**The interaction of agricultural practices, soil characteristics, and plant communities in vineyards in Southern France.**

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# **Abstract**

Salinization is the process of increasing the salt content in water and soil which can be caused by natural processes but also because of human activities. Salinization is a pressing issue as it can affect production in crops, pastures, and trees. This study examines how the agricultural and intensity of management practices, salinity and type of the soils, and plant communities interact, intending to better understand the ecological and pedological processes involved in viticulture. Some sampling and analyses have been done in the vineyards in the area of Narbonne, a [commune](https://en.wikipedia.org/wiki/Commune_in_France) in [Southern France](https://en.wikipedia.org/wiki/Southern_France) in the [Occitanie](https://en.wikipedia.org/wiki/Occitania_(administrative_region)) [region](https://en.wikipedia.org/wiki/Regions_of_France). This sampling allowed us to show the links between salinisation, agricultural practice and the category of the plants based on Grime Strategy.

Key Words: Soil Salinity, Mediterranean, Vineyards, Agricultural Practice, Plant Community, Grime Strategy

# **Introduction**

In a warmer climate, soil salinity is anticipated to be a substantial and growing concern being one of the major threats to soil stability, fertility, and biodiversity. Salinisation is the accumulation of water-soluble salts in the soil solum or regolith to a level that impacts agricultural production, environmental health and economic welfare [1](https://www.zotero.org/google-docs/?T0VzYw). There are three types of salinity, namely primary, secondary, and linked to the climate. There are three types of salinity, namely primary, secondary, and linked to the climate-primary salinity results from natural phenomena such as parental material erosion. Secondary salinity is caused by human activities such as soil pollution by the overuse of fertilisers or improper irrigation. Lastly, climate change is causing a rise in sea levels, which leads to an increase in the salinity of coastal lands. Coupled with groundwater overexploitation, it intensifies saltwater intrusion in coastal and island aquifers.

In a global estimate, 20% of all cultivated land and 33% of the irrigated agricultural area are affected by high salinity [2](https://www.zotero.org/google-docs/?OR4ft1). The listing of countries where salt-induced land degradation has occurred is long, including the Euphrates Basin in Syria and Iraq, the Murray-Darling Basin in Australia, the San Joaquin Valley in the United States, and the Aral Sea Basin (Amu-Darya and Syr-Darya River Basins) in Central Asia, and few others[3](https://www.zotero.org/google-docs/?DqLiLN). According to Stanners and Bourdeau (1995)[4](https://www.zotero.org/google-docs/?Pu3050), 3.8 Mha in Europe are affected by secondary salinization. Particularly in France, winegrowers in Petite Camargue are left devastated after seeing the rapid deaths of their vines due to salt damage, and the catastrophe could proceed to harm 40% of the vines [5](https://www.zotero.org/google-docs/?AKKymq).

The effects of salinity stress on plant growth and development are significant. Not to mention, a plant's ability to grow in salty soil can vary greatly from one species to another, which can be seen in their physiological responses [6](https://www.zotero.org/google-docs/?Tl4b0u). These effects manifest as suppression of seed germination, root length, plant height, fruitification, and photosynthesis [7](https://www.zotero.org/google-docs/?9QMFwo). This harms crop yields, leading to the abandonment of agricultural lands, severely restricting the potential for sustainable development and generating an economic imbalance and poor farmers’ welfare.

In order to address this issue of soil salinization and its impacts, our study examines how the agricultural and intensity of management practices, salinity and type of the soils, and plant communities interact, intending to better understand the ecological and pedological processes involved in viticulture. We have taken an interest in doing this work in the vineyards of Narbonne, a [commune](https://en.wikipedia.org/wiki/Commune_in_France) in [Southern France](https://en.wikipedia.org/wiki/Southern_France) in the [Occitanie](https://en.wikipedia.org/wiki/Occitania_(administrative_region)) [region](https://en.wikipedia.org/wiki/Regions_of_France). Narbonne is linked to the nearby [Canal du Midi](https://en.wikipedia.org/wiki/Canal_du_Midi) and the river [Aude](https://en.wikipedia.org/wiki/Aude_(river)) by the [Canal de la Robine](https://en.wikipedia.org/wiki/Canal_de_la_Robine), which runs through the centre of the town. The chosen study site has an interesting soil characteristic and has plenty of orchards and vineyards in different conditions. We also took into account how the area reached the present level of soil salinity, which has resulted in unproductive agricultural fields. Historically, seawater flooding has afflicted this region for both short and lengthy periods [8](https://www.zotero.org/google-docs/?sQ7U8V).

