



Mid-mountain adaptation to
climate change



LIFE MIDMACC

Mid-mountain adaptation to climate change

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Implementation of the vineyard assays pilot experiences

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Executive summary

This deliverable gives an in deep description of one of the climate change adaptation measures applied in the project: conversion of scrubs into vineyards and the adaptation of agricultural practices to climate change in long-established vineyards, in La Rioja and Catalonia. These measures, designed and deployed together with local stakeholders, were implemented by the end of 2019 and beginning 2020. An in deep description of the location of the experiences and the initial planned actions can be consulted in Nadal-Romero et al (2019, Deliverable 1).

The first section is a short introduction to the deliverable. The second section describes the vineyard assays activity in Catalonia, with a brief description of the pilot experience in the project proposed and the detailed description of the implemented pilot experience. The third section reproduces the same information from the vineyard assays in La Rioja. Finally, the fourth section summarizes all the implementation activities related to the vineyard assays pilot experiences.

This deliverable presents the activities carried out to implement the action C3, fundamental in the LIFE MIDMACC project. We have tried to define, from the global to the concise, all the activities that have been carried out, up to now, and those that are going to be carried out with more detailed in the next months, and where and how they are going to be done.

This deliverable is finished with a delay of five months regarding the initial date of delivery (June 2020). The main cause of this delay is attributable to the COVID19 pandemic that provoked a retard of about four months in all the field work needed to finish implementation tasks, to perform all the inventories (forest, vegetation, soil ...) and to conclude with the installation of the instruments needed for the monitoring tasks (sensors, dataloggers ...).

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1. Introduction

Mediterranean mountain landscapes have traditionally been characterized by a mosaic of traditional farming areas combining multiple agro-forest-pastoral land. However, rural abandonment of Mediterranean mountain slopes mainly in the 1960s and 1970s resulted in a dramatic decrease of the landscape mosaic and a simplification of landscapes, with an increase of forests and scrubland forming large homogeneous areas (Van Eetvelde & Antrop, 2003; Lasanta et al., 2016). As a result, current landscapes are highly vulnerable to climate change processes due to many reasons, such as the increase of forest fire risk, the low resilience of homogeneous landscape or the reduction of water resources in mountain areas, among others, becoming, thus, a specific case among Mid-mountain areas of Southern Europe, which are vulnerable regions to many physical and anthropogenic impacts (García-Ruiz et al., 2011; Iglesias et al., 2011)

Due to the poor adaptation of these mid-mountain landscapes to climate change and the need of development sustainable societies adapted to climate change, the conversion and/or maintenance of agro-forest-pastoral mosaics can be considered as an excellent climate change adaptation.

In that context, the main objective of LIFE MIDMACC is to promote the adaptation to climate change through the implementation and testing of different landscape management alternatives in marginal mid-mountain areas of Spain, while improving their socioeconomic development: scrubland clearing, forest management and different assays in vineyards in three study areas (Aragón, La Rioja and Catalonia).

In this report, we present the implementation actions of one of the landscape management practices considered in this project, that is, the promotion of mountain agriculture by means of vineyards, both by the conversion of scrubs into vineyards and by the adaptation of agricultural practices to climate change conditions in long-established vineyards, with the purpose of improving the restrictive environmental conditions for agriculture in the mid-altitude Mediterranean mountains. The demonstrative activities have been performed in different pilot sites representative of the study cases to be upscaled to the regional level and also replicable to other Mediterranean mid-mountain areas. Conversion of scrubs into vineyards has been implemented in La Rioja (Leza River basin) and the adaptation of agricultural practices in Catalonia (Empordà DO and Llívia).

This report presents the implementation action, the description and methods employed (what, how, where and when) in both regions (Catalonia and La Rioja) and briefly presents the monitoring program.

2. Vineyard assays pilot experience in Catalonia

2.1. The pilot experience in the project proposal

Following, a description of the pilot experience as it was included in the proposal is shown, in order to better explain the final pilot experience implemented.

