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Water availability, use and governance in the wine producing region of Mendoza, Argentina

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ABSTRACT

This paper explores current and future issues of water availability and use in one of the world's major wine-producing areas, Mendoza Province in Argentina. The region is located close to the Central Andes and is characterized by an arid to semi-arid climate, which exacerbates pressures on land-use and water resources for wine production. The principal supply of water originates in the snow and ice fields of the nearby Andean peaks. Already under stress today, the environmental, economic and societal structure of the region, highly dependent on the wine industry, is likely to be vulnerable to climate change in the course of the 21st century. In this study, the possible impacts of shifting temperature and precipitation patterns and climate variability linked to extreme events and El Niño/Southern Oscillation ENSO on water resources in the region and consequently on the wine industry will be investigated. While climatic factors already today exert a major control on water availability, water use is also shown to be influenced by non-climatic factors, in particular overexploitation of the resource and a certain degree of opacity of policies related to water rights and water allocation. Climate model results for the future suggest that there may be important changes in the quantity and timing of stream flow, highly dependent on the Andean cryosphere where many glaciers are already rapidly shrinking today. The direct impacts of a changing climate on wineries include extreme events and also decreased water availability for irrigation in the long term. In view of the importance wine as a major income-earner for Argentina, public water policies will need to address both the issues of unreliable current water governance practices and the adaptations necessary to cope with a changing climate.

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1. Introduction

Wine production in the Province of Mendoza (western Argentina) is both the main source of economic income and the main consumer of water for irrigation. Any sustained change in climate, resulting not only in shifts in temperature and precipitation in the region, but also in the snow and glacier fields of the nearby Andes – the major source for surface waters downstream – may have significant impacts on the wine industry and the local to national economy as a whole. However, climate is not the only source of concern when assessing plausible future changes; indeed, there is a lack of legislation and regulation related to water allocation and use (Carbonneau, 2010) that also need to be taken into account.

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The region of Cuyo concentrates 98% of the population on 4% of Mendoza province (Morábito et al., 2009) and receives all its waters, upon which a large fraction of economic activities depends, from glacier melt in spring. The largest fraction of water used in the region is taken up by the wine industry (DGI, 2004), in particular because one of the most common irrigation practices is through inundation techniques that are obviously extremely resource-intensive. Under current climate conditions, the annual water balance is in deficit (i.e., more uptake than supply) and only 75% of the annual demand can be satisfied because of an annual deficit of 32 Hm^3 (DGI, Annex 4). However, those quantities remain hard to evaluate because of the lack of control and regulation by local authorities.

By necessity, the development of the region needs to be linked to good water management practices, which is unfortunately far from being the case. Addressing issues of long-term water scarcity thus needs to be a dominant priority for current and future water management policies.

Because of the high climate variability of the region, closely linked to El Niño/Southern Oscillation (ENSO) events in today's climate, and likely increases in extreme events such as heavy rainfall, hail and frost in tomorrow's climate, reductions in the availability of water associated with more intense/more frequent extremes could threaten the viability of the wine industry on the long term (e.g., IPCC, 2013). Indeed, wineries are very sensitive to weather and for each grape variety, optimal climate conditions are necessary to ensure an abundant harvest and grapes of high quality (Van Leeuwen et al., 2009).

Grape cultivation is generally viable in climates with a mean annual temperature "bandwidth" between 10 and 20 °C (e.g., Tonietto and Carbonneau, 2004). According to the grape variety, some grapes may be more robust at the upper end of the temperature spectrum, but others may be more adapted to cooled temperatures. Overall the quality of wines has been seen to improve in many regions, in part due to an increase in average temperatures in most regions where wines are cultivated, but also to new wine maturation techniques that today reduce the dependency of wine quality on climatic factors alone.

This study will therefore attempt to link both climate and regulatory factors to the wine industry in Mendoza and will focus on water use and water scarcity relations on both the short and long terms. Because much of the available surface waters are related to the presence and behaviour of snow and glaciers in the nearby Andes, the rapid decline of ice mass in the mountains as a consequence of atmospheric warming will have a significant influence on the seasonality, quantity and timing of maximum discharge in the future. This study will therefore report on the evolution of snow and glaciers and their influence on discharge of the Mendoza River, as well as shifts in water availability for irrigation for the wine industry in Mendoza. A further objective of this paper is to provide an overview of political, economic and social impacts of climate variability on the wine industry by highlighting the supply and demand side of water management under current and future climates.

2. Data and methods

Despite significant sparseness in the data available for the Mendoza region of Argentina (INV, 2010; INDEC, 2012; DGI, 2012) and inconsistencies in the quality of data (Masiokas et al., 2013; Leiva et al., 2008; Espizua and Maldonado, 2007; Compagnucci and Vargas, 1998) this work has attempted to highlight a number of climate tendencies of relevance to water availability by using a number of indicators, such as temperature, precipitation, stream flow, and snow water equivalent (SWE).

Temperature data is available for the Mendoza Airport which is located in the plains at the foot of the Andes. Unfortunately, this station is not representative of sites located in the mountains, which would have been more useful for analysing the time evolution of snow accumulation and melt, but many mountain recording sites have numerous gaps in the data. However, the Guido station, at an elevation of 1550 m (DGI, 2012; SMN, 2012) has been selected because it includes a hydrological gauging site that enables an estimation of the amount of discharge related to snow melt in the Mendoza river catchments (see the Map in Fig. 1).

As the Cuyo region is considered to be a desert, it is important to highlight the difference between precipitation at high elevations in the mountains and at lower altitudes in the plains. Indeed, the lowlands receive around 200 mm of liquid precipitation per year while the mountains receive on average 500 mm of snow precipitation. According to the season and to the variability of temperatures, precipitation will have a varying influence on snow accumulation and on water availability. ENSO has been based on the ONI (Oceanic Niño Index), which uses sea surface temperature data in the Niño Region 3.4 and analyzed on a monthly basis (NOAA, 2012).

Issues related to water policies, water allocation, and irregularities in the use and distribution have been established on the basis of legal publications, in particular the DGI (DGI, General Plan and 2020 Management Plan). Most of the qualitative analysis comes from interviews realized with local wine producers, local authorities and scientists. The questionnaire that helped establish the qualitative assessments in this study included items pertaining to the activity and production of wine growers (size of domain; whether export-oriented products; possible extension of the domain in the future, etc.), the perception of local actors to climate change and variability (whether the wine growers have noticed sustained changes in temperature or precipitation patterns; whether they notice different qualities of grapes that they may attribute to climatic conditions; whether they have or are considering adapting to extreme events – e.g., hail protection nets, etc.), and water usage (what type of irrigation is used; what sources of water are employed; whether there are problems of water salinization or contamination; whether droughts are considered to be a major issue; can wine-growers envisage cultivating grapes by using less water; etc.). These enquiries were undertaken to understand how local wine growers possibly perceive, if at all, problems of climatic variability, change, and water-scarcity. Although the small number of samples implies that the statistical robustness of the responses by wine-growers may be low, they do shed some light as to the overall feeling in the region that water shortage and climatic change is not an issue. In order to increase the sample size, semi-structured interviews (open discussions) with institutional stakeholders (e.g., water agencies) and scientists specialized in hydrology, glaciology and climate were conducted.

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