



HAL
open science

Grapevine yield gap: identification of environmental limitations by soil and climate zoning in Languedoc Roussillon region using big databases

Hugo Fernandez Mena, Nicolas Guilpart, Philippe Lagacherie, Renan Le Roux, Mayeul Plaige, Maxime M. Dumont, Marine Gautier, Jean-Marc Touzard, Nina Graveline, Hervé Hannin, et al.

► To cite this version:

Hugo Fernandez Mena, Nicolas Guilpart, Philippe Lagacherie, Renan Le Roux, Mayeul Plaige, et al.. Grapevine yield gap: identification of environmental limitations by soil and climate zoning in Languedoc Roussillon region using big databases. Terclim2022: 14. International Terroir Congress ; 2. ClimWine Symposium, Jul 2022, Bordeaux, France. 2022. hal-04719399

HAL Id: hal-04719399

<https://hal.inrae.fr/hal-04719399v1>

Submitted on 3 Oct 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Grapevine yield-gap: identification of environmental limitations by soil and climate zoning in Languedoc -Roussillon region (south of France)

Hugo Fernandez-Mena^{1,2,*}, Nicolas Guilpart³, Philippe Lagacherie⁴, Renan Le Roux⁵, Mayeul Plaige¹, Maxime Dumont¹, Marine Gautier¹, Jean-Marc Touzard⁶, Nina Graveline⁶, Hervé Hannin⁷, Christian Gary¹

Affiliations :

1. UMR ABSys – INRAE, CIRAD, Institut Agro – Montpellier, France
2. UMR EMMAH – INRAE, U. Avignon – Avignon, France
3. UMR Agronomie – AgroParisTech ; INRAE, Université Paris-Saclay, France
4. UMR LISAH – INRAE, CIRAD, IRD – Montpellier, France
5. U. AgroClim – INRAE – Avignon, France
6. UMR Innovation – INRAE, CIRAD, Institut Agro – Montpellier, France
7. UMR MOISA – INRAE, CIRAD, Institut Agro – Montpellier, France

* hugo.fernandez-mena@inrae.fr

Context

In Languedoc-Roussillon region, many **IGP Pays d'Oc** producers are far from the label yield quality threshold, *i.e.* **90 wine hl·ha⁻¹·year⁻¹** for red and white wine. These **yield-gaps** are weakening the profitability and durability of many vineyards (Touzard et al., 2017). Yield-gaps at the regional level have been widely studied in arable crops, but very little in perennial crops, such as grapevine. Understanding **environmental factors** involved in yield-gaps, such as climate and soil limitations, is the first step for the grapevine yield-gap analysis. **At the regional scale**, numerous studies of the 'terroir' involved in wine quality exist. However, there have not been studies to classify environmental factors concerning grapevine yield-gaps yet.

Data used

1. Wine yield dataset

IGP Pays d'Oc label (~1100 cellars, ~80-120.000 ha, ~50% of Languedoc-Roussillon viticultural area)
96 667 individual yield data aggregated into 606 municipalities
4 456 average yield in municipalities from 2010 to 2018
58 grapevine varieties

2. Climate Data

MétéoFrance **SAFRAN** reanalysis with grids of 8km by 8km
Extraction of Languedoc Roussillon region from 2010 to 2018

3. Soil data

Soil Available Water Capacity (SAWC) regional map (Styc and Lagacherie, 2021)
Soil pH *GlobalSoilMap* cartography regional map (Vaysse and Lagacherie, 2015)

