio-economic system. On the ecosystem side, soil microbial activity and berry microflora will likely be modified. Grapevine diseases are also an important issue. Changes in the epidemiological pattern and geographical distribution of pests and pathogens are expected, but these topics are still very poorly addressed by the scientific community (Caubel *et al.*, 2014). On the socio-economic side, climate change will impact the technical and value chains from vine growers to wine consumers. Direct impacts include the economic costs, incomes and work organization at the farm level, the competitiveness of firms and wine

making regions, and conditions of transport and consumption. Indirect impacts, which integrate the consequences of adaptation strategies, will affect both the geographical distribution of vineyards and the institutional framework of the wine industry. Different options will be discussed during the next 30 years, and the labeling system (geographical indications) and market regulation will likely change, at least by taking into account new practices and new (re) locations of vines. As reported by various representatives of the French wine industry, actors should consider different climate change perceptions as well as a variety of adaptation strategies. The impacts of climate change have to be evaluated according to these strategies, which combine innovation, choice of location and institutional change.

Despite ongoing effort to reduce greenhouse gas emissions, adaptation is the only solution. Viticulture and wine processing have existed for more than 2000 years and have proved to be able to adapt to new conditions throughout this period. Consequently, drama is not an issue (Van Leeuwen *et al.*, 2013). The diversity of genetic resources, geographical and climatic conditions, and wine-producing systems is highly important for adaptation and has to be studied and used. However, in order to minimize the negative impacts, the rate of adaptation is a matter of concern. This special issue of JISVV gives an overview of possible technical adaptations for vine growing and wine making processes. Investing in research for improved scion x rootstock x training system less vulnerable to water stress or developing reverse osmosis facilities are “no regret” choices (Duchêne *et al.*, 2014). Oenological practices can be considered as the most flexible adaptation strategy with a short life span, but long-term costs and acceptance have to be considered (Zamora, 2014). Experimenting and planting late ripening varieties are also reversible strategies, because over grafting is always possible. Even if it appears as the most efficient and quickest way to cope with drought, investing in costly irrigation systems could be more hazardous on a long-term scale. Indeed, there are serious evidences that climate change will reduce water availability in regions where water is the major limiting parameter for yield. On a long-term scale, the conception and experimentation of more radical options have to be considered.

Developing scientific approaches to support adaptation processes in the wine industry is a major challenge, which becomes per se a lever for adaptation. It is without any doubt a multidisciplinary work, which starts by building a common view among scientists about the possible futures and the main

issues for the wine industry. It has been the first step of the LACCAGE project, leading bio-physicians and social scientists to release a special issue of JISVV. Strong collaborative research needs agreements about targeted climatic scenarios in terms of intensity and timing as well as agreements about strategic adaptation scenarios. Gathering and exchanging data, experimenting and modeling climate and processes at local scale, and confronting and integrating assumptions and explanations have to be strongly supported on a long-term scale. These tasks may be performed in close collaboration between scientists and actors of the wine industry: producers, institutional representatives, teaching and training institutions, sellers, decision-makers, and consumers. The representatives of the French industry clearly expressed that they are concerned about the forthcoming changes. They have already implemented mitigation and adaptation strategies and are familiar with adaptive options. They have already defined their goal, advocating for maintaining, as much as possible, the current productive system and type of wines. Scientists working on adaptation need to explore, compare and assess these actions and projects that are emerging in wine making regions all over the world. On the other hand, actors of the wine industry need references, new solutions, and climate scenarios for impact assessment combined with different options of adaptation. These cross contributions between scientists and actors can be achieved by the implementation of a foresight exercise, such as that programmed under the LACCAGE project (Ollat and Touzard, 2014).

All these issues and challenges are clearly the core of the LACCAGE project. Results and recommendations will not be absolute at the end of the project. The objective is to open the path and build a network to carry out this huge and decisive task for the future of the French wine industry. A lot of work remains to be done. This special issue of JISVV has helped us to define the main directions that should be taken.

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