CLIMATE CHANGE AND VARIABILITY IN ONTARIO'S WINE APPELLATIONS, CANADA

Tony, B. Shaw¹
& Don Cyr²

¹Department of Geography &
Cool Climate Oenology and Viticulture Institute
²Dean, Goodman School of Business
Brock University
St. Catharines, Ontario
L2S 3A1
Canada
Corresponding author: tshaw@brocku.ca
905-688-5550, Ext.3866

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Rationale
Ontario’s wine appellations comprise the Niagara Peninsula and the adjacent regions of Lake Erie Northshore, Pelee Island and Prince Edward County. Although the Great Lakes moderate their climates throughout the year, these areas are often incorrectly perceived as being on the climatic limits of successful commercial viticulture, owing to their cold, snowy winters and short cool growing seasons. Endowed with a favourable range of mesoclimates, topographies and soils, wine production has evolved slowly under a scrupulous system of site selection matched by suitable cold-tolerant international grape varieties. Although cold winters are the norm for this semi-continental climate, climate could threaten the stability of wine production. On one hand, these regions are likely to benefit from a warmer climate that could extend the growing season and moderate the severity of winter temperatures, allowing the production of cold-sensitive varieties and expansion of the industry into new areas.

In Ontario's wine appellations, the severity of winters has determined the spatial distribution of perennial fruit and vine crops, but warmer winters in a climate change scenario are not altogether beneficial. Winter damage could actually increase in Ontario’s wine regions due to reduced cold hardening during the fall, an increase in the frequency of winter freeze-thaw events, and a decrease in protective snow cover. In particular, an increase in winter free-thaw events would decrease the hardiness of the vines, and increase their sensitivity to cold temperatures in late winter. Also, damaging to dormant vines are temperature fluctuations within the winter season (repeated freeze-thaw cycles) and the annual variability that are related to the occurrences of extreme events. These can significantly affect the health of the vines and consequently, substantially reduce yields. Finally, climate change research generally suggests that extreme weather conditions are likely to increase in the future resulting in higher volatility of weather conditions in countries such as Canada.

Objectives and Methodology
The main objective of this research is to develop a prototype expert climate system to enable grape growers to adapt suitable vineyard management practices and grape varieties to projected changes in the regional climates of Ontario’s main wine appellations. The study will examine the projected increase in the number of heat units (>1400 GDDs (Winkler Index)), (>1800 GDDs (Huglin Index)) a frost-free period (>180 days), growing season diurnal temperature range (>10°C), maximum temperatures (>30°C), damaging minimum temperatures (<-20°C) and precipitation reduction in the growing season of <400 mm and their effects on the phenology, grape quality (sugar and acid content) and the per acre yield. Determining how these projected climatic changes will impact winter and the growing season conditions of the established grape varieties and yield in Ontario is crucial to the sustaining the production of quality grapes and therefore high-quality style wines. An accelerated increase in temperature could significantly increase the phenological stages of the vine thereby reducing the viticultural suitability of some varieties.

These objectives will be achieved by (i) analyzing the daily historical climatic data from the 1960 to 2011 period for six representative locations in Ontario’s wine region using linear regression analysis (to determine long-term trends in the critical viticultural indices and climatic variables, (ii) providing a baseline analysis of the temperature and precipitation data for the 1961-1990 normal period (iii) employing the Canadian Regional Climate Model (CRCM) predictive model based on three greenhouse emission scenarios (2020s, 2050s and 2080s)

**Benefits**

Many factors influence climate change and the interaction of these factors is very complex, predicting future changes involves some degree of uncertainty. However, this is new research that is especially crucial for the wine industry due to its acute sensitivity and vulnerability to the climate variability. Grape yield and quality are greatly dependent on climatic conditions. Therefore, determining how the climate of these regions evolve over the next thirty years is crucial in developing adaptive strategies in order to reduce risks and optimize the growing conditions. In particular, this aspect of the project will assist growers to reduce the risks related to climatic hazards such as freeze damage, extreme maximum temperatures and high precipitation during the harvest. It will also assist growers to plant grape varieties that are most suited to the climate of the respective wine region and allow them to produce wines of consistent quality in the highly competitive Ontario market. The industry currently consists of about 500 growers and 140 estate wineries. 

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