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

Climate Influences, Risks, and Challenges

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.

Crop Risk

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

Production & Quality Variability

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

Suitability

Climate Structure, Suitability and Change

Variety-Climate Thresholds

Too Cold Threshold
Lower sugar levels,
Unripe flavors,
Unbalanced

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

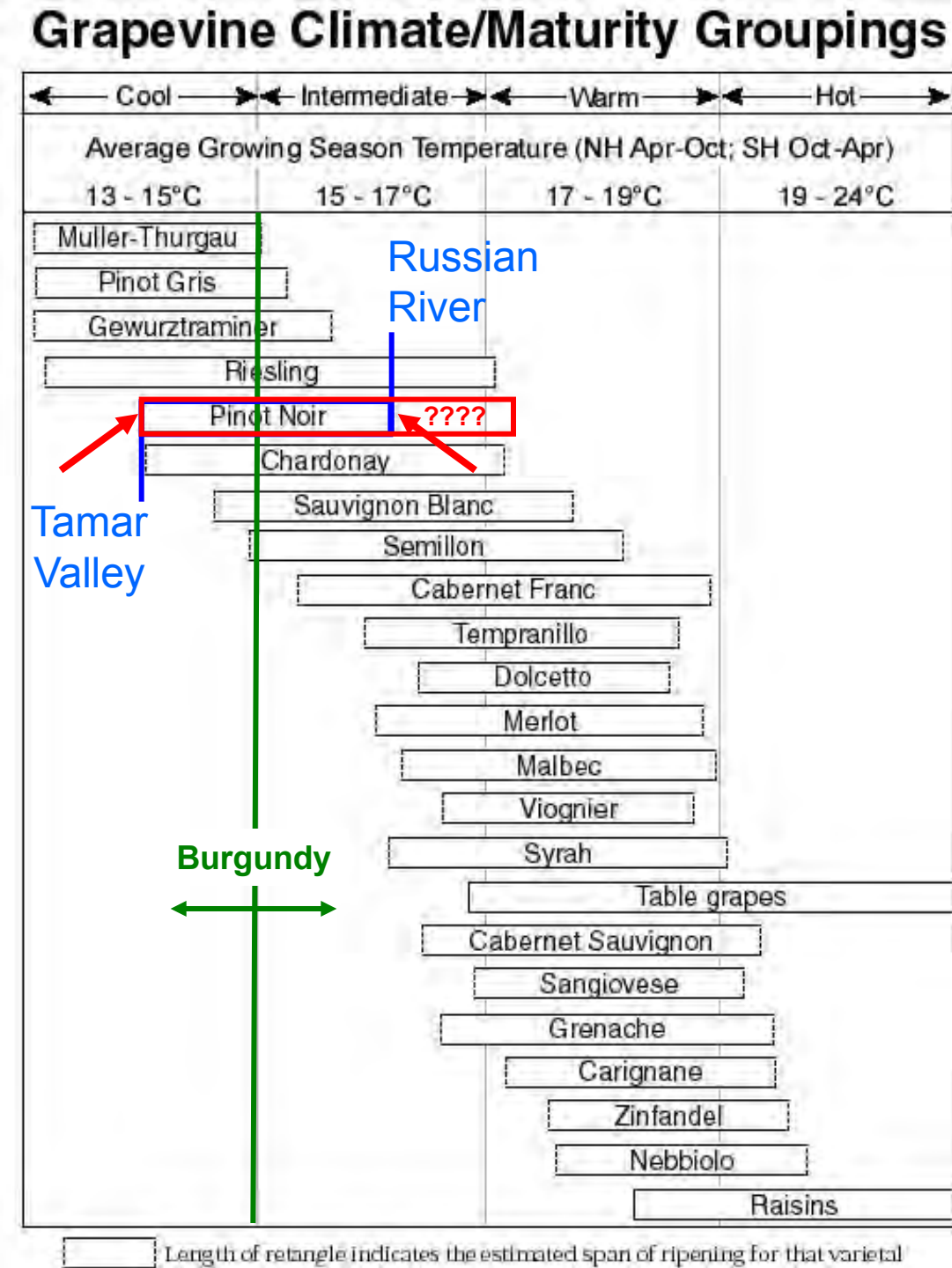
Plasticity – Adaptation
Management (short-term)
Varietal (long-term)