Sub-action C3.1 Vineyards assays in Catalonia

The pilot experiences will be implemented at Empordà area, recognized with the Empordà DO (Designation of Origin) (Figure C3.1). Empordà is situated in the north east of Catalonia. These assays will be conducted in long-established vineyards:

- Espolla Winery Cooperative: Located in the north of Espolla municipality (Girona province), it counts with lots of vineyards, some of them with small terraces to avoid excessive slopes.
- Vilajuïga Company: Viticulture growers located in Roses municipality (Girona province): an area with planting vineyard recovery.

The pilot experiences will mainly consist of vineyards assays in a plot of approximately 1 ha. Vineyards assays will rely on practicing different agronomical practices (e.g. green soil coverage, pruning, trellising and the use of different varieties).

In all demonstrative plots we will have information about the weather, edaphic and agronomical conditions and its evolution along the time, by the assessment of the variables included in table C3.1

Results will be qualitatively compared with other mid-mountain vineyards not monitored in this project. The aims is to evaluate the effects of adapting agricultural practices in contrasted climatic conditions. This point will be developed in agreement with some representative stakeholders such as Bodegas Miguel Torres and Castell d'Encus and administrative institutions such as INCAVI, VITEC and DOs.

2.2. The implemented pilot experience

The vineyard pilot experiences in Catalonia have been established in three different locations in two different mountain regions: **two sites in Empordà DO** (Roses and Espolla), in the Coastal Pyrenees, and **one site in Llivia, Cerdanya**, in the Central Pyrenees. The latter was not present in the proposal, and was added to the project after first contact with stakeholders, to include a representation of the Central Pyrenees. In total, **the experience has been implemented in 9 plots covering a total area of 7.5ha.**

The vineyard pilot experiences encompass a range of conditions and agricultural practices than will be compared among different plots and sites and to other commercial, mid-mountain vineyards not participating in the project, to select best practices for mountain vineyards to adapt to climate change.

The location of pilot experiences can be seen in Figure 1:

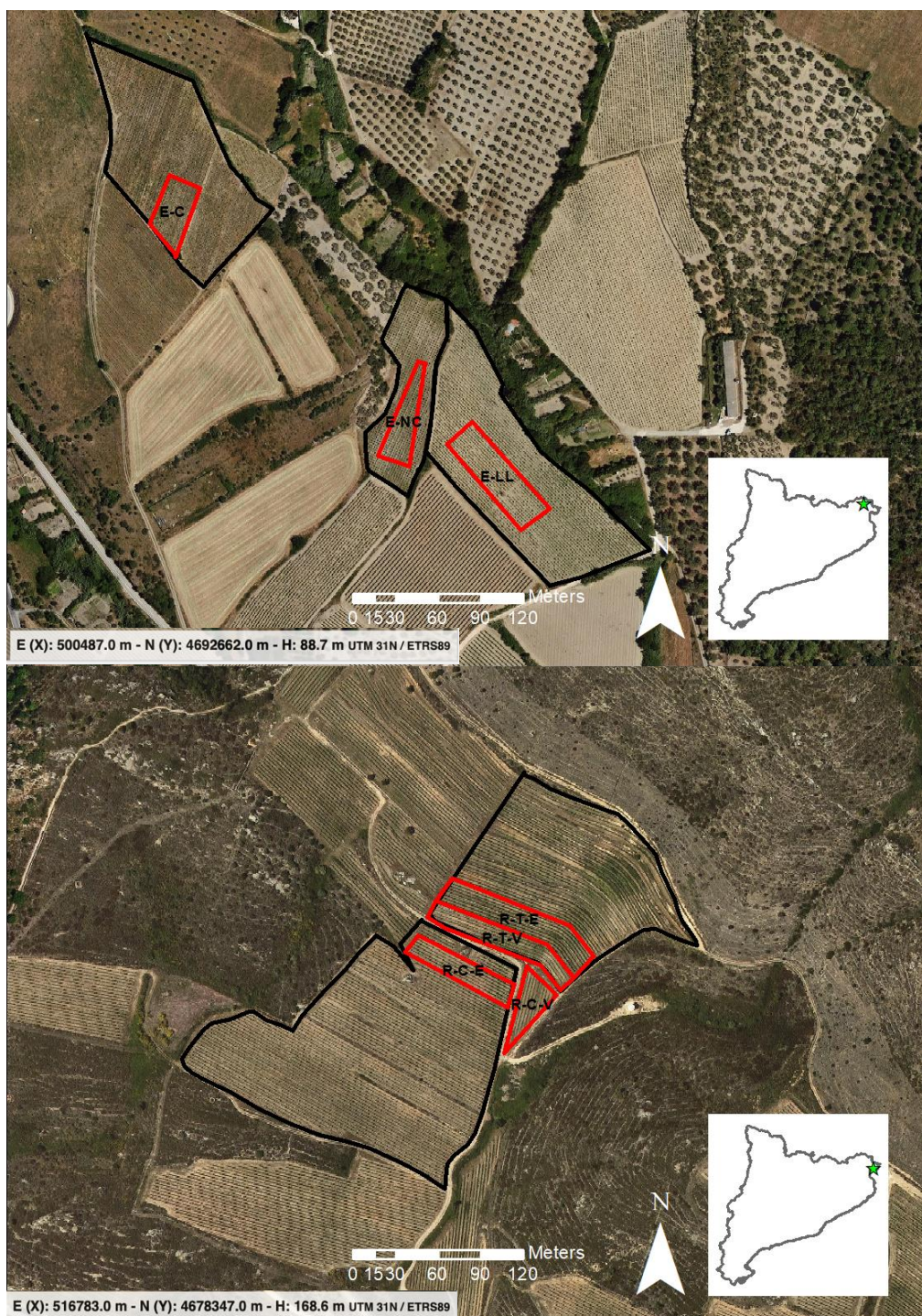


Figure 1. Location of the vineyard pilot experiences: Espolla (up) and Roses (bottom). In red, monitored plots; in black, larger plots that share the agronomical practices. E-C, green cover; E-NC, new green cover; E-LL conventional soil management; R-T-E, terrace, trellised vines; R-T-C, terrace, gobelet vines; R-C-E, hillslope, trellised vines; R-C-V, hillslope, gobelet vines. Initials correspond to the Catalan denominations (see text).