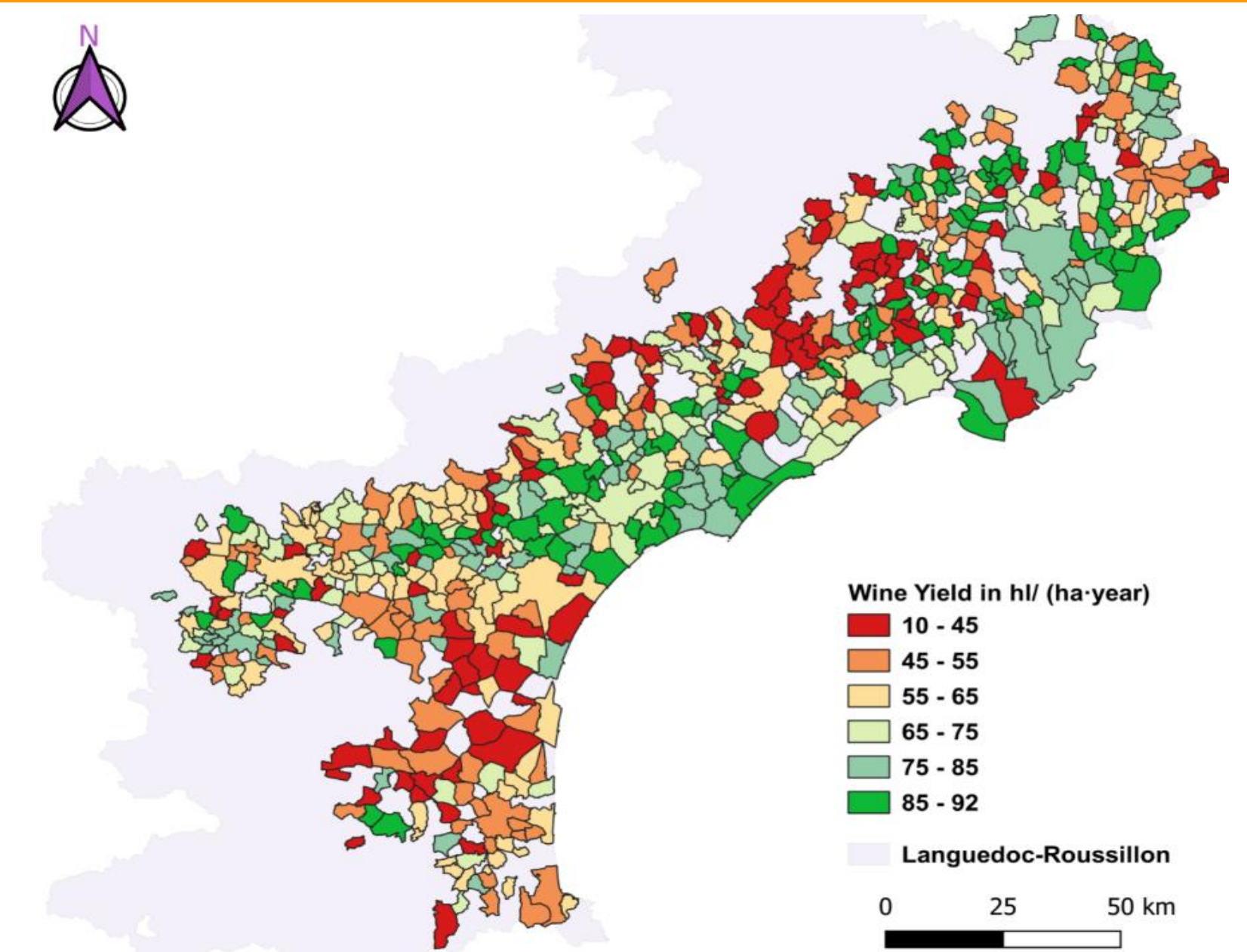


Fig. 1. Average wine yield in the municipalities (2010-2018)

Selection of relevant soil and climate indicators at the municipality scale

We used a **backward stepwise model selection** process using **linear mixed-effects models** (with the 'nlme' R package) to discriminate and **select the statistically significant** indicators capable to estimate grapevine yield at the municipality scale.

