2025

BASELINE REPORT
VERIFIED WATER CREDITS (VWC)

Ecological restoration in Alia, Cáceres, Spain

LT-007-SPA-072023 CÁCERES, SPAIN

Life Terra (foundation)

Cáceres, Spain

June, 2025

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EXECUTIVE SUMMARY

The baseline report is a critical requirement for project certification, as it establishes the initial environmental parameters of the project area using the NDVI (Normalized Difference Vegetation Index). This index serves as a key indicator of vegetation cover and plant health, enabling a clear assessment of conditions prior to any planting activities. The baseline will also serve as the reference point for ongoing quarterly monitoring, which will be conducted in accordance with the "*aOCP Methodology for Satellite Monitoring of Projects V1.0.*" Additionally, the baseline report serves as the foundation for estimating the number of credits each project may be eligible to receive, based on the project's specific characteristics and in alignment with the aOCP credit calculation methodologies.

The ecological restoration of a forested area in Alía, Cáceres (Spain) entailed planting a total of 60,717 trees, representing nineteen (19) distinct species mainly native to the region and well-suited for adverse environmental conditions. The primary objective of this initiative was to enhance biodiversity, improve soil quality, and provide resources to landowners. The project area, situated within the Alía municipality, covered 383,421.50 square meters.

The dense planting technique was employed, providing numerous benefits such as increased yield and efficient resource utilization. The average planting density within the plot was one tree per 5.4 square meters, equivalent to an average of 1,861 trees per hectare in the plot.

Beyond reforestation, the project’s soil and water conservation measures play a crucial role in ecosystem restoration by reducing soil erosion and preventing excessive fertile soil loss, improving soil quality and promoting land stability, enhancing local biodiversity and supporting wildlife habitats, improving water quality and hydrological regulation and contributing to climate change mitigation through carbon sequestration.

By Year 40, model estimates indicate an additional 1,195.99 m³/ha of infiltrated water in the Project Area compared to the Counterfactual Area. Given the total surface area of the Project (32.60 ha), this translates to an estimated 38,986.02 m³ of additional infiltrated water over the long term. These figures underscore the project's significant contribution to Groundwater Recharge and overall environmental restoration. The successful reforestation endeavor in Alía demonstrates the positive impact of employing dense planting techniques and strategically selecting native species to reclaim and revitalize degraded landscapes, providing ecological, economic, and social benefits for the region and its communities.

I. PROJECT DESIGN

This section is based on the information compiled in the PSF Format - Project Submission Form prepared by the project developer.

I.1. PROJECT LOCATION

The project is located in the Alía municipality, in the province of Cáceres (Spain). The afforested plot lies close to adjoining Coniferous Forest areas and Natural grasslands. A project location map is illustrated in Figure 1. Table 1 shows the coordinates of the reforested Plot.