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

Wine Production and Quality Metrics
Yield/Production
Balanced Composition
Typical Varietal Flavors
Vintage Ratings/Price

Climate Metrics
Growing Season Temperatures, Heat Accumulation

- 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

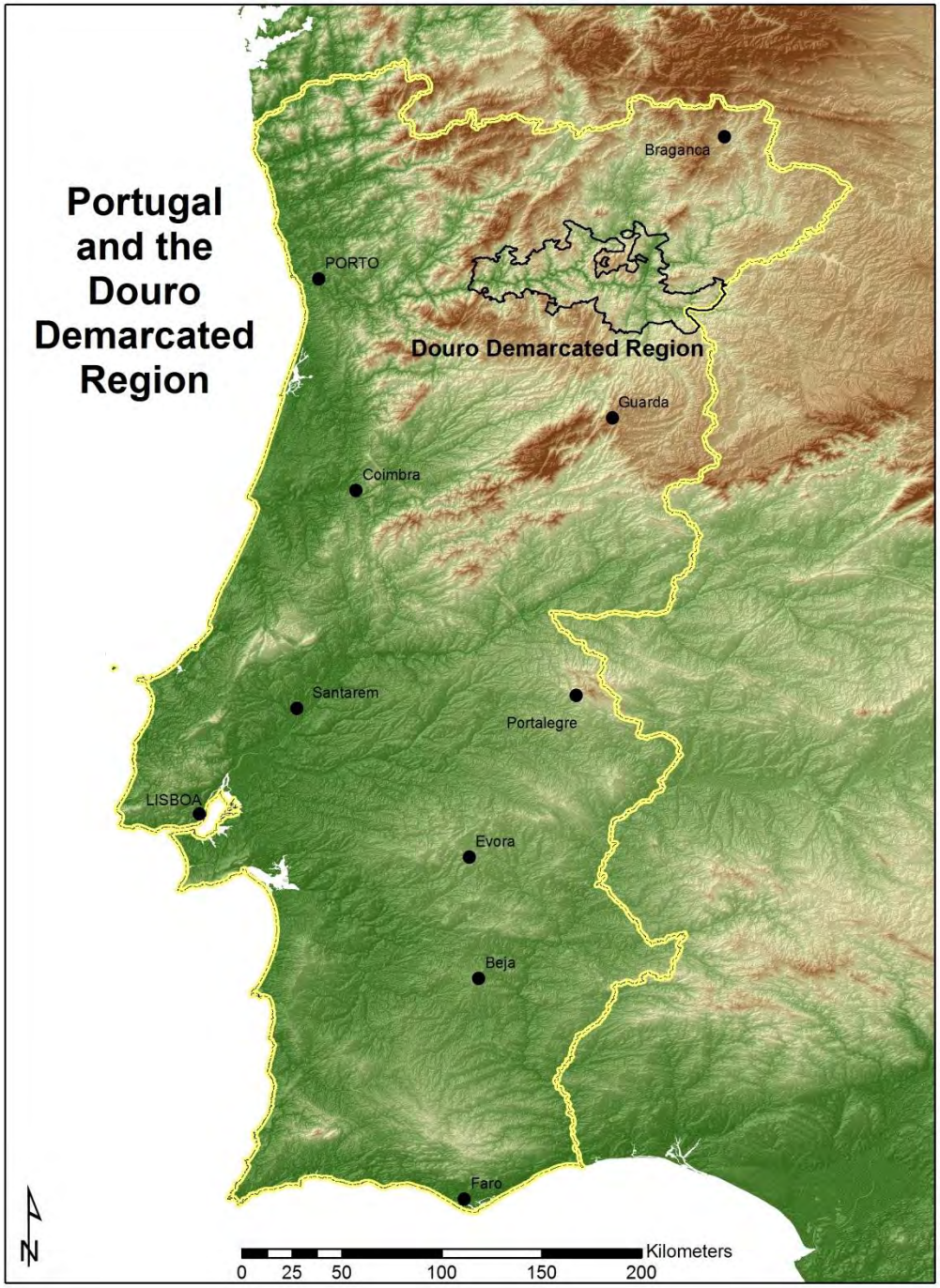
Climate Change Effects on Viticulture/Wine