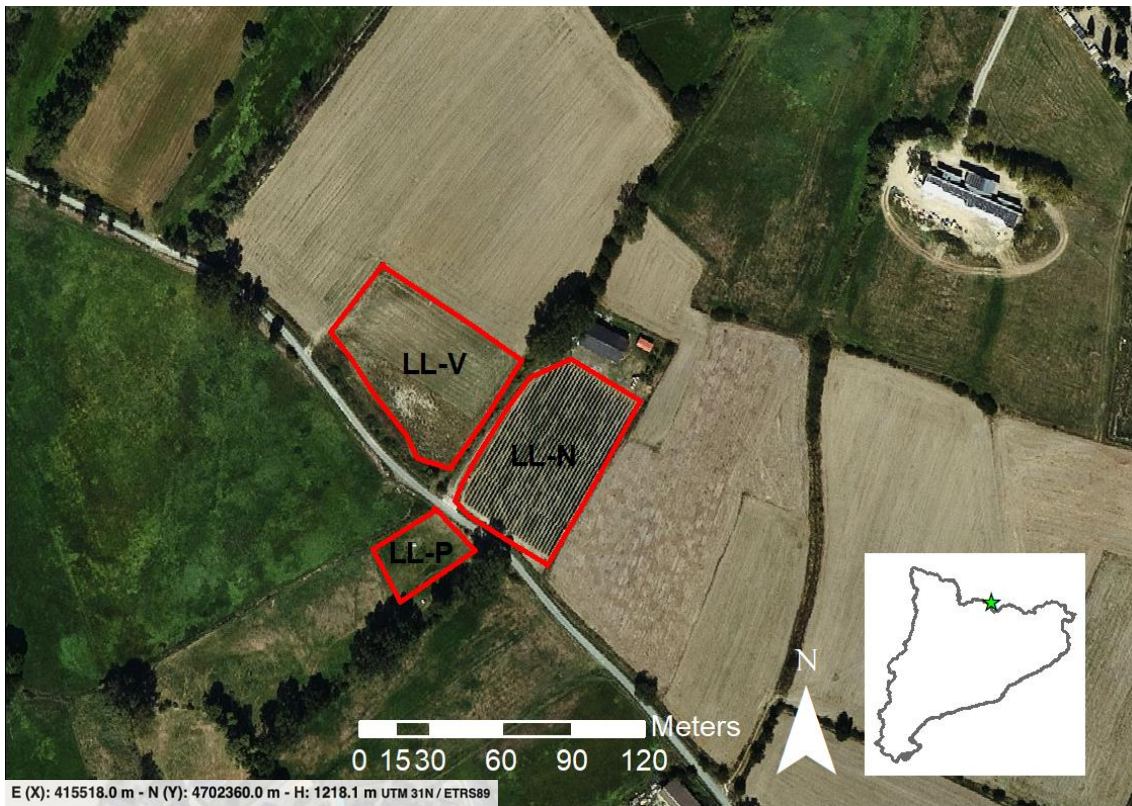


Figure 1 (continuation). Location of the vineyard pilot experiences: Llivia. In red, monitored plots, here coincident with whole plots. LL-V, 2012 vineyard; LL-N, 2020 vineyard; LL-P, pastureland.

New practices have not been established in the pilots: instead, specific plots where the **practices to be tested had already been implemented, or were about to be implemented by owners, were chosen**. This way, we believe there is more chance that the practices will be kept at least for the duration of the project with no additional effort for plot owners. Also, owners' interest is assured, as the agronomical practices had been decided by plot managers for their own reasons, which included adaptation to climate change (without imposing a specific definition for "adaptation") and their own goals (keeping production, productivity, costs, product characteristics...).

Agronomical practices in the different locations and plots are as follows:

- **Three plots** have been selected in **Espolla**, between 90 and 100m a.s.l.(UTM 31N/ETRS89 coordinates: E(X) 500487.0m N (Y) 4692662.0). Plots have a surface of 1, 0.5 and 1.2 ha, from which a smaller region is monitored (E-C, 0.1ha; E-NC, 0.1 and E-LL, 0.2ha; figure 1, up). Espolla is at Albera massif, in the Eastern Pyrenees, near the coast but 13 km apart from the sea. All three plots are in a plain area with low or no slope. In all three plots vines are of the Carinyena (Carignan) variety grafted on Richter-110. In one of the plots, spontaneous cover crop has been allowed for several years, while in a second plot spontaneous cover has only been allowed from 2019 (Figure 2). Finally, in the third plot soil is kept free of vegetation other than grapevines with conventional methods used in the area: tilling or herbicides. With this design,

the impact of an established or new spontaneous cover crop will be compared to the conventional soil management.



Figure 2. Cover crop in winter (left) and summer (right) in Espolla plots

- **Four nearby plots** have been selected in **Roses**, in Mas Marés state at about 170 m a.s.l. (UTM 31N/ETRS89 coordinates: E(X) 516783.0m N (Y) 4678347.0m). Plots were chosen as a combination of two factors: trellised vs gobelet (“vas”) vines, and hillslope (“coster”) vs. terrace plots (Figure 3). The second factor was proposed by plot managers (Espelta winemakers) due to their interest in balancing workforce costs with higher quality. The first factor responds to an interest in **controlling increasing soil erosion in the area**. Plots in Roses are less than a kilometre from the sea, so receiving full sea influence. In all plots, the Garnatxa variety (Grenache, or Lledoner as per its local denomination) is grafted on Richter-110 rootstocks. Plots have a surface of 1.5, 2.3 and 0.1ha, from which a smaller region is monitored (R-T-E, 0.2ha; R-T-V, 0.2ha; R-C-E, 0.1ha and R-C-V, 0.1ha; figure 1, bottom).