South of France, especially Narbonne, has taken pride in their grape production. However, due to increasing salinity, vineyards are currently devastated, challenging the productivity of the farms. These vineyards are also the source of economic income for hundreds of local farmers, which is now at stake. That said, developing a set of integrated and sustainable solutions to this salinity issue is crucial, as land and water resources are central to agriculture. The problems raised can be formulated in questions that this research aims to answer as follows:

1. How does the agricultural and management practices in Narbonne’s vineyards affect the salinity of their soils?
2. What are the types of vegetation present in the vineyards according to the Grime Strategy?
3. What are some possible suggestions that can aid the problem of salinity in vineyards?

We expect some limitations in this study, such as time and human resources limitations. Therefore, we do not expect this cross-disciplinary work to be a thorough examination with detailed lists and traits for every part of our subject. We will choose the most significant ones to depict a general diagram of the relationships between soil properties, agriculture and management practices, and plants' functional traits and community structure. We seek a result that will help keep cultivation going in the area and deal with the problem of salinisation. The study can also help with future research about soil salinisation in Southern France, especially in vineyards.

# **Methods**

## **Ethics Information**

This study will conduct a survey targeted towards the winegrowers in several areas of Narbonne to assess the current agricultural and management practices. The survey will have several questions, both open and close ended. The name of the respondents’ will remain anonymous and the information gathered from this survey will be used solely for academic purposes. The survey will only be conducted by the students of L’Institut Agro Montpellier involved in this project namely Mazaya Dhiya HANIIFAH, Lise LAYOTTE, Marindra MILLET, and Valentine PLANCHET. The research complies with all relevant ethical regulations.

## **Design**

| **Traits or parameters measured directly in the field** | **Tools** | **Processes and intermediary measures** |
| --- | --- | --- |
| Electrical conductivity | EM38 (geophysical instrument) to be confirmed in the lab  → ESAP  → see the pdf “conductivity\_measurement” |  |
| Recovery of bare ground and pebbles | Quadrant: percentage (%) of soil covered |  |
| Species | \* “Liste des espèces recensées dans Commune : Sérignan 401 taxons terminaux”  \* “Guide des espèces dominantes sur le site des Orpellières”  \*Flores / Flora App | * Identify the species * Identify the number of species * Identify the dominant species * Identify the species tolerant to salinity |
| Average vegetation height | Ruler | * Measure the distance between the highest photosynthetic tissue and the base of the plant |
| Presence and cover of grasses and dicots | Quadrat → number of species per quadrant |  |
| Species cover (specifically: rosette plants, plants with erect stems, woody shrubs, woody trees) | Quadrat → percentage (%) of soil covered (estimation by sight) |  |

## **Sampling Plan**

### **Method to Assess the Agricultural and Management Practice**

To obtain the status quo of the management and agricultural practices in the vineyards, the researchers will use a secondary data from preceding questionnaires that was done in **(year)** by **(who)**. The questionnaire was developed over extensive library analysis and group discussions. Previous literary works were used as inspiration to formulate some of the statements incorporated in them. The questionnaire will have several closed-ended questions and will be constructed in French. There will be **(xx)** sections in total. The first section is to investigate the background information of the respondents. The second section **….(?)** The questionnaire employed the 5-Point Likert Scale that provided a collection of statements of attitude. Respondents were asked on a five-point scale to express agreement or disagreement. A numerical value of one to five was given for each degree of agreement. Thus, a cumulative numerical value can later be determined from all the answers. Around 5 minutes of respondents’ time will be needed for the self-completed questionnaire.

### **Method to Study Plant Communities**

The purpose of this part will be to characterise the environment as well as the plant communities according to a gradient of intensity of agronomic practices on the vineyards. For this we will study the area in five places on vineyards that present different intensities of agronomic practices.