- 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)

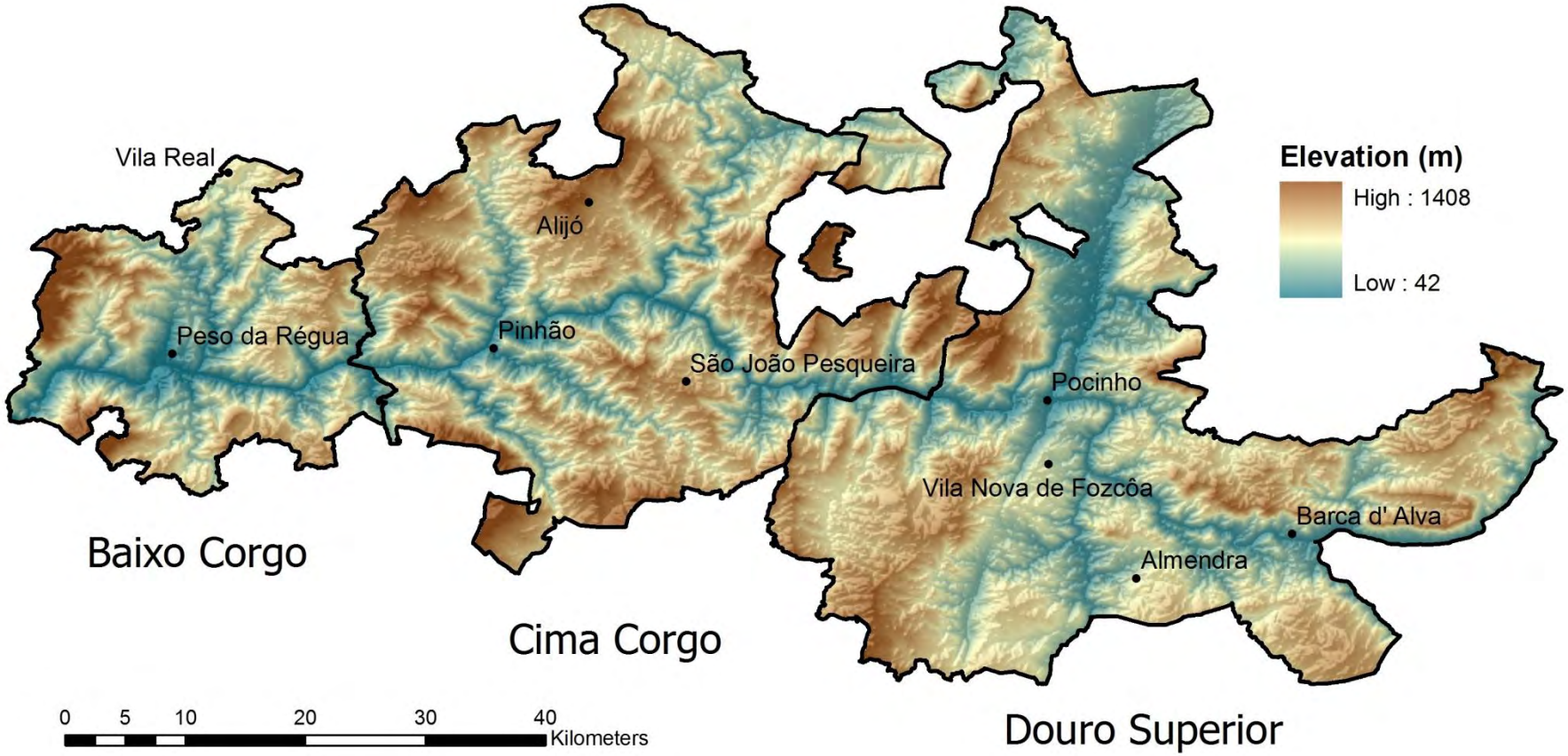