Figure 3. Gobelet in “coster”(left) and trellised vines on coster and terraces (right) in Roses plots

- **Two plots** of about 1/3 of ha have been selected in **Llívia**, in the Central Pyrenees, in a single estate, at a much higher altitude, 1220 m a.s.l (UTM 31N/ETRS89 coordinates: E(X) 415518.0m N (Y) 4702360.0m). One plot is quite new (right in figures 1 cont. and 4), established as a vineyard in 2012 in a former mare pasture area, and a second plot is newer and has been

established in 2020 in an adjacent plot (left in figures 1 and 4), formerly a cropland. A pastureland plot will be used for some analyses as representative of original conditions of the older vineyard (bottom in figures 1 cont. and 4). The original conditions of the newest vineyard have been obtained in 2020 before the establishment of the vineyard. In this pilot, **the short and very short term effects of transformation of pastures or cropland to vineyard will be obtained, which, together with higher altitude, makes this pilot more comparable to La Rioja pilots.**



Figure 4. Newly established vineyard (2020; up left), older vineyard (2021, up right) and mare pasture (bottom) in Llivia

2.3. The monitoring of the pilot experience

Soil moisture sensors (Teros 10, Meter) have been installed in all plots at 15, 30 and 45cm depth (one sensor per depth and plot). In one plot per location, the 15cm sensor has been replaced with a Teros 11 (Meter), which also includes a soil temperature sensor. We rely on nearby official meteorological stations of the Catalan Meteorological Service (Servei Meteorològic de Catalunya, SMC) for other environmental variables.

Several physical and chemical soil parameters will be monitored according to Table 4 in Deliverable 1, along with microbiological variability. First samples have been collected in July 2020.

3. Vineyard assays pilot experiences in La Rioja

3.1. The pilot experience in the project proposal

Following, a description of the pilot experience as it was included in the proposal is shown, in order to better explain the final pilot experience implemented.

Sub-action C3.2 Vineyards experiences in La Rioja

These assays will be conducted on recently converted vineyards belonging to Dinastia Vivanco winery and San Prudencio winery. They are located at high altitudes in the Iberian range and benefit from a Mediterranean climate. The pilot experiences will be conducted on terraces or hillsides:

1. Two different experimental plots of approximately 1 ha will be selected in each kind of field (terrace or hillside).
2. Two plots (1 ha) covered with scrubland in each kind of site.

A set of variables summarizing information about soil conditions (erosion, water availability, biodiversity, carbon storage) and crop productivity will be periodically collected to assess the evolution of pilot experiences in comparison with plots without intervention (control plots).

3.2. The implemented pilot experience

As indicated in the proposal, the pilot experiences have been installed in the vineyards of the two wineries mentioned above (Dinastia Vivanco and San Prudencio). However, in the case of Dinastia Vivanco, the selected plots are located outside of the Leza River basin, as it was described in the Deliverable 1 and later on accepted by the EC: “*There have been two reasons to select this study site (without any change in the design of the LIFE MIDMACC project): (i) these plots are one of the only vineyards in altitude management by Dinastía Vivanco winery; and (ii) the magnificent possibility, offered by the winery, to compare two vineyards located in altitude with different ages*”. In that way, we can evaluate in the long-term the effects of vineyards located in mountain areas, and compare it with the first stages of this new landscape measure.

