Climate Change and the Evolution of Canada’s Wine Appellations

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THE MAIN VITICULTURE AND FRUIT GROWING AREAS OF CANADA
• Trends in Spring
• Trends towards and early warm up
Evolution of Winkler Index for Granby, Estrie Region Quebec

Lucy Kuhlman
Ste. Croix, Chancellor, De Chaunac
Vidal, Seyval, Marechal Foch

Region I
Trends in GGDs For Niagara Region
1970-2015

- Merlot
- Cabernet Sauvignon
- Cabernet Franc
- Sauvignon Blanc
- Chardonnay
- Chasselas
- Pinot Noir
- Chardonnay
- Gamay
- Riesling
- Pinot Gris

Region I
Region II
Chasselas
Pinot Noir
Chardonnay
Gamay
Cabernet Franc
Riesling
Gewürztraminer
Region I
Long-term trends in Growing Degree Days For Vines (1970-2016, Norfolk County)
Trends in GDDs Value For Huron County

Region I
Evolution of South Okanagan’s Wine Climate, British Columbia

- Cabernet Sauvignon
- Merlot, Syrah, Cabernet Franc, Sangiovese, Malbec, Chardonnay, Riesling

Regions:
- Region I
- Region II
- Region III
Evolution of the Winkler Index

(a) NIAGARA

(b) LAKE ERIE NORTHSHORE

(c) PRINCE EDWARD COUNTY

Syrah, Petit Verdot & Grenache
Merlot, Cabernet Franc, Cabernet Sauvignon & Sauvignon Blanc
Chasselas, Pinot Noir, Chardonnay, Gamay, Riesling, Pinot Gris & Gewürztraminer

Syrah, Petit Verdot & Grenache
Merlot, Cabernet Franc, Cabernet Sauvignon & Sauvignon Blanc
Chasselas, Pinot Noir, Chardonnay, Gamay, Riesling, Pinot Gris & Gewürztraminer

Chasselas, Chardonnay, Cabernet Franc, Riesling, Gamay, Sauvignon Blanc, Pinot Noir, Pinot Gris & Gewürztraminer
Mean Growing Season Temperature
Observed and Projected Changes in GDDs to 2070s using the downscaled HADCM3
**A2**- Scenario- A heterogeneous world, increasing population, slower and fragmented technological change

**A1B**- Rapid population that peaks in mid-century and declines followed by rapid introduction of energy-efficient technologies and a balance between fossil and non-fossil fuels

**B1**- A convergent world, population peaks in mid-century, and declines, global solutions and emphasis on social and environmental sustainability
Past and Future Growing Degree Days
Niagara, Ontario, Canada

GDD Baseline 10°C

Year

Past and Future Growing Degree Days
Niagara, Ontario, Canada
Pa st and Future Climate Normals Growing Degree Days
Niagara, Ontario, Canada

GDD Baseline 10°C

- Observed 1971-2000
- Observed 1981-2010
- Observed and Modelled 1991-2020
- Observed and Modelled 2001-2030
- Modelled 2011-2040
- Modelled 2021-2050
- Modelled 2031-2060
- Modelled 2041-2070

A2  A1B  B1
Observed and Projected Extreme Minimum Temperatures
What are Extreme Climate Events in Viticulture

• An extreme climate event is the exceedance of a threshold value by a climate variable on a particular occasion or one or more occasions within a time period for a particular crop.

• Extreme events are relatively more sensitive to the variability of climate than to its average and this sensitivity is relatively greater the more extreme the event.

• Extreme events can also be defined by the impact an event has on vineyard production that may involve excessive loss in yield and deterioration in quality or the destruction of the vines.
Trends in Potentially Damaging Temperatures <-20° C

(a) NIAGARA

(b) LAKE ERIE NORTHSHORE

(c) PRINCE EDWARD COUNTY
Potentially Damaging Temperatures <-20°C (Norfolk)
Trends in the Lowest Temperatures for January at Vineland
Occurrences of Extreme Maximum Temp > 30°C

(a) NIAGARA

(b) LAKE ERIE NORTHSOIRE

(c) PRINCE EDWARD COUNTY
• **Definition:** Volatility is the pace at which a climatic variable or index (temperature or precipitation) moves higher or lower over a time period, and how widely it varies or how extreme is the fluctuation.
Daily temperature Variations December 1/16 to March 3/2017
Precipitation Variability during Growing Season for Niagara, 1970-2014  Mean=528mm
Ice Wine and Climate Change
Vineyard Scale
Hand Picking icewine
grapes
Trends in Ice Wine Picking Days For December
Trends in Picking Days For January
Trends in Ice Wine Picking Days in Dec & Jan (1970-2016, Niagara Ontario)
Great Lakes and Climate Change
March 2016 Ice Cover
Lake Ontario’s Ice Cover vs GDDs Values For Niagara