The Douro Demarcated Region

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



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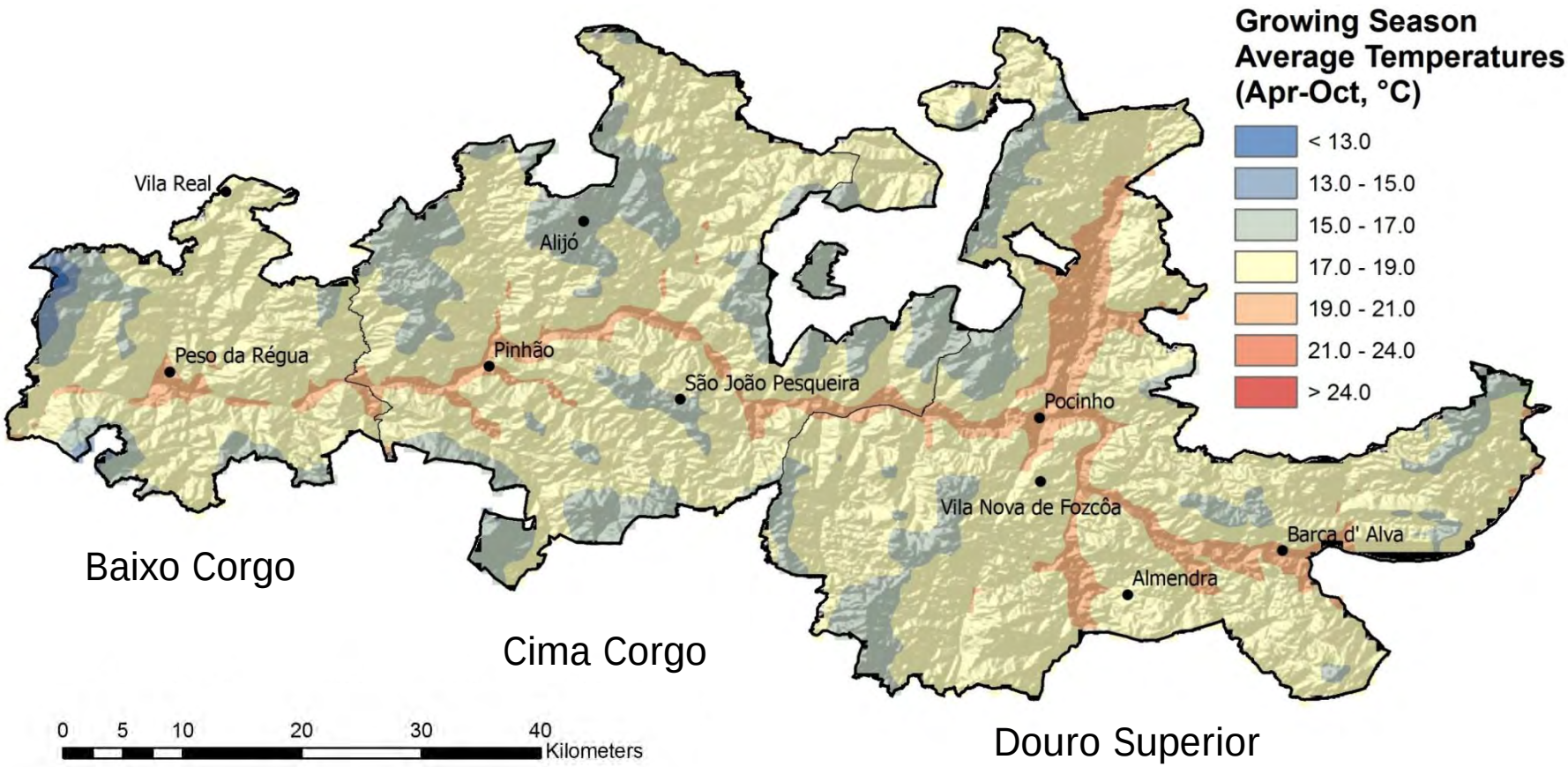
