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## "Wine-Growing and Global Warming: What Lessons for Prune Production?"

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### INTRODUCTION

Grapevines are an **excellent climate proxy**:

- 1) global presence
- 2) the plant's natural cycle evolves yearlong in phase with the weather.

**Method:** Current research into the impact of **global warming (GW)**  
on **wine-growing in mid-latitude vineyards**.  
Predictive models for wine-growing at the end of the **21st century**.

**Results:** This allows the present and future impact of GW on wine-growing  
to be assessed.

**Conclusion:** What lessons can be drawn from this for **prune production**?

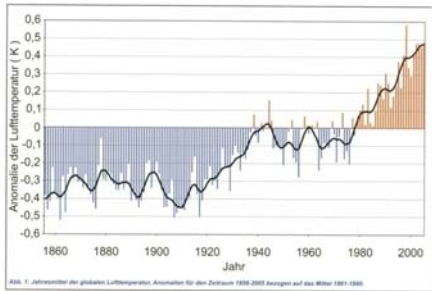
**Outline:**                   **Global Warming (GW)**  
                                  **Wine-Growing and Prune Production**  
                                  **Consequences of GW on Wine-Growing**

# I) GLOBAL WARMING

## 1) AN ONGOING REALITY

### • AT A GLOBAL SCALE :

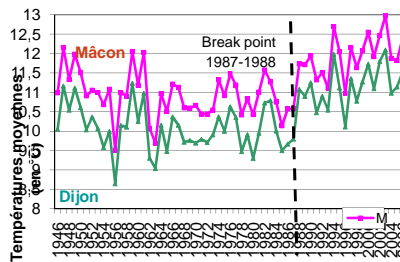
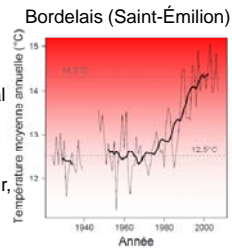
- × average GW: + 0.75°C in the 20th century
- × a sharp, strong, lasting rise in temperature from the 1980s onward (a break in the curve)
- × other parameters, e.g. rainfall, show more complex evolution



Der Klimawandel, 2007.

### • AT A REGIONAL SCALE (France)

- In Burgundy:
- + 1.2°C mean annual temperature;
  - GW in all seasons;
  - Change in rainfall: even lower in summer, even higher in winter.



## 2) GW, a very strong PROBABILITY for the end of the 21st century

- Link between greenhouse gases and GW; link between GW and human activity  
Anthropogenic effect proved with regard to increase in main greenhouse gases (except H<sub>2</sub>O)  
e.g. increasing CO<sub>2</sub> comes from a rise in fossil fuel burning.

- all IPCC ([Intergovernmental Panel on Climate Change](#)) predictive models indicate **increasing GW**

### • Still under debate:

#### amount and rate of GW?

Size of temperature increase (between +1.1°C and +5.4°C); speed of increase. A great deal depends on policies to limit greenhouse gas emissions

#### What is the impact of GW at a regional level?

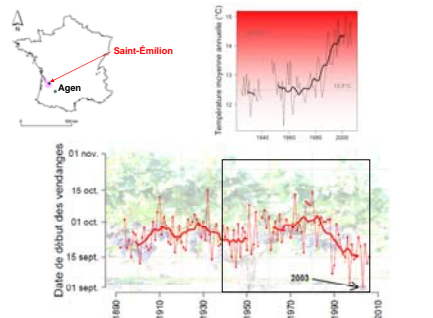
### 3) A METHODOLOGICAL QUESTION:

Does GW have a **key role** in the evolution of agricultural conditions?  
Does the climate effect **outweigh** the anthropogenic effect?  
(agricultural and commercial practices)

For grapevines, in France, **the answer is clear**: phenology (the link between climate and vegetative stages) responds chiefly to GW

- coincidence in time:

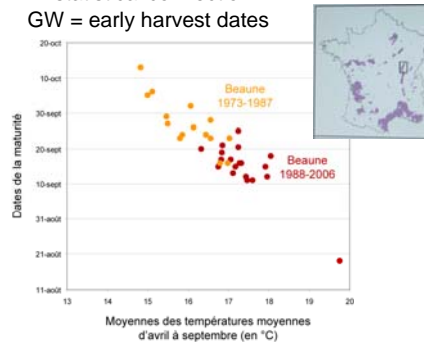
GW and grape harvest dates



Date de début des vendanges à Château Cheval Blanc (Saint-Émilion)  
Source : B. Bois et K. Van Leeuwen (Comm. Personnelle)

Grape harvest start date, Château Cheval Blanc, St Emilion  
B. Bois & K. Van Leeuwen (Pers. comm.)