The vineyard pilot experiences encompass a range of conditions and agricultural practices than will be compared among different plots (slope and hillslope) and sites (Clavijo and Tudelilla). In total, **the experience has been implemented in 9 plots covering a total area of 13.24 ha.**

- Pilot experience in **Clavijo – San Prudencio** (Figure 5). Different areas have selected to study **the effects of new vineyards installed on hillsides and terraces**. In addition, thanks to the collaboration with the winery, some agricultural practices will be tested.
 - o One plot **on terrace of 0.2 ha** has been selected and will be monitored and studied. One part of this terrace will be covered by vegetation (grass) while the other will ploughed as usual (bare soil) (
 - o Figure 6 left) to analyze the effects of this vegetation on environmental properties.

- One plot **covered with scrubland of 0.3 ha (control plot)** (
- Figure 6 right) in terrace will be monitored and instrumented to compare with previous terraces.
- One plot of **hillslope of 0.8 ha has been selected** and will be monitored. In this case, a small area of 0.03 ha of the slope will be covered by vegetation (grass).
- One plot **covered with scrubland of 1.03 ha (control plot)** in hillslope will be monitored and instrumented to compare with precious hillslope plot.

Action C3. Vineyards - Clavijo (La Rioja)

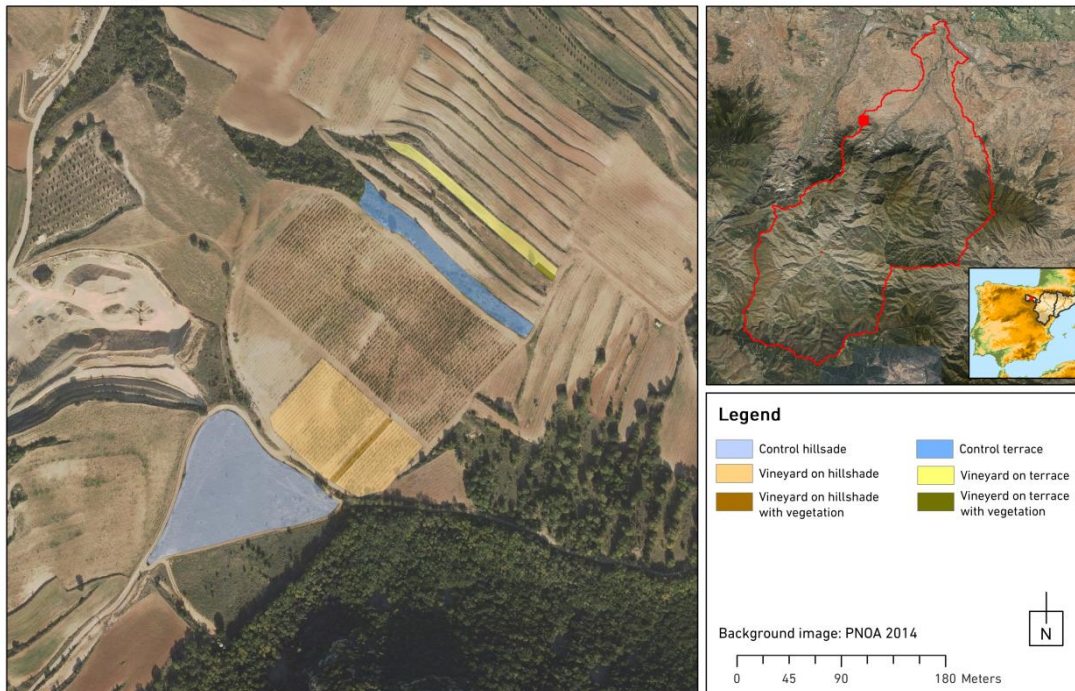


Figure 5. Location of vineyard pilot experiences in Clavijo (La Rioja)



Figure 6. Overview of the selected terraces in San Prudencio.