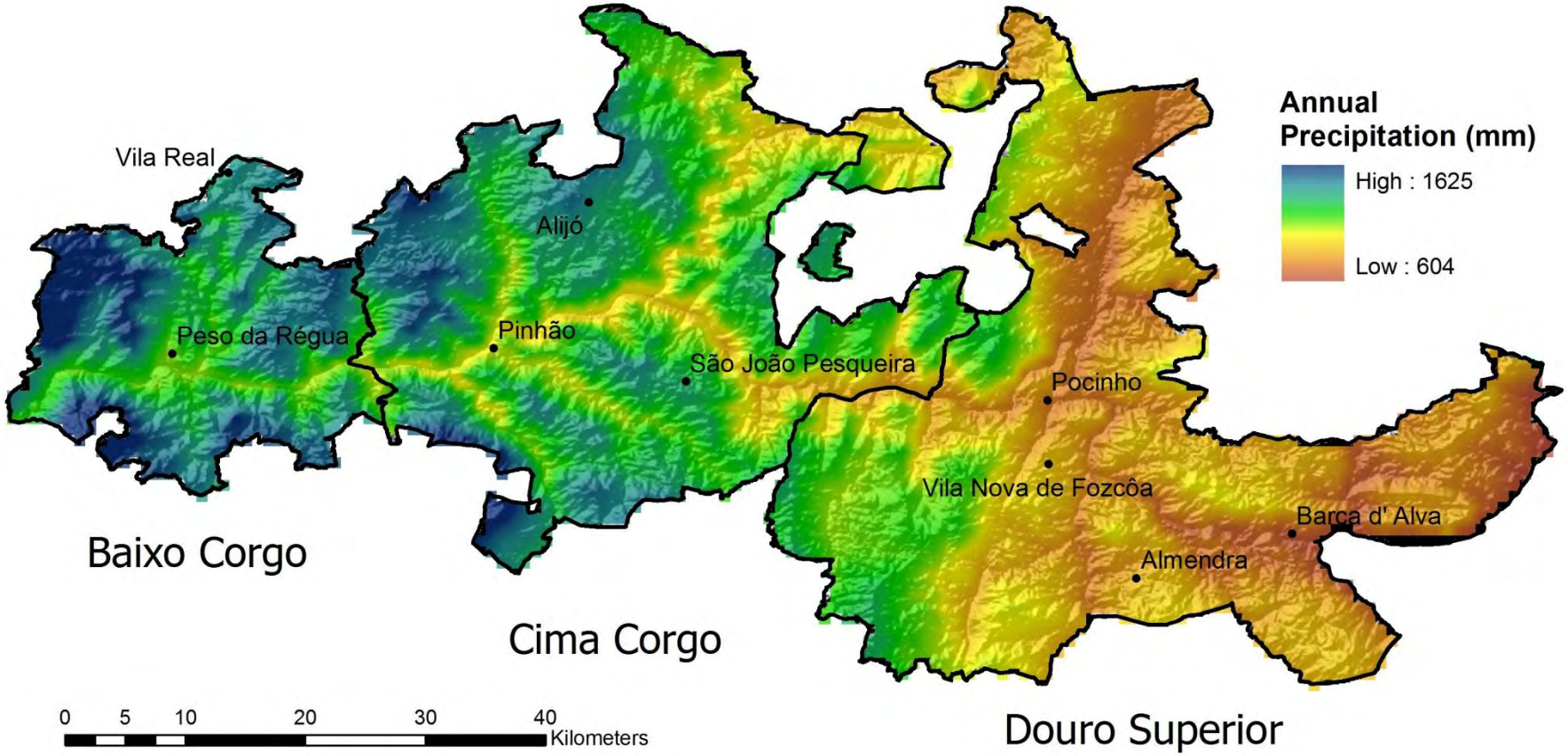
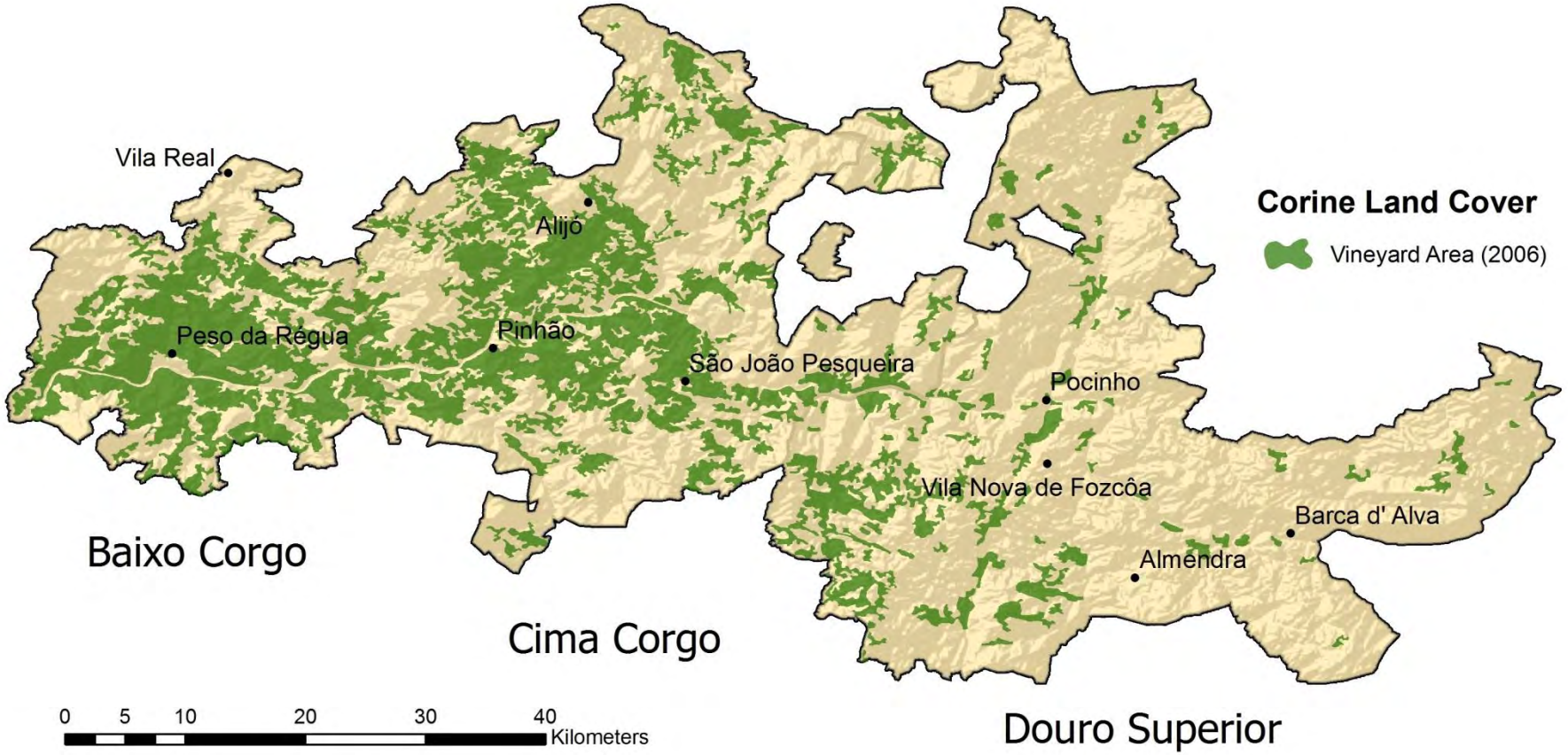