- statistical connection:  
GW = early harvest dates



Evolution of temperature and grape harvest dates  
in Beaune

## II) WINE-GROWING AND PRUNE PRODUCTION

### 1) Similar ecosystems

### 2) Similar ecosystems: Does GW lead to identical fates?



### 3) A regional example: the “wine-growing climate” for the end of the 21st century in the USA.

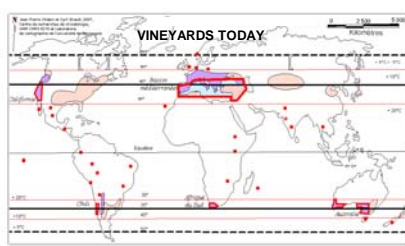
## 1) SIMILAR ECOSYSTEMS

- Similar ecosystems in relation to geography

### VINEYARDS AROUND THE WORLD

The main vineyards are found in **mid-latitudes**, from 30-50° north and 30-40° south, with mean annual temperatures of 10-20°C; rainfall = 200-2000 mm.

But the largest wine-growing areas are found in a **MEDITERRANEAN TYPE CLIMATE**.

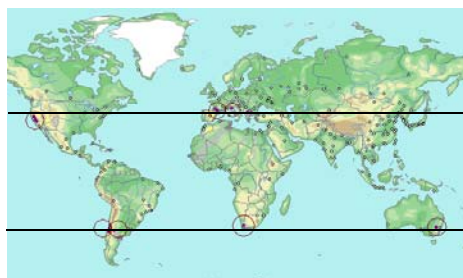


### PLUMS FOR PRUNE PRODUCTION AROUND THE WORLD

Mainly in the same zones as vineyards

Climates with hot, dry summers (**Mediterranean type**)

Main difference: in south-west France and in the **region of Agen, the climate is milder**, and less hot and dry in summer than the Mediterranean type.



[www.ipaprunes.org](http://www.ipaprunes.org)

### Similar ecosystems at the phenological level

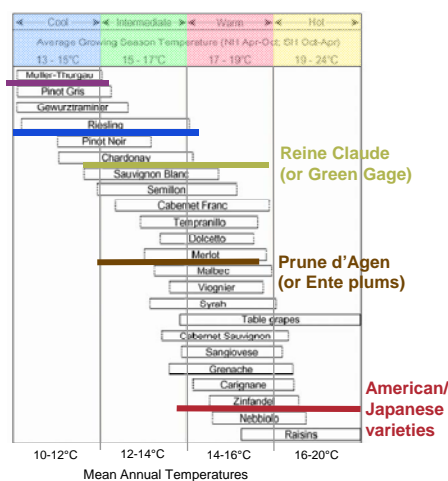
\* This figure by Gregory Jones (Southern Oregon University) shows that:

- the link between **grape maturity** and climate zone (temperature) defines **four potential temperature bands for quality wine-making**;

- these bands allow **each grape variety** to cover a more-or-less extensive area and adapt to climate variability;

\* temperature bands constructed for **plum varieties** along the same lines can be **superimposed** on the grapevine model.

### Grapevine climate/maturity groupings



Adapted from Gregory Jones (2007) completed by Jean-Pierre Chabin and Bernard Lafargue (2009, INRA Bordeaux)

**2) Similar ecosystems:  
Does GW lead to identical fates?**

- Yes, on a general point of view

Example of south-west France (Agen):

- From 1950-79, "normal" temperature; from 1990-2006, first GW effects.
- Will the exceptional climate of 2003 be repeated in 2100?

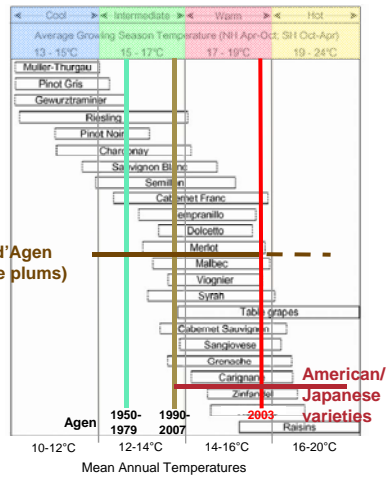
**GW affects wine-growing and prune production in the same way.**

In both cases, the same tactics must be brought into play:

Either a different, better adapted, variety must be used;

Or the traditional variety must be modified to adapt to GW.

