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The impact of climate change on the global wine industry: Challenges & solutions

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Abstract

This paper explores the impact of climate change upon the global production of winegrapes and wine. It includes a review of the literature on the cause and effects of climate change, as well as illustrations of the specific challenges global warming may bring to the production of winegrapes and wine. More importantly, this paper provides some practical solutions that industry professionals can take to mitigate and adapt to the coming change in both vineyards and wineries.

Keywords: Climate change; Global warming; Vineyards; Wineries; Policies

1. Introduction

Climate and weather have been critical to the story of human development. From the continuous movement of nomadic tribes seeking seasonal feed for their animals to the establishment of agriculturally based civilizations of Egypt, Mesopotamia and China, early humans were dependent upon the benefit and limitations of climate to establish roots and survive (Jones and Webb, 2010). However with the advent of the Industrial Age and the growing dependence upon fossil fuels, the widespread elimination of forests, and the expansive use of agrochemicals, there has been a slow, but steady, shift of the earth's average temperature upward, a phenomenon known as "global warming" (Burney et al., 2013; Jones and Webb, 2010; National Geographic, 2013; Venkataramanan, 2011; IPPC, 2013a).

Though there are some who do not believe humans have an influence upon global climate change, a commanding percentage of scientists have evidence to prove otherwise (IPPC, 2013a). In the past two decades, through private and government-sponsored initiatives, the world community is calling for increased attention to the worsening climate crisis (Iglesias et al., 2012; Schultz, 2010; IPPC, 2013a).

Though wine is not essential to human survival, wine is an important product of human ingenuity. All agricultural activity is decidedly dependent upon and inherently interconnected to climate and weather; grapes are no different. Though grapes are grown worldwide, premium winegrape production occurs within very narrow climate ranges. "Individual winegrape varieties have even narrower climate ranges…for optimum quality and production putting the cultivation of winegrapes at greater risk from both short-term climate variability and long-term climate changes than other crops (Jones and Webb, 2010)." Any shift in climate and weather patterns may potentially affect the wine industry. As a constant companion of human development and an important component of human economic activity, winegrapes, as an agricultural product, and wine (especially premium wine), as an economic commodity, are both at risk due to climate change.

Therefore the purpose of this paper is to explore the impact of climate change upon the global production of winegrapes and wine. It will begin with a review of the literature, including an examination of the cause and effects of climate change, as

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well as illustrations of the specific challenges climate change could bring to the production of winegrapes and wine. Next the paper will provide a list of practical solutions scientists and industry professionals can take to mitigate and adapt to the coming change in both vineyards and wineries. The third section provides suggestions for additional research on the topic, while the fourth section outlines limitations to this paper. It concludes with a highlight of major implications.

2. Review of the literature

In order to explore the impact of climate change upon global wine production and the potential challenges it could bring, this literature review will cover: (1) the definition and causes of global warming, (2) the shift in premium winegrape regions and grape variety cultivation, (3) the change in grape chemistry and the quality of wine, (4) the impact of a rising sea level and the loss of vineyard acreage, (5) the increase in insects and insect-borne diseases, and (6) the change in the quality of oak.

2.1. Definition and causes of global warming

Global warming is defined as the increase of the average temperature on the Earth. This includes both atmospheric and oceanic temperatures. Since the beginning of the twentieth century, the average global temperature has risen about 1.4° F, with about two thirds of that rise occurring since 1960 (IPPC, 2013a, 2013b). "The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change meeting every two years. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts (IPPC, 2013a, 2013b)." Though predictions vary widely, the IPCC believes that in the 21st century average global temperature could rise, if humans fail to mitigate the anthropogenic causes of global warming, by 11.5° F. With mitigation this rise could be reduced to 2° F. However, even at the lowest rise, the planet faces serious, if not catastrophic, results.

The primary cause of global warming is the "greenhouse effect." According to Venkataramanan (2011) when the Earth radiates the energy back toward space, it is sent in longer wavelengths than the energy received. While most of these longer wavelengths are still lost to space, a portion is captured by several atmospheric gases. This capture warms the atmosphere. Additionally, some of this energy is reflected back, once again, to the Earth's surface by these gases, slowly warming the surface of the Earth, especially the oceans (Tate, 2001). This process distributes heat and maintains the relative consistency of the Earth's climate, weather and ocean current patterns.

The primary "greenhouse gases" found naturally in the atmosphere are "water vapor, which causes about 36–70% of the greenhouse effect; carbon dioxide (CO_2), which cause 9–26%; methane (CH_4), which causes 4–9%; and ozone (O_3), which causes 3–7% (IPPC, 2013a)." Other greenhouse gases are soot, sulfur hexafluoride, nitrous oxide, and the chlorofluorocarbons once found in aerosol sprays (Venkataramanan, 2011). Any increase in the concentrations of these greenhouse gases would thicken the atmosphere, intensify the capture of re-radiated heat, and warm the Earth. Since the advent of the Industrial Revolution, and especially in the last half century as the global population and energy consumption have skyrocketed, this is precisely what is happening.

The increase in atmospheric greenhouse gases that causes global warming has several primary contributors: the burning of fossil fuels, widespread deforestation, the loss of natural "carbon sinks," oceanic acidification, the use of landfills, and large scale cattle and sheep ranching (Burney et al., 2013; Tate, 2001; National Geographic, 2013). The greatest contributor, however, is the rise in greenhouse gases, and the greatest contributor to the rise of greenhouse gases is the burning of fossil fuels (IPPC, 2013a). Fossil fuels are hydrocarbons formed from the buried remains of dead plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the earth's crust over hundreds of millions of years (Science Daily, 2013). According to the IPPC (2013a, 2013b, p. 2): "Fossil fuel burning has produced about three quarters of the increase in CO_2 from human activity over the past twenty years." Furthermore, coal burning, primarily for the creation of electricity, contributed 43% of total emissions; oil, for heating, contributed 34%; gasoline, primarily for transportation, 18%; and the balance is due to a variety of factors.

Deforestation is another powerful contributor to the increase of atmospheric CO_2. All plants are carbon-based and, as such, when they die, they decompose, releasing CO_2 back into the atmosphere. Large-scale removal of existing forest land, particularly by third world countries, for agriculture releases "enormous amounts of stored carbon (Venkataramanan, 2011)."

As the Earth's temperature rises, even slightly, another event occurs: the loss of "carbon sinks" (natural systems, such as arctic tundra, continental peat bogs, and oceanic phytoplankton, that store carbon over thousands of years). Tundra and peat are vulnerable to slight increases in temperature; their death and decay will release even more CO_2. However, according to Venkataramanan (2011), the greatest carbon sink are the oceans' phytoplankton reserves, holding 50 times as much carbon as the atmosphere. Rising ocean temperatures would increase the level of acid in the water ("acidification") in the form of carbonic acid causing "substantial reductions" of phytoplankton thereby releasing a potentially cataclysmic release of CO_2 as the phytoplankton reserves die. Current estimates suggest there has been a decrease in oceanic surface pH (an increase in acid) to 8.2 (a level capable of killing phytoplankton), a marker not reached in the last two million years (IPPC, 2013a).

Methane, a non-CO_2 greenhouse gas, is released from farm animals, especially livestock, and from landfills. In terms of its heat-trapping ability, a molecule of methane produces more than twenty times the warming of CO_2 (National Geographic,