Douro Demarcated Region



Douro Demarcated Region



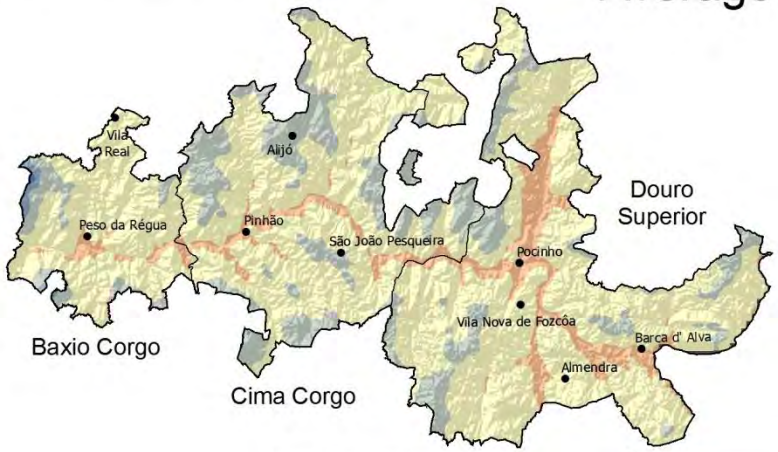
Douro Demarcated Region

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

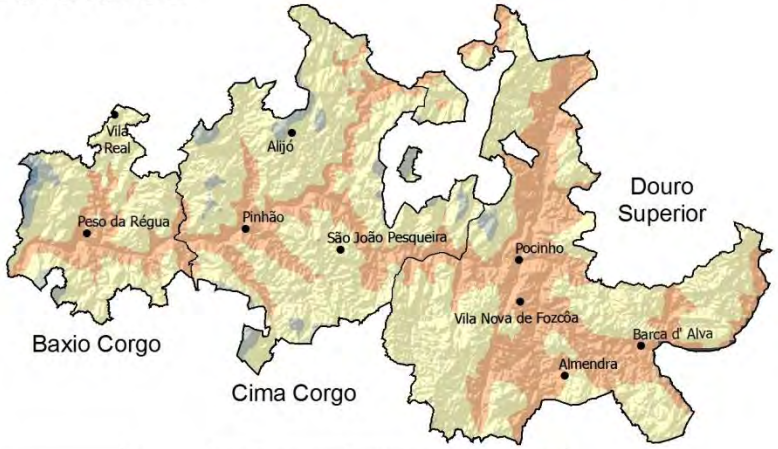
Growing Season (Mar-Sep) Average Temperatures

1951-2000



Region	Median
Baixo Corgo	17.8
Cima Corgo	17.5
Douro Superior	18.0

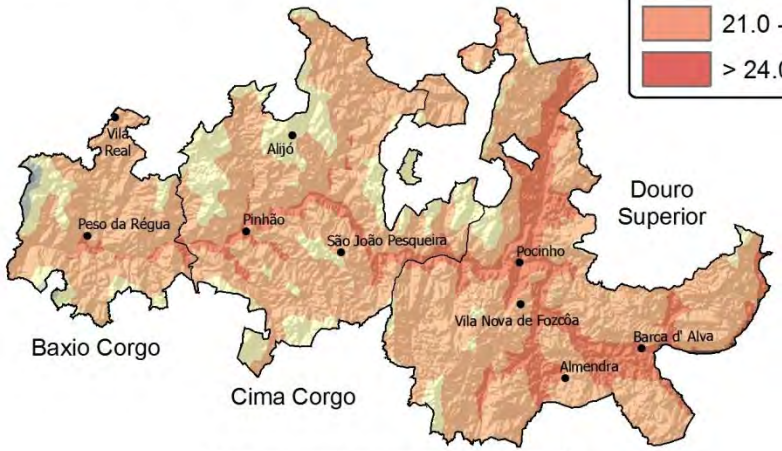
A2 - 2020



Region	Median	Δ 1950-2000
Baixo Corgo	18.5	0.7
Cima Corgo	18.3	0.8
Douro Superior	18.9	0.9

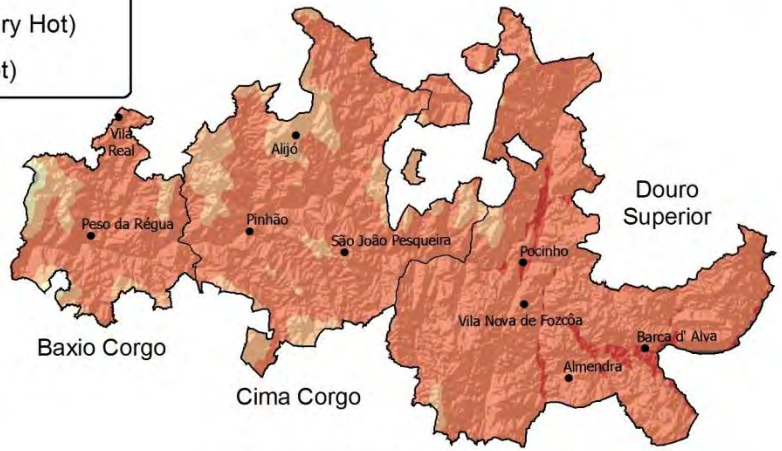
- < 13.0 (Too Cool)
- 13.0 - 15.0 (Cool)
- 15.0 - 17.0 (Intermediate)
- 17.0 - 19.0 (Warm)
- 19.0 - 21.0 (Hot)
- 21.0 - 24.0 (Very Hot)
- > 24.0 (Too Hot)

A2 - 2050



Region	Median	Δ 1950-2000
Baixo Corgo	19.7	1.9
Cima Corgo	19.6	2.1
Douro Superior	20.4	2.4

