Comment la viticulture européenne conçoit son adaptation au changement climatique et quelle place elle peut tenir vis à vis de la production mondiale dans les prochains décennies dans le contexte de dérèglement climatique ?
A sense of place

Château Johannisberg, Geisenheim, Germany

50th degree latitude North

Hans R. Schultz
A sense of place
# Outline

- some key factors on global grape production
- Regional Trends for some grape growing areas
- The water issue
- Soils, the under rated climate factor
- Biodiversity and genetics
- Other challenges
The image of Viticulture

Tuesday, 1st of December 2015
The start of the Paris climate summit
LACCAVE : Long term impacts and adaptations to Climatic Changes in Viticulture and Enology

Objectives: 1- to predict at a long term scale, the impacts of climate change on grape growing and wine making, 2- to build-up the necessary knowledge to develop innovations allowing the required adaptations, 3- to propose adaptation strategies at the level of the wine industry (including viticulture) and 4- to evaluate their economic, sociological ad environmental consequences. 5-To unify and structure the french research on this issue, in order to interact with the growers and wine industry, and to be part of the international network on CC.

Coordination : Nathalie OLLAT – Jean Marc TOUZARD
Diminishing yields in Australia correlated to changes in the climate?

Webb et al. 2013 nature climate change 26 February
Questions

- are recent fluctuations in global (regional) yield climate driven?
- spring frost, hail, drought; 2017 had everything, climate driven?

Spring frost 19.4.2017-21.4.2017, Lake Constance, Rheingau area
some key factors on global production

Regional Trends for some grape growing areas

The water issue

Soils, the under rated climate factor

Biodiversity and genetics

Other challenges
Global Viticultural zones

Temperature isothermes during the growing season (12-22 °C)
Northern hemisphere (Apr.-Oct.), southern hemisphere (Oct.-April)

Isothermes move to the poles~280-500 km (basis 2000)
extension NH, reduction SH

Warming has occurred everywhere and continues...
The variety question, Truth and speculation - Consequences of misunderstandings

Fig. 1. Global change in viticulture suitability RCP 8.5. Change in viticulture suitability is shown between current (1961–2000) and 2050 (2041–2060) time periods, showing agreement among a 17-GCM ensemble. Areas with current suitability that decreases by midcentury are indicated in red (>50% GCM agreement). Areas with current suitability that is retained are indicated in light green (>50% GCM agreement) and dark green (>90% GCM agreement), whereas areas not suitable in the current time period but suitable in the future are shown in light blue (>50% GCM agreement) and dark blue (>90% GCM agreement). Insets: Greater detail for major wine-growing regions: California/western North America (A), Chile (B), Cape of South Africa (C), New Zealand (D), and Australia (E).

Climate change, wine and conservation  
Hannah et al. 2013, www.pnas.org/cgi/doi
Grapevine Climate/Maturity Groupings

Response of OIV-group climate:


Why climate change will not dramatically decrease viticultural suitability in main wine-producing areas by 2050 (2013) PNAS, 1307927110, 1-2

Jones et al. 2005; Climate Change 73: 319-343
Questions

- Is the increase in temperature a problem for some grape varieties?
- What is the adaptive potential?
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Production systems climate and landscape have always been related

Exposition and slope (evapotranspiration)

High precipitation rates and rel. High temperatures

Water distribution

Increase in climatic variability

Access to water

Water availability/hail

Decrease of precipitation in winter
Dryness indices are getting better but are still only rough indicators of current and past vulnerability.

Including the CO₂ effect on water use.

The Clausius-Clapeyron relationship tells us, a 1°K (or 1°C) warming at 15 °C means about a 7% increase in evaporation but it also means a 1-2% increase in precipitation!

In some regions we find increases in evaporative demand according to theory, however in many regions we don’t!

Regional effects need to be studied carefully.
Observations and simulations (hydrological summer)

May-October

ETp Geisenheim 50° N, 7,9° E obs.
precip. obs.
ETp simulated
precip. simulated

ETp Oakville (Napa) 38,3° N, 122,2° W obs.
ETp Avignon 43,9° N, 4,9° E obs.
precip. Avignon observed
precip. Oakville observed

Year
1960 1980 2000 2020 2040
potential Evapo-transpiration (ETp) (mm)
precipitation (mm)

ETp

Geisenheim, D

Oakville, Ca, USA
Avignon, F

P

French data: DB, CLIMATIK, Agroclim, INRA; German data: Deutscher Wetterdienst; US data: IPM set, Univ. of Calif. Davis
<table>
<thead>
<tr>
<th>Difficult terroir</th>
<th>Degree of slope</th>
<th>Total evapotranspiration (mm/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0°</td>
<td>791</td>
</tr>
<tr>
<td></td>
<td>15°</td>
<td>872 (+81)</td>
</tr>
<tr>
<td></td>
<td>30°</td>
<td>998 (+207)</td>
</tr>
</tbody>
</table>
Surface water run-off (erosion)

Difference to 1961-1990, 30 year mean

Increase in surface run-off (mm/year)

<table>
<thead>
<tr>
<th>Year</th>
<th>CLM-ECHAM5</th>
<th>CLM-HADCM3</th>
<th>REMO-UBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr-Sept</td>
<td></td>
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<td>Oct-March</td>
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</table>

(INKLIM III, Hofmann and Schultz unpublished)
These differences are also one of the reasons we need specific regional based modelling efforts.