Prune d'Agen  
(or Ente plums)

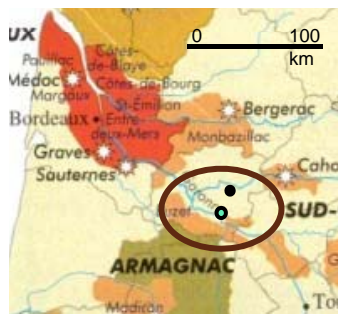
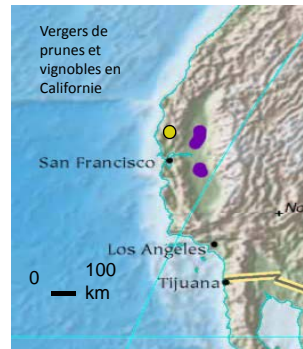


And there is **the same** ecological dynamics: + 1°C = + 200 km to the North (or the South) and + 150 / 200 meters in altitude.

- But there are two major differences:

At local and regional scales, the sites are different:

e.g. California



and south-west France

- Agen
- Villeneuve-sur-Lot

○ Main plum-tree orchards (Ente plums)

And the plant varieties and the types of agriculture are also different: in particular, irrigation makes prune production less natural, and makes plum trees more vulnerable to GW.

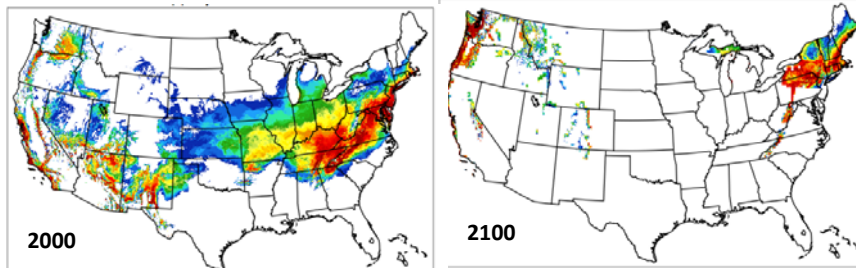
So, although the same stress factors affect both wine-growing and prune production...

... their futures may be different ... unless GW changes the situation completely.



**3) A regional example: the “wine-growing climate” for the end of the 21st century in the USA, with projected GW near the upper limits (+5°C during the century).**

Example of the spatial evolution of suitable wine-growing regions (in Gregory Jones, 2007).



Growing degree-day suitability, red high - blue low

Average warming and increases in temperature extremes by 2100:

- Indicate potential reduction of viable production acreage for high to premium quality wine by up to 81%.
- Resulting in shifting of viable zones, toward the coast, upward in elevation, and to the north.

**Consequence: prune production seems to be even more severely affected than wine-growing.**

**III) CONSEQUENCES OF GW ON WINE-GROWING  
(in mid-latitudes)**

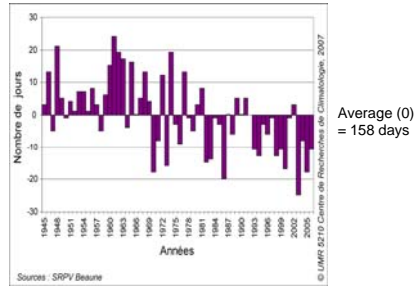
- 1) PHENOLOGICAL CONSEQUENCES: CURRENT STATUS
- 2) PHENOLOGICAL AND ECOLOGICAL CONSEQUENCES:  
WHAT FUTURE?
- 3) SPATIAL CONSEQUENCES: NEW WINE-GROWING MAPS?



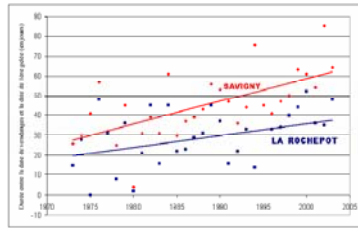
## 1) CURRENT EFFECTS OF GW ON THE PHENOLOGICAL CYCLE:

- **“Economical” cycle length:**  
More rapid, shorter cycle: under 20 days for Beaune.

Evolution of budburst/ripeness in Beaune (Pinot Noir)



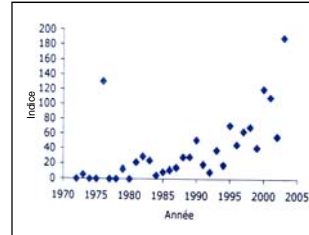
- **“Ecological” cycle length:**  
Longer in autumn



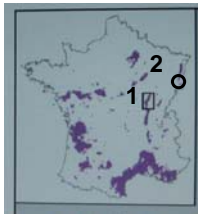
Length of time between grape harvest and first frosts in Côte-d'Or for Pinot Noir (C.Bonnefoy, 2007)

Therefore:  
Little or no winter rest

A high level of photosynthesis  
Plant reserves reconstituted at the end of the year...usable the following year.