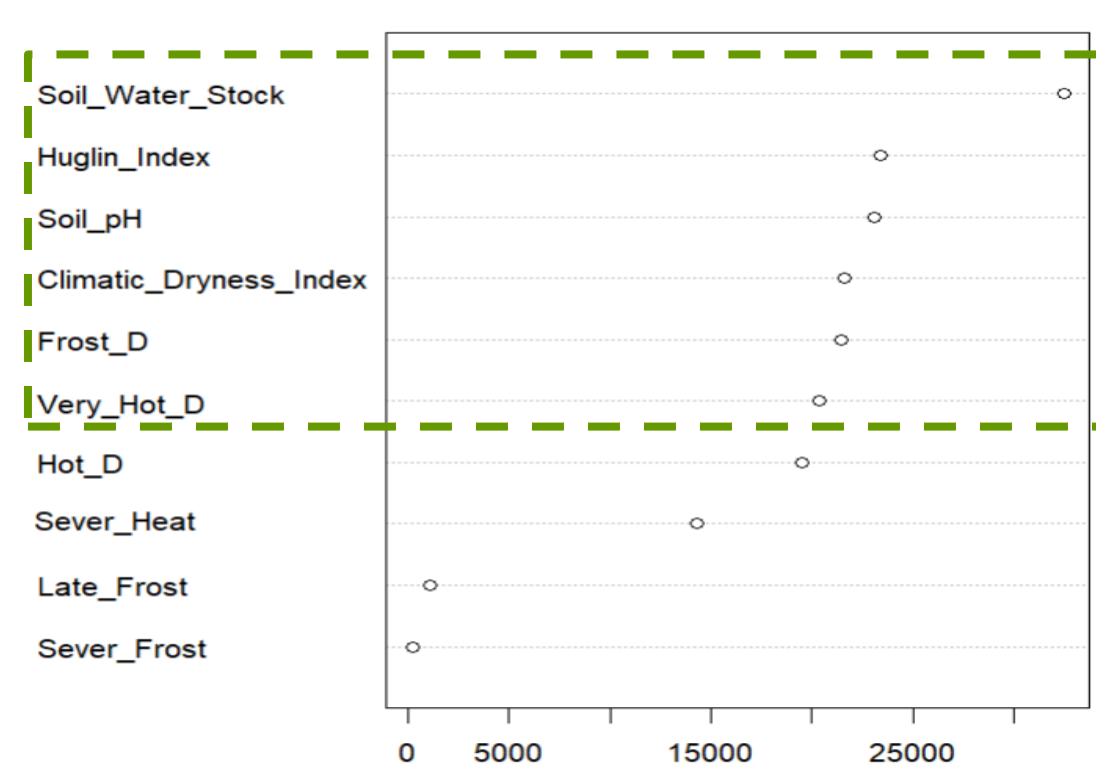


Fig 2. Random forest partial dependence plot of variable importance

Indicator selected	Units (units/year)
Soil Available Water Capacity	mm
Soil pH	-
Climatic Dryness Index	mm
Huglin Index	Degree Celsius
Days of Frost	days
Very Hot Days	days
Severity of Heat Stress	Degree Celsius