Expl. REMO-UBA, changes in drought days 2041-2070 minus baseline 1971-2000, region Rheingau, Germany.
Questions

- Why is the potential evapotranspiration in some areas increasing (according to theory and all model predictions); why is it constant and even decreasing in other areas (South Africa, Australia, China) against theory and model predictions?
- Will irrigation be the only solution or other means (rootstocks a.s.o)?
- Water use in a future world – in which direction?
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Climate effects on soils, increase in **soil temperature** (the Potsdam time-series)

Since **1889** strong warming May-August (1m depth **2.4° - 3.2°C !!**)

Soil temperatures at different depths as compared to air temperature

Böhme und Böttcher, Klimastatusbericht des Deutschen Wetterdienstes 2011
soil GHG emission estimation

simulated annual total soil (root and soil) respiration rate (g C m\(^{-2}\) year)

- soil respiration, Geisenheim, Germany
- 10-year running average
- Projections A1
- Projections A2
- Projections B1

Year
1900 1950 2000 2050 2100

+ 15 %

C\(_4\) source or sink?

Measurements: Lehmann and Löhnertz (2014) unpublished

Measurements Franck et al. (2011) New Phytologist 192, 939-951

+ 15 %

3. Soils are the key to sustainability its our most valuable resource

But soils in Viticulture are mostly C-sources and not C-sinks, and 0.4% increase in C-sequestration in the soil PER YEAR are unrealistic.
Modeling of soil nitrogen dynamics (first estimates)

Schultz, Ehlig, Hassemer-Schwarz unpublished
Questions

- soil carbon, how to increase it?
- underground dynamics of nitrogen, how to control it?
- how to add biomass without degradation of water quality through nitrogen leaching?
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Genetic progress/genetic losses: We have a large clonal and varietal variability – but the potential is largely unused

Expl. Italy, around 400 varieties in production

Expl. French varietal catalogue (Pinot noir) 48 clones (318 varieties / 820 clone) Catalogue des variétés et clones de vigne en France

We do not use disease resistant varieties, although they exist, we have not sufficiently exploited the gene pool around us
The rootstock question needs to be newly addressed.

The Geisenheim Population – Phenotypic Variance

- Large spectrum of „biotypes“
- *V. berlandieri* approx. 3800

Joachim Schmid, Institut für Rebenzüchtung, Hochschule Geisenheim
Questions

- selection and collection projects are expensive, could there be an international effort?
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Sustainable disease management – may be the greatest challenge

- Old problems are becoming more difficult
- New diseases
- Wood diseases
- New insects
- There are certainly more surprises ahead

2016 was a European downy mildew disaster
Never before was such a disease pressure observed
Worldwide wine risk map (James Daniell of the Karlsruher Institut für Technologie (KIT) presented at the European Geosciences Union (EGU), Vienna) (Spiegel-online, 27.4.2017)

red = high, yellow = medium, green = low

Most at risk: Mendoza/San Juan, Argentina
            Racha, Georgia
            Cahul, Moldova,
            North-west Slovenia
CO₂, an experimental view into the future
Grapevines in a future higher $\text{CO}_2$ world: The Geisenheim FACE system for special crops
The Geisenheim FACE for special crops to tackle the big questions

• Will water consumption decrease in a higher CO$_2$ world?
• How will different varieties behave (plant and fruit physiology)?
• soil population of micro-organisms, will they be affected?
• gene expression of insects, what to expect?
• greenhouse gas emissions, where to go?
Summary

- Many new potential regions are emerging due to climate evolution, but regional/local factors need to be considered.
- Water will be the dominant issue in the future (both, too much and too little).
- Why is ETp not changing in many regions despite increases in temperature?
- How to control erosion in a future world?
- How to control greenhouse gas emissions in a future world?
Summary

- The dangers of soil warming (organic matter decay, nitrogen release)
- Restart programs on rootstock biodiversity
- Preservation of varietal and clonal diversity
- We need large experimental systems to study the future
La stratégie Champenoise

La Champagne pionnière du développement durable

Objectifs
- Rédaction empreinte carbone de 25% d’ici 2020
- Vigniculture 100% écologique

Résultats depuis 2000
- -15% d’empreinte carbone par bouteille
- 90% des déchets industriels traités et valorisés
- 25% de la production certifiée ISO 14001
- -50% d’engrais azotés
- -50% des effluents vinicoles traités et valorisés
- 100% des effluents vinicoles traités et valorisés

Le vignoble de Champagne / 2016
- 300 maisons
- 15,000 vignerons
- 34,000 hectares
- 306 millions de bouteilles expédiées

www.Champagne.fr / @Champagne
Look at it differently

1 ha vineyard produces 10 Mio L of oxygen, enough for 20 people, worldwide we have 7.6 Mio ha, producing enough oxygen for 121 Mio. people.

And: save the earth, it’s the only planet with WINE!

Thanks for the opportunity to be here, and thank you for your attention.