- Pilot experience in **Tudelilla – Dinastía Vivanco** (Figure 7). In this case, **hillside** and **terraced** vineyards have been selected with **different ages** to evaluate the **effects of new vineyards in the environment**. Thus, **young, mid-term and old vineyard have been chosen**. The absence/presence of grass cover will also be taken into account in these experimental plots depending on the requirements of the winery.
 - One plot on **a small terrace of 0.74 ha** has been selected occupied with **young vineyard** (Figure 8).
 - One plot on **a large hillslope vineyard of 6.7 ha** has been selected occupied with **mid-term vineyard** (¡Error! No se encuentra el origen de la referencia.).
 - One plot on **a large hillslope vineyard of 1.13 ha** has been selected occupied with **old vineyards** (Figure 10).
 - One plot **covered with scrubland of 2.16 ha (control plot)** in hillslope will be monitored and instrumented in Tudelilla.

The analyses described in the proposal will be carried out on these plots, distinguishing between grass cover and bare soil.

Action C3. Vineyards assays pilot experiences - Tudelilla (La Rioja)

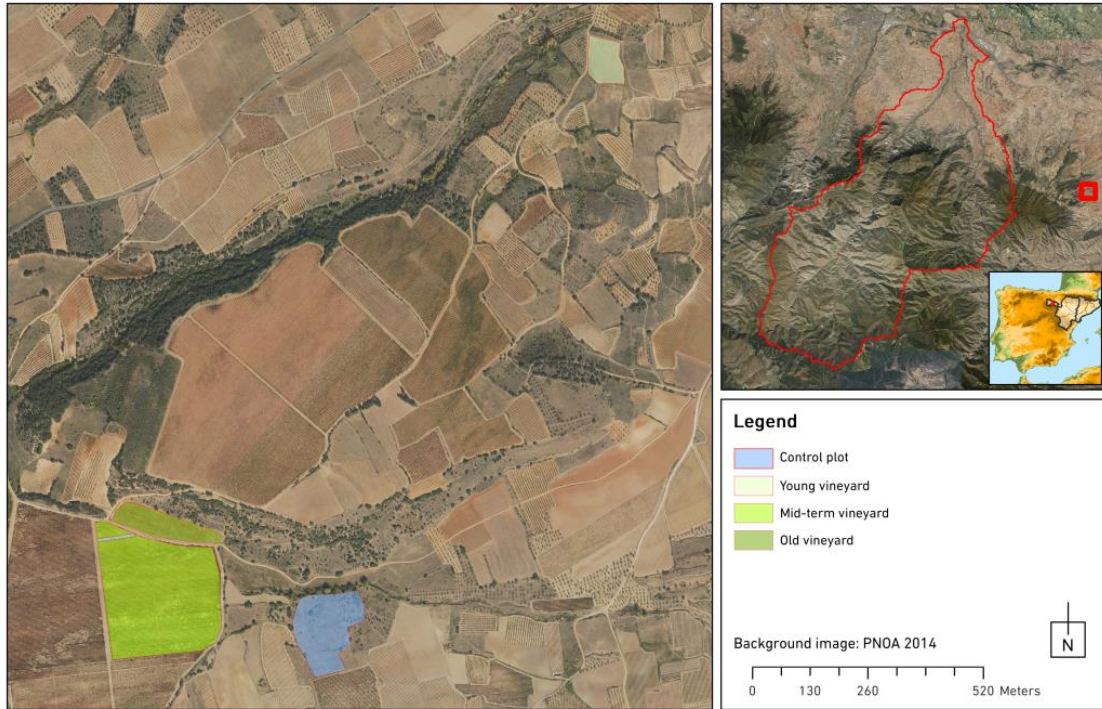


Figure 7. Location of vineyard pilot experiences in Tudelilla (La Rioja).



Figure 8. Overview of the young vineyard selected in Tudelilla (La Rioja), Dinastia Vivanco Winery.



Figure 9. Overview of mid-term vineyard and control plot in Tudelilla (La Rioja).



Figure 10. Overview of old vineyard with herbaceous cover in Tudelilla (La Rioja).

3.3. The monitoring of the pilot experience

Soil moisture, temperature and relative air humidity sensors will be installed in the selected plots in autumn 2020 (Figure 11).