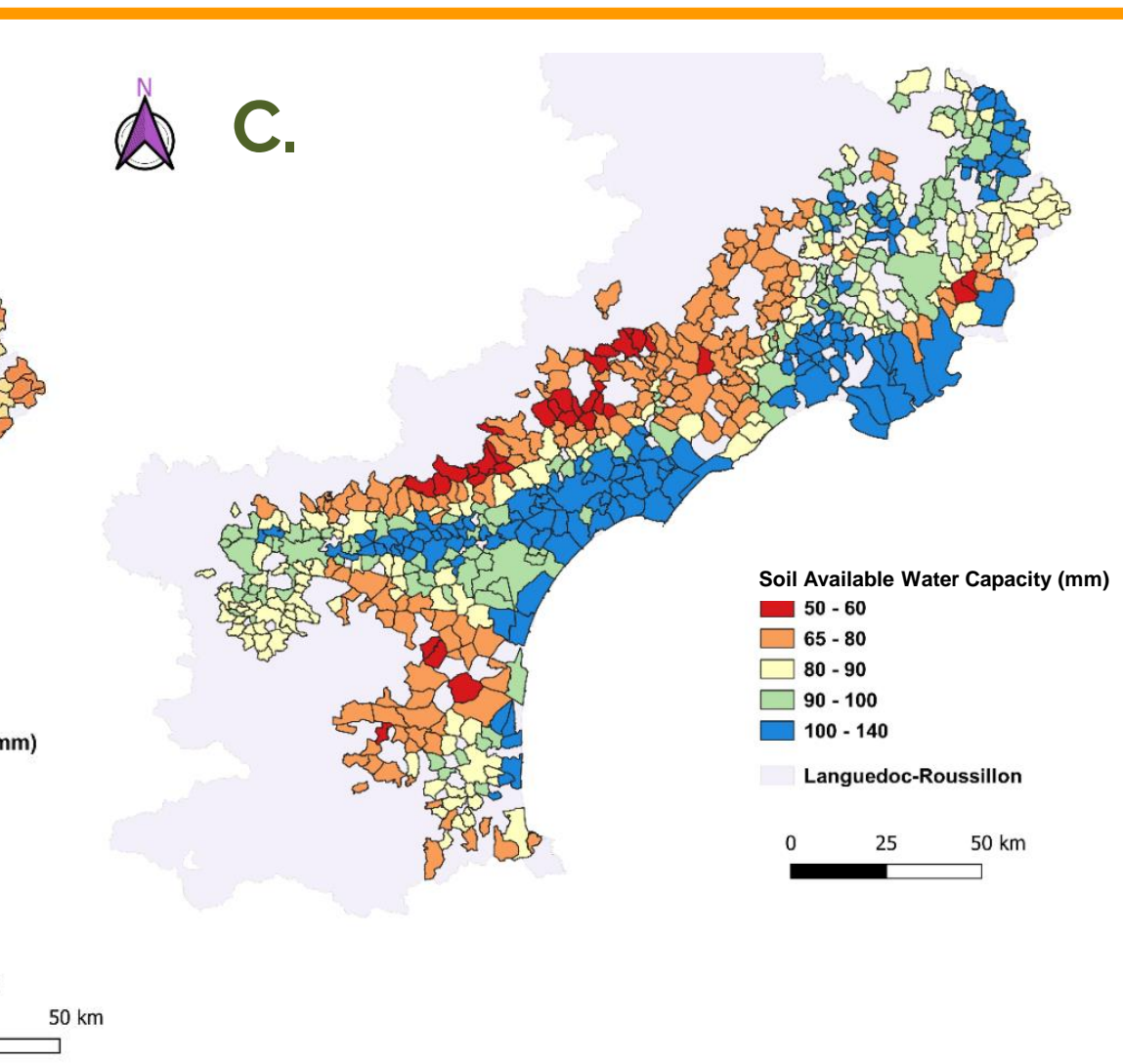
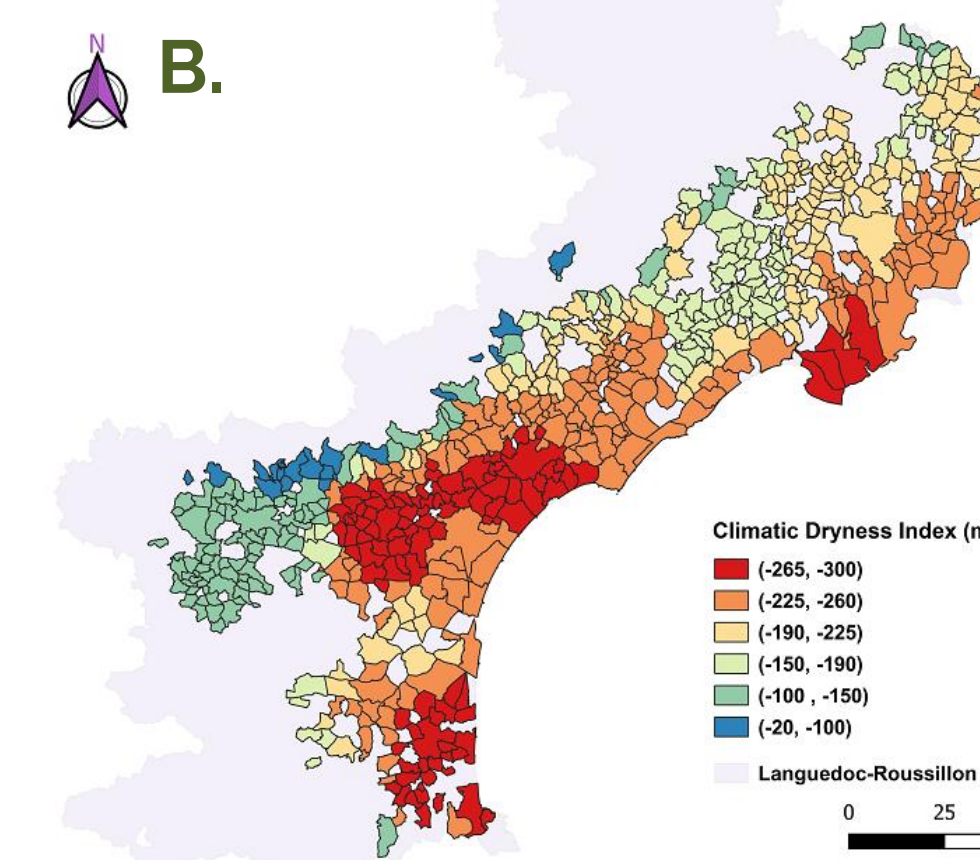