#### **Equipments**

* Quadrats (1x1m)
* Meters
* Rulers

#### **Resources**

* Document: “Liste des espèces recensées dans Commune : Sérignan 401 taxons terminaux”
* Document: “Guide des espèces dominantes sur le site des Orpellières”
* Book : “Plant Strategies and Vegetation Processes”, Grim
* Flores / Flora App

#### **Protocols**

* Delimited 4 squares of 1 m² with the quadrats in each area
* Save the gps coordinates by using [MyGPS coordinates](https://play.google.com/store/apps/details?id=com.freemium.android.apps.gps.coordinates&hl=en&gl=US)

#### **Characterisation of Habitats**

Using the benchmarks presented in the following table, determination of the structure, composition and degradation of the habitat**.**

#### **Characterisation of Communities**

* In each quadrat, using the resources, determine the list of species present.
* Complete the community characterization table.
* Determine Grim's Strategy of Species using the book: “Plant Strategies and Vegetation Processes

### **Method to Measure Soil Properties**

In each quadrant determine the type of soil. Measure the Electrical Conductivity : Using the EM38, one person in charge of the measures will take measures across one plot and note them in the table (two measures: vertically and horizontally).



Then try to draw the profile of the soil and to be as precise as possible. In order to :

* Determine the different horizon of the soil and their depth
* Check the soil chart and identify the closest colour to the soil (in the horizon 0-20cm) in the quadrant.
* Raise the texture of the soil aggregate by making the test of the Boudin [annexe 1].

## **Analysis Plan**

We will perform an analysis of variance, using the aov() function of Rstudio [stats package], in order to highlight the dependence between a qualitative variable (the agricultural strategy or practice), and a quantitative variable (salinity). We checked the variance with a Bartlett test (barlett.test() function of Rstudio [stats package]), the normality from a Shapiro-Wilk test (shapiro.test() function of Rstudio [stats package] ), and the difference between the samples with a Kruskal-Wallis test (kruskal.test() function from Rstudio [stats package]). We also carried out tests of the 𝜒² between each of the qualitative variables using the chisq.test() function of Rstudio [package stats].

# **Data Availability**

Upon the completion of this research, controlled access and sharing of data and materials would be possible. The authors are committed to contributing to the research community by sharing the raw data and materials upon acceptance of the manuscript and by official and valid request.

# **Code Availability**

Upon the completion of this research, controlled access and sharing of the code(s) would be possible. The authors are committed to contributing to the research community by sharing the raw data and materials upon acceptance of the manuscript. The code will be provided through a shareable link by official and valid request.

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# **Author Contributions : ok**

# **Competing Interest**

This study does not have any non-financial competing interests including political, personal, religious, ideological, academic, and intellectual competing interests.

# **Figures & Figure Captions**

# **Tables (A Design Table is mandatory)**

*Soil types and salinity, vegetation communities, and farmers’ agricultural and management practices.*

| **Question** | **Hypothesis (if applicable)** | **Sampling plan (e.g. power analysis)** | **Analysis Plan** | **Interpretation given to different outcomes** |
| --- | --- | --- | --- | --- |
| How does the agricultural and management practices in Narbonne’s vineyards affect the salinity of their soils? | *H1 : The insensitivity of practices have an impact on soil salinity levels.*  *H2 : The salinity level is independent of the intensity of practices.*  *H3 : The salinity level is independent of the soil type.*  **H4 :** **The salinity of the soils in the Narbonne vineyards is higher for the intensively farmed plots** | Measurement of electrical conductivity.  3 measures in each place.  The choice of sampling locations will be based on farmers responses to the questionnaire | Analysis of Variance (ANOVA)  qualitative variable : farmer practices  quantitative variable : salt rate | If there are a link  If there aren’t link :  H1 :  H2 : |
| What are the types of vegetation present in the vineyards according to the Grime Strategy? | H1 : vegetation communities dependent on salt rate soil.  **H2 : Soil salinity favours stress resistant species.** | We will use quadrats to characterise the special distribution of plant species  The plant species will be identify thanks to :  - “Liste des espèces recensées dans Commune : Sérignan 401 taxons terminaux”  - “Guide des espèces dominantes sur le site des Orpellières”  - Flores / Flora App | 2 tests :  \_\_\_\_\_\_\_\_\_\_  Analysis of Variance (ANOVA)  qualitative variable : type of plant (R,  quantitative variable : salt rate  \_\_\_\_\_\_\_\_\_\_ |  |
| What are some possible suggestions that can aid the problem of salinity in vineyards? | Depends of answers of preview questions |  |  |  |

# **Supplementary Information**