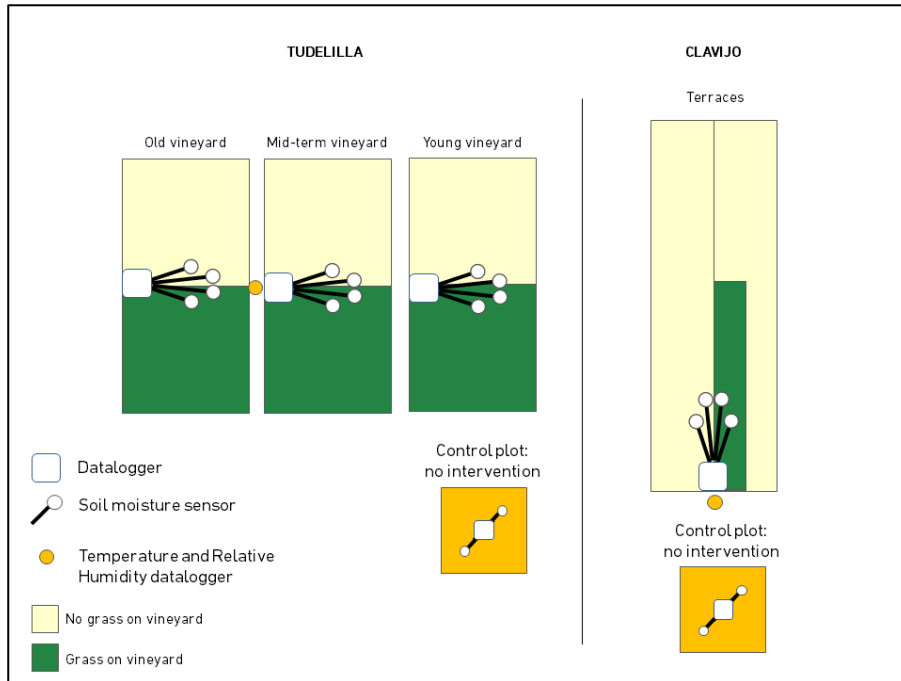


Figure 11. Experimental design in Tudelilla and Clavijo.

4. Conclusions

One of the main objectives of this deliverable is the presentation and description of the implementation action: C.3. Climate change adaptation measure: Assays and experiences in vineyard.

During the previous action A.2., the localization of the pilot experiences was successfully fulfilled in all the study areas: Catalonia (Empordà DO and Cerdanya) and La Rioja (Clavijo and Tudelilla).

Sub-action C3.1 Vineyards assays in Catalonia

- Vineyards assays were carried out in nine plots covering a total area of 7.5ha. Three plots have been selected in Espolla, where the impact of an established or new spontaneous cover crop will be compared to the conventional soil management. Four plots have been selected in Roses, where the evolution of the soil erosion will be captured. And two plots have been selected in Llivia, where the short and very short term effects of transformation of pastures or cropland to vineyard will be obtained. This third area was added after first contacts with stakeholders to represent higher altitudes, which will be more comparable to La Rioja pilots.

Sub-action C3.2 Vineyards assays in La Rioja

- Vineyards assays were carried out in nine plots covering a total area of 13.24 ha. Five plots have been selected in Clavijo, where the effects of new vineyards installed on hillsides (one plot) and terraces (two plots) will be compared with two control plots. Four plots have been selected in Tudelilla, where the effects of different ages vineyards will be evaluated, comparing young, mid-term and old vineyards with a control plot.

Sub-action C3.3 Vineyards assays monitoring

- The monitoring network has been started: Soil moisture and temperature sensors have been installed in the plots. First samples of soil have been taken along summer 2020 to monitor physical and chemical soil parameters.

Finally, and in spite of the changes already presented in A2, the activities defined in the proposal have been successfully completed: selection of the study areas, implementation of vineyard assays and start on the monitoring program, being a perfect starting point for the future work defined in the LIFE MIDMACC project.

5. References

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