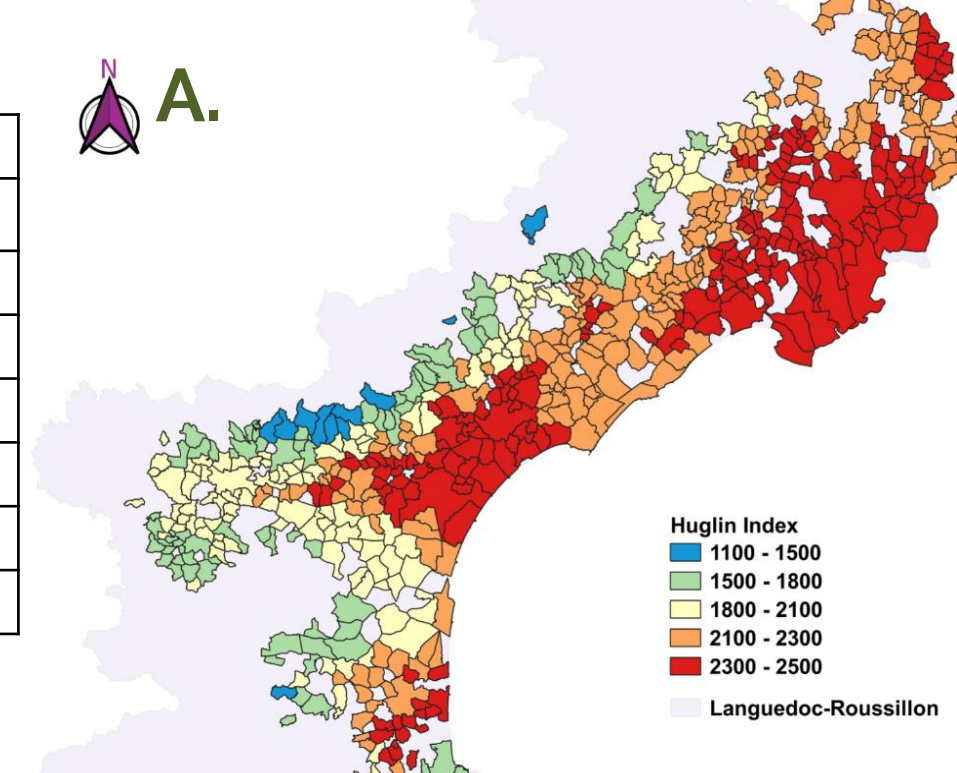