GDDs

Ice Cover
April – October Precipitation For Vineland
Trends in Growing April-October Rainfall Totals

(a) NIAGARA

(b) LAKE ERIE NORTH SHORE

(c) PRINCE EDWARD COUNTY
Past and Projected Climate Normals
Growing Season (AMJJASO) Total Precipitation
Vineland, Ontario, Canada
Extreme Precipitation Events

31-50mm yearly precipitation from 1930-2012

$y = 0.002x + 2.4567$
Temperature During the Ripening Period
(a) NIAGARA

(b) LAKE ERIE NORTHSHORE

(c) PRINCE EDWARD COUNTY
Trends in Diurnal Temperature Range During Ripening Period

(a) SEPTEMBER

Lake Erie North Shore

Prince Edward County

Niagara

(b) OCTOBER

Lake Erie North Shore
Niagara Max and Min T For September

Degree C

Temperate
Cool
Very Cool

DTR
Vineland's Lowest Fall Minimum Temperatures

September

October

November
Precipitation During Ripening to Harvest
August Rainfall Totals for Vineland 1970-2013

September Rainfall Totals for Vineland 1970-2013
October Rainfall Totals for Vineland, 1970-2013
Precipitation Totals for September and October

(a) NIAGARA

(b) LAKE ERIE NORTH SHORE

(c) PRINCE EDWARD COUNTY
Impacts and Implications
Winter Freeze Damage

- **Positive**: Reduction in number of damaging winter extreme minimum freeze events <-20 degrees

- **Negative**
  - **Prolonged temperatures above 0o C can reduce cold hardiness**
  - Winter damage could actually increase due to occurrences of warm freeze-thaw events followed by cold snaps
  - Therefore, freeze damage could occur at a higher minimum temperatures for varieties with low chilling requirements
Implications for Viticulture in the Long-Term

• Impact on Vine Phenology

  **Spring**

  • Positive: Earlier bud break and flowering

  • *Negative: Potential damage from late spring frosts* for varieties with early bud break
April to October  Growing season

- **Positive**
  - Warmer and longer growing seasons could enhance ripening potentials for red and late season varieties

- **Negative**
  - More volatility in growing season conditions leading to a greater degree of variability in vintages

- **Positive**
  - Potential for Full maturity of mid to late season varieties (Merlot and Cabernet Sauvignon)
  - Expansion into new areas around the Great Lakes currently considered climatically marginal

- **Negative**
  - Accelerated ripening for early season varieties
  - Lower acidity and higher sugar and alcohol levels due to higher daytime and night-time temperatures
Climate Change Adaptation Strategies

- Most studies on adaptive strategies consider implementation based on experiences with recurrent environmental and viticultural challenges.

- Examples of adaptation based on long-term future projections of climate change are uncommon.

- Anticipatory adaptive strategies present many challenges due to uncertainties in future climate change projections.

- Combine reactive and anticipatory adaptive strategies.
Farming systems respond not only to environmental conditions, but also to economic, technological, institutional, political and social conditions. Any changes in these areas can be disruptive and costly.
Reactive Strategies
Diversify the Number of Cultivars and Growing Areas

• Expand the range of commercial varieties, but must consider consumers’ preferences

• Target new Areas with suitable soil types and climates (In progress in emerging areas)
Implement Active and Passive Freeze Protection Methods
Currently widely practised by growers
Hedging Winter Injury and Vintage Variations

• Consider Insurance Policies and Institutional Support to hedge against losses from freeze injury and variations in vintage quality and yield

• Government support for technological innovations is a key driver in development of the adaptation and mitigation strategies related to climate change
Blending

• Blending the same varieties or different varieties from several areas or vineyards to reduce vintage variations and to create unique sensory attributes
Monitoring Systems

• Develop Micro-climate Monitoring Systems to assess evolution of established areas and to identify new areas

• Should include real time and archived data of key climatic parameters and indices for long-term analysis

• Monitoring various stages of plant phenology, fruit maturation and harvest

• (Vine Alert System and Vine and Fruit Tree Innovation Monitoring Systems)
Climate Change

- Long-Term Adaptation Strategies Through Institutional Support

- Develop cold-resistant varieties to accommodate cycles of freeze and thaw and higher chilling requirements
- Develop disease-resistant varieties
- Develop Climate Prediction Models for analysis at smaller spatial scales
Conclusions

• Potential impacts are mixed containing challenges and opportunities
• Adaptive strategies in response to recurrent climatic events and economic factors are widely practiced
• What strategies we should implement in anticipation of future changes will depend on accuracy of our forecasts and support from various governmental and academic institutions
Thank You
Thank You
Implications for Viticulture in the Long-Term

- **Impact on Vine Phenology**
  - **Spring**
  - **Positive:** Earlier bud break and flowering
  - **Negative:** Potential damage from late spring frosts

- Earlier veraison and ripening

- **Impact on Quality**
  - Accelerated ripening for early season