Impacts of Climate Change on Wine Production: A Global Overview and Regional Assessment in the Douro Valley of Portugal

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Talk Outline

- Climate Influences, Risks, and Challenges
- Climate Structure and Suitability
- General Overview of Climate Change Impacts on Viticulture and Wine Production
- The Douro Demarcated Region Assessment
- Summary and Future Work
Weather and Climate present three distinct spatial and temporal scales of influences and risks to viticulture and wine production:

- **Individual Weather Events (short-term/localized)**
  - Hail, frost/freezes, heavy rain, etc.

- **Climate Variability (seasonal-decadal/regionalized)**
  - Dry or wet & warm or cold periods

- **Climate Structure/Change (long-term/regional-global)**
  - Average temperatures, rainfall regimes
  - Warming, cooling, changes in moisture regimes

**Climate Influences, Risks, and Challenges**

- **Crop Risk**
- **Production & Quality Variability**
- **Suitability**
Climate Structure, Suitability and Change
Wine Production and Quality Metrics

Yield/Production
Balanced Composition
Typical Varietal Flavors
Vintage Ratings/Price

Climate Metrics
Growing Season Temperatures, Heat Accumulation

Variety-Climate Thresholds

Too Cold Threshold
Lower sugar levels, Unripe flavors, Unbalanced

Optimum Zone
Consistent sugar levels, Ripe flavors, Generally balanced - Vintage variations driven by seasonal climate factors (frost, untimely rain, etc.)

Too Warm Threshold
Lower retention of acids, Overripe flavors, Unbalanced

Plasticity – Adaptation Management (short-term) Varietal (long-term)
- All varieties have inherent climatic thresholds for optimum quality and production characteristics.
- Pinot Noir exhibits one of the most narrow climatic niches for premium quality production.
- From what we know about today’s Pinot Noir regions, growing season average temperatures range from ~14-16°C, or ~a 2°C climatic niche.

Jones, 2006
Climate Change Effects on Viticulture/Wine

- Changes in average climate structure and variability
- Warmer and longer growing seasons
- Warmer dormant periods
- Reduced frost damage (in some areas)
- Altered ripening profiles
- Earlier phenology (plant growth events)
- Altered/new disease/pest timing and severity
- Changes in soil fertility and erosion
- CO$_2$ fertilization ... but wine effects?
- Water availability and timing of irrigation (some places drier, some wetter)
The Douro Demarcated Region
Douro Demarcated Region

- 1st demarcated wine region with controlled regulations for production and quality
- Covers ~252,000 hectares
- Vineyard area represents ~45,600 hectares or 18% of the total land area
- Produces both the classic Port wines (79%) and also dry wines (21%), made from 78% red and 22% white cultivars
- Research and innovation in the region is being carried out by ADVID, fostering knowledge of and adaptive capacity to climate change
Douro Demarcated Region

- Vila Real
- Peso da Régua
- Alijó
- Pinhão
- São João Pesqueira
- Pocinho
- Vila Nova de Foz Côa
- Almendra
- Barca d’Alva

Baixo Corgo
Cima Corgo
Douro Superior

Elevation (m)
High: 1408
Low: 42

Distance Scale:
0 5 10 20 30 40 Kilometers
Douro Demarcated Region

Annual Precipitation (mm)
High: 1625
Low: 604

Baixo Corgo
Cima Corgo
Douro Superior

Vila Real
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Douro Demarcated Region

Climate Change Research Areas

- Organize and examine historic climate data for the region, develop spatial climate products
- Develop models examining climate influences on:
  - Vine Growth
  - Production
  - Quality
- Examine climate projections across a range of IPCC SRES and time periods
- Provide growers/producers information on the range of potential changes and mitigative/adaptive responses
1951-2000 Growing Season (Mar-Sep) Average Temperatures

- **Baxio Corgo**: 17.8
- **Cima Corgo**: 17.5
- **Douro Superior**: 18.0

<table>
<thead>
<tr>
<th>Region</th>
<th>Median</th>
<th>Δ 1950-2000</th>
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<tbody>
<tr>
<td>Baixo Corgo</td>
<td>18.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Cima Corgo</td>
<td>18.3</td>
<td>0.8</td>
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<tr>
<td>Douro Superior</td>
<td>18.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

A2 - 2050

A2 - 2080

Data Source: WorldClim HADCM3 (Hijmans et al. 2005) 1km resolution

Prepared by: Gregory V. Jones, PhD
Douro Demarcated Region

- Average growing season temperatures (GST) over the DDR during 1950-2000 were 17.8°C (+/-0.9°C)
- Station trends in the DDR show +2.0°C warming in GST over the last 40 years
- HADCM3 A2 projection to 2050 is for GST over the DDR of 20.2°C (+/-1.1°C)
- GST changes of these magnitudes will likely shift viticulture to higher elevations, closer to the coast, require irrigation, and/or shifts to other heat and stress tolerant varieties
Summary

Climate Structure and Suitability
- Incomplete understanding of global structure and suitability for all varieties, especially the upper limits

Climate Variability
- Variability in wine region climates as increased and is projected to increase even more in the future; need to understand the range of the variability and extremes

Climate Change
- Observed warming is evident, some benefits and opportunities, but negative impacts have occurred
- Meta-Analysis indicates a \( \sim 1.5-2.5^\circ C \) warming in wine regions globally by 2050, but uncertainties exist
Summary and Future Work

Douro Demarcated Region

- Very important wine region for Portugal; large economic impact, rich cultural heritage
- Already warm and dry with heat and water stress in most years, small changes in climate may push regional suitability thresholds sooner than other regions
- Large genetic potential and adaptive capacity

Future Work

- Further develop the understanding of spatial climate structure and range of observed and projected changes
- Further develop plant, production, and quality models
- Assist growers/producers with mitigation/adaptation to reduce vulnerability and increase adaptive capacity
Thank You!

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