Fig. 3. A. Huglin index (°C from 1 April to 30 September); B. Climatic Dryness Index (P-ET from 1st April to 30th August); and C. Soil Available Water Capacity (mm/ 2m depth)

Zones clustering and assessment

We **clustered** the municipalities with similar soil and climate using a combination of **principal components analysis (PCA)** and **ascendant hierarchical classification** (with 'FactomineR' R package).

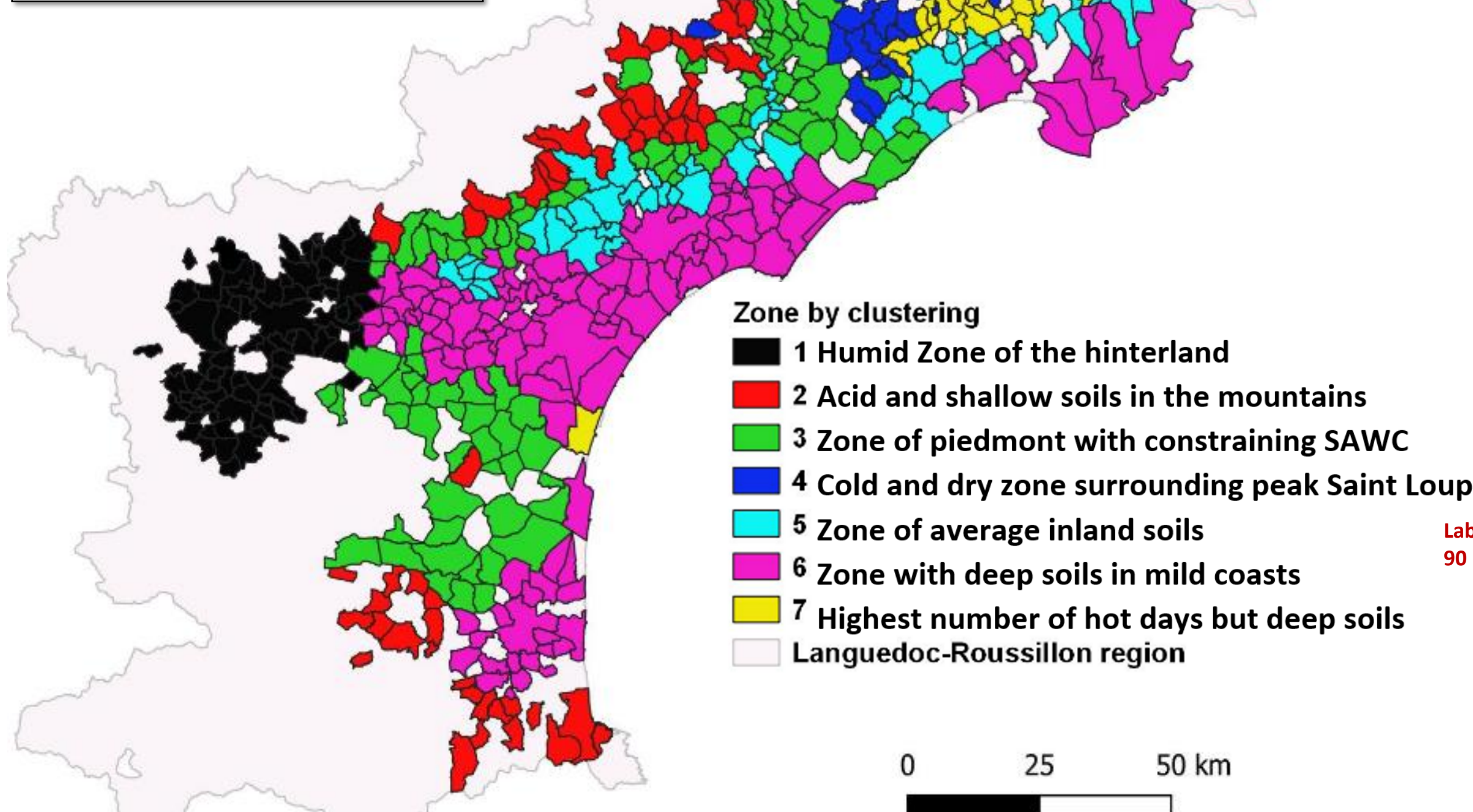
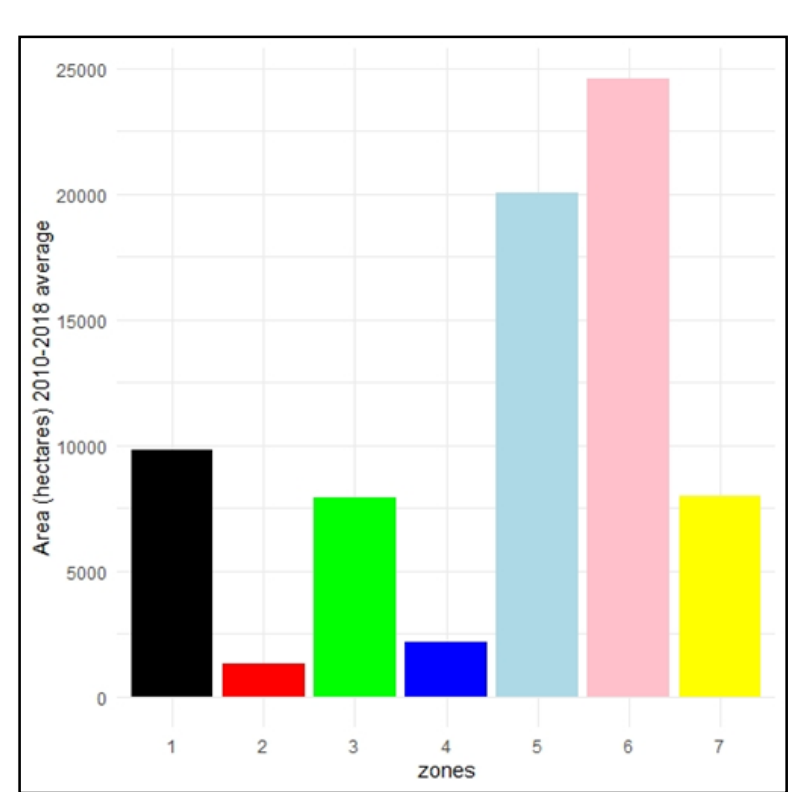