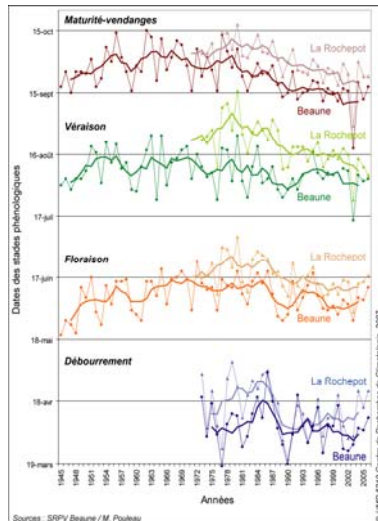
Evolution of theoretical biomass production potential after harvest for Riesling in Alsace (E..Duchêne and C. Schneider, 2007)



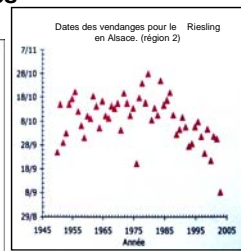
Each stage starts earlier.  
This tendency increases in the final stages.

The main consequences of this evolution: vintage quality has been ensured for the past 20 years...

### • Timing of phenological stages



Evolution for Pinot Noir in the Beaune area (2007) Region 1.



(E.Duchêne and C. Schneider, 2007)

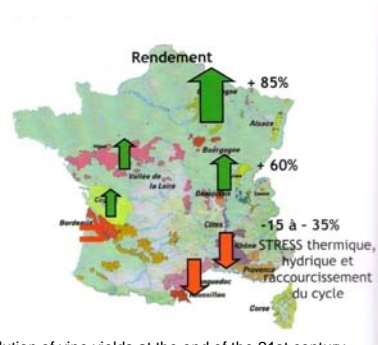
Therefore grape-harvest dates are brought forward: 13 days in Beaune (from September 27 to September 14) over the compared time-intervals: 1973-1987 and 1988-2006.

But traditional hierarchies have been destabilised (e.g. Burgundy).

## 2) PHENOLOGICAL AND ECOLOGICAL CONSEQUENCES, AS GW CONTINUES TO INCREASE: WHAT CAN BE SAID ABOUT THE FUTURE?

- The major risk in traditional vineyards is the loss of wine individuality and quality.

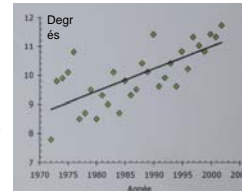
The problem of **higher yields** in northern vineyards: "carbon fertilization" and increased photosynthesis are the main causes.



Evolution of vine yields at the end of the 21st century (Inaki Garcia de Cortazar Atauri, Conf. BIVB, 2007)

Wine from all vineyards suffers from **excess sugar and insufficient acidity...**

Average degree of alcohol at harvest for Riesling in Alsace (E. Duchêne and C. Schneider, 2007)



...And, to make matters worse, **ripening** under a hotter, drier climate **burns off aroma and standardizes the harvest...**

**Consequence :**  
**"We will no longer be able to make such fine wines" (a wine-maker).**

**But quantity is incompatible with quality, in this case.**

### • Ecological risks

New risks: **disease** moves north with insect carriers

Increased risks: **flooding and erosion** from torrential rainfall



Storm on 10 June 2008, Côte de Nuits (Fixin)



Persistent risks: danger from **spring frosts** (April) if bud-burst is early (March)



### 3) SPATIAL CONSEQUENCES (FOR 2100?)

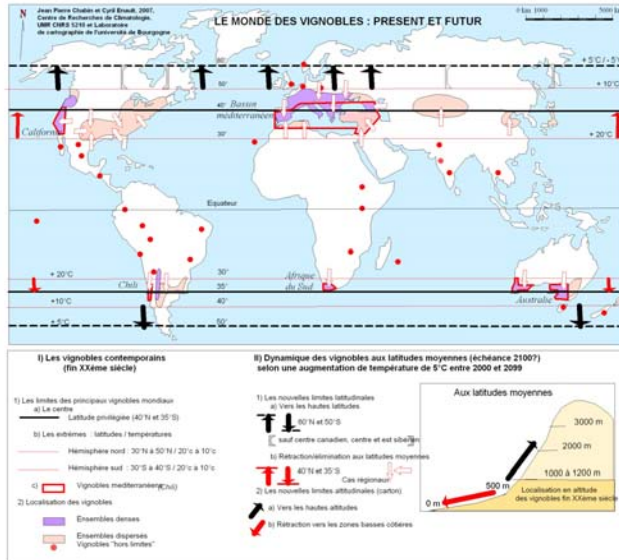
• Worldwide:

\* to higher latitudes and altitudes

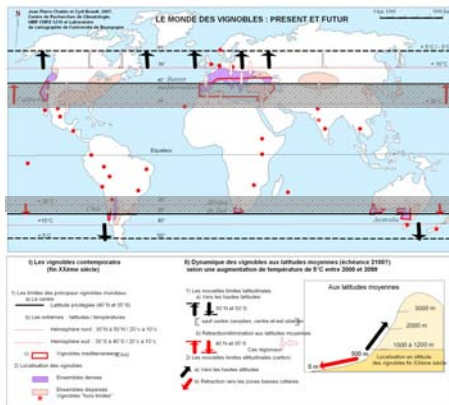
With GW at +5°C in the 21st century, vineyards will relocate:

**1000 km** beyond traditional limits (60° north and 50° south, apart from inner continental areas)...

And from **800 to 1000 m** in altitude.



### \* The losers: vineyards in Mediterranean-type and continental-type climates



Mediterranean latitudes will be outside the limit (with GW at + 5°C in 2100)

The same problems, but much worse for Mediterranean vineyards

Why? As global temperatures increase, Mediterranean latitudes **will be off the scale of optimal climate conditions**. The climate will be far too hot and dry.

Current problems: lower yields, over-ripeness, no dormant period in winter

**Future solutions?**

**IRRIGATION?**

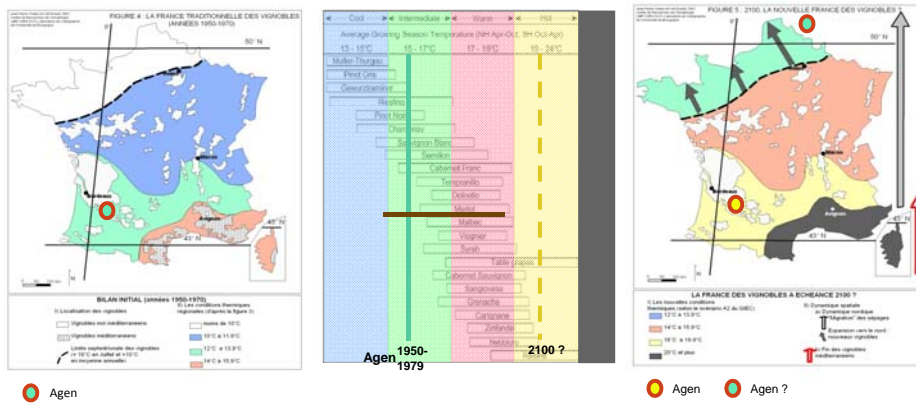
Impossible to generalize because of GW.

**RELOCALIZATION:**

to higher altitudes, or lower coastal zones or river banks.

• **Consequences in France: change, move or disappear?**

**Mediterranean vineyards: shrink or disappear**  
(as in other Mediterranean-type regions of the world)



**Other traditional wine-growing areas** will not disappear, but will be subjected to new climate conditions (hotter and drier) depending on region and GW evolution.

**Solutions: adapting traditional grape varieties? Or planting new grape varieties?**

**New wine-growing areas in the north** = transfer of grape varieties, and new competitors.

## CONCLUSION

**1) What conclusions can be drawn for prune production?**

**a) Two laws affect the future of wine-growing and prune production**

**Interdependency** of ecosystems:

an identical problem for both

**Interactivity**: systemic logic at play

GW affects crops...but agricultural practices affect GW (and other factors in the environmental crisis)

**b) Prune production is more sensitive to GW than wine-growing for two main reasons:**

prune production takes place in warmer climates;

prune production is more dependent on irrigation, but this could present a major risk for the near future.

**2) The answer? Can only be “global”...**

but with **local** forms for different activities: like the “carbon plans” developed in certain wine-growing areas to limit the effects of GW.



Michel Steib, “Ploughing by horse in the clos des Amoureuses, Vougeot”  
www.equipages-en-bourgogne.com

**AND, I THANK**

**Mr. Christian AMBLARD and the promoters** of this Congress for their invitation in Agen;

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