A2 - 2080



Region	Median	Δ 1950-2000
Baixo Corgo	21.6	3.8
Cima Corgo	21.7	4.2
Douro Superior	22.7	4.7

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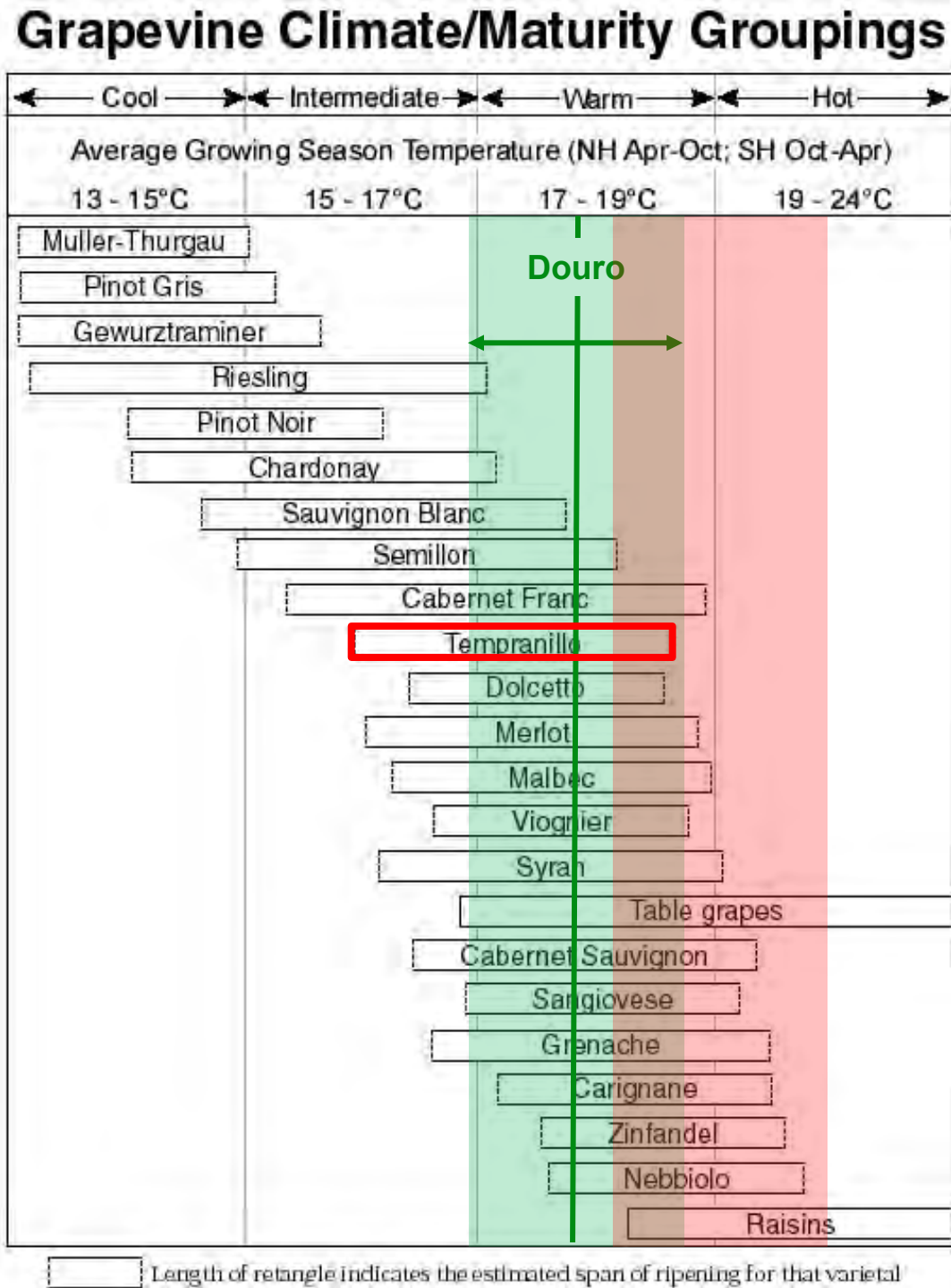
Data Source: WorldClim HADCM3 (Hijmans et al. 2005) 1km resolution

0 5 10 20 30 40 50 Kilometers

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 ~1.5-2.5°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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