Fig 4. Map of the clustered zones presenting similar soil and climate indicators

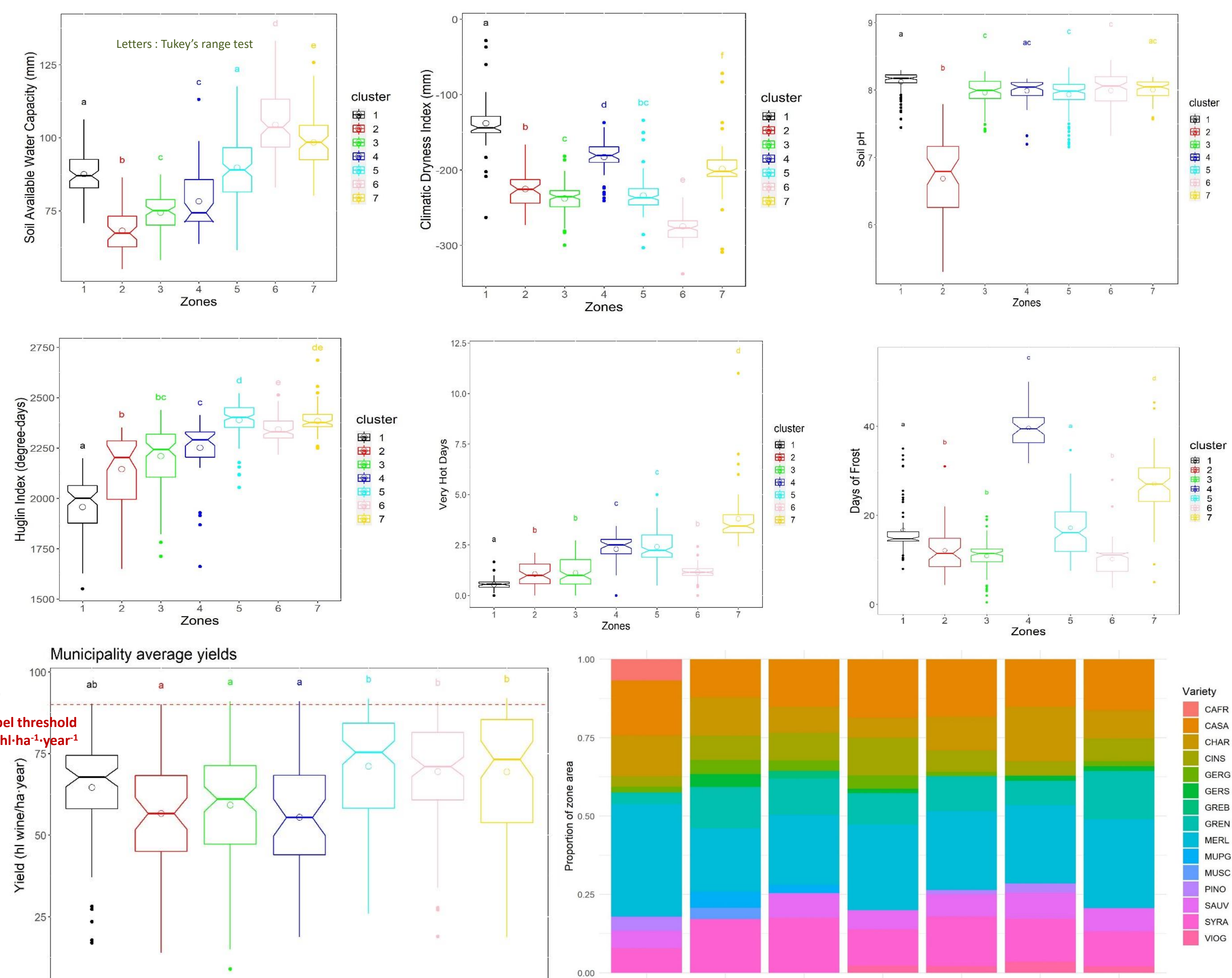


Fig 5. Boxplots of yield, soil and climate indicators in the municipalities of each zone and barplot of 10 most grown grapevine varieties. CAFR for Cabernet Franc; CASA for Cabernet Sauvignon; CHAR for Chardonnay; CINS for Cinsault; GERG for Générique Rouge (several red wine varieties mixed); GERS for Générique Rosé (several rosé wine varieties mixed); GREB for Grenache Blanc; GREN for Grenache Noir; MERL for Merlot; MUPG for Muscat Petit Grain; MUSC for Muscat; PINO for Pinot Noir; SAUV for Sauvignon Blanc; SYRA for Syrah and VIOG for Viognier.

Conclusions & Perspectives

The zones identified had similar yield-gap **levels** but because of **different environmental factors**. This work helped to identify the **environmental factors** involved in grapevine yield-gaps at the **regional** scale. Further research needs to be done concerning the plant material and the farming practices involved in the vineyards to understand the best **Genotype x Environment x Management** interactions (Van Ittersum et al., 2013)

References

- Styc, O., Lagacherie, P., 2021. Uncertainty assessment of soil available water capacity using error propagation: A test in Languedoc-Roussillon. *Geoderma* 391, 114968.
Touzard, J.-M., Aigrain, P., Bois, B., Duchêne, E., de Cortazar Atauri, I.G., Giraud-Heraud, E., Gautier, J., Hannin, H., Ollat, N., 2017. Lessons from a Prospective on the French Wine Industry Under Climate Change (2050).
Vaysse, K., Lagacherie, P., 2015. Evaluating digital soil mapping approaches for mapping GlobalSoilMap soil properties from legacy data in Languedoc-Roussillon (France). *Geoderma Reg.* 4, 20–30.
Van Ittersum, M. K., Cassman, K. G., Grassini, P., Wolf, J., Tittonell, P., & Hochman, Z. (2013). Yield gap analysis with local to global relevance—a review. *Field Crops Research*, 143, 4–17.