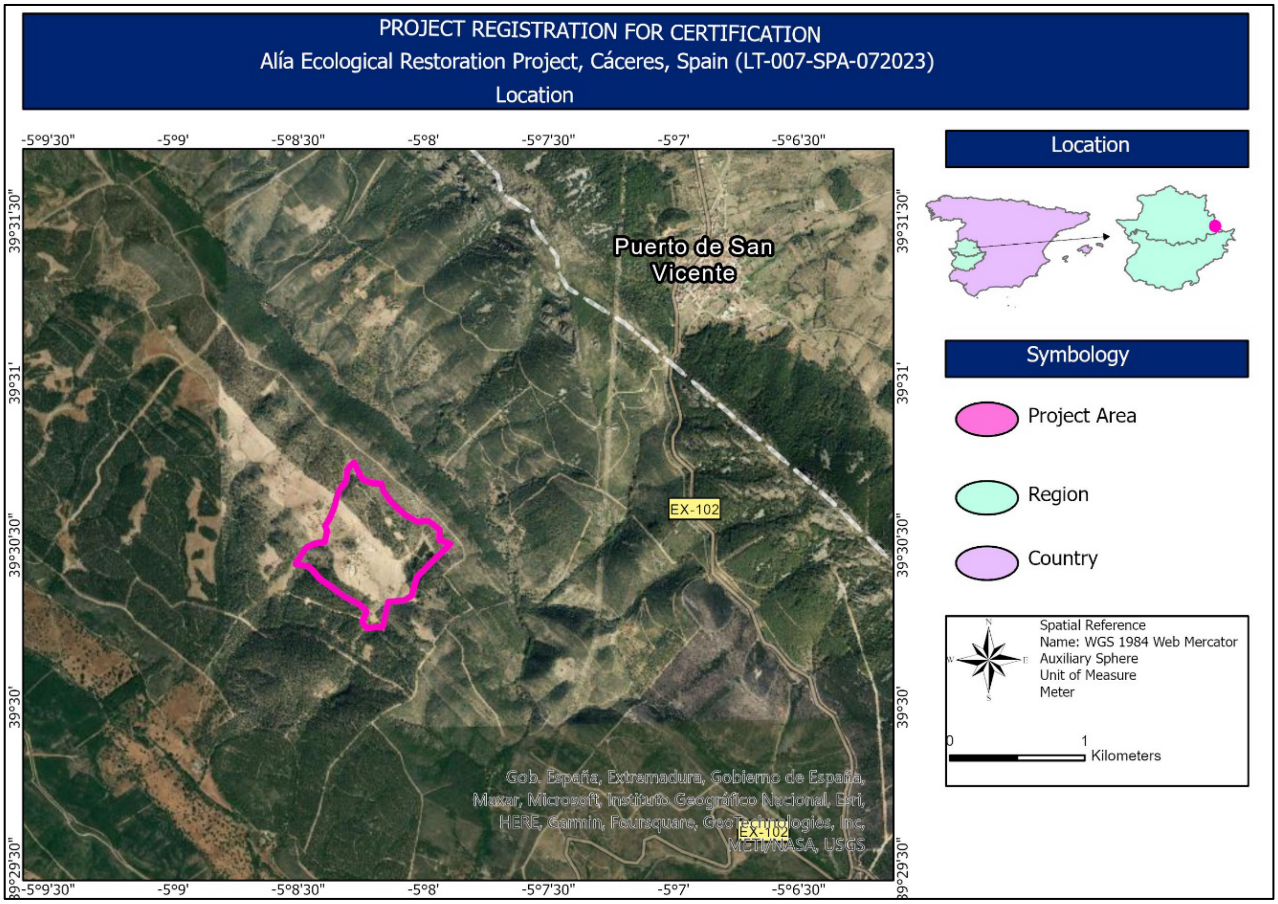


FIGURE 1 PROJECT LOCATION.

Table 1 Location Of Project Plot

Plot	Coordinates	
	Latitude	Longitude
1	39.5076876°N	5.1373499°W

I.2. Administrative Specifications

This section introduces the project developer, outlines the project type, and specifies the nature-based credits for which the proponent is applying.

I.2.1. Project Developer

Key project	**LT-007-SPA-072023 CÁCERES, SPAIN**
Title of the project activity	Ecological restoration in Alia, Cáceres, Spain
Company	Life Terra (foundation)
Person responsible	Sven Kallen

I.2.2. Type of project

Project registration year	Project registered in 2023 for the issuance of VCC and VBBC.
Project duration	40 years Registered for VWC 2025, with retroactive calculation from 2023.
Issuance of credits	Annual
Methodology applied	*"Methodology for the Issuance of Verified Water Credits V2.3,"* dated February 2025[1].
Type	☒ Forest management ☐ Regenerative agriculture ☐ Silvopastoral management ☐ Individual tree-based climate action / urban forest ☐ Water flow restoration ☐ Biochar

[1] https://www.nat5.bio/wp-content/uploads/2025/03/aOCP-Methodology-for-water-balance-assessment-V2.3.pdf

I.2.3. VNPCs the project is applying to

Type of VNPCs the project is applying for	☐ Verified Carbon Removal Credits (VCC) ☐ Verified Biodiversity Based Credit (VBBC) ☒ Verified Water Credits (VWC) ☐ Verified Soil Credits (VSC)

II. PROJECT AREA BASELINE

According to the Corine Land Cover mapping, the project area falls within Forest and semi natural areas with Scrub and/or herbaceous vegetation, Sclerophyllous vegetation associations, as well as Transitional woodland-shrub and Natural grasslands in the Alía municipality, Spain. Adjoining land covers include Coniferous Forest areas, Natural grasslands and herbaceous vegetation associations extending few kilometers from the site. An evaluation of the ESA-worldcover-v200 for 2021, focusing on land use and land cover, revealed that the project site was situated within a predominantly Grassland area with Tree cover areas, Shrublands, and areas with sparse vegetation. To further ascertain the project's potential contributions to biodiversity, a survey was conducted to count and identify the plant species present in the vicinity of the project area. This will be further elaborated in the biodiversity section of the baseline report.

II.1 SPECTRAL RESPONSE

When solar radiation interacts with an object, one of three situations can occur, either individually or in combination:

- **Reflection:** The radiation can bounce off the object partially or entirely, resulting in reflection.
- **Absorption:** The object can absorb the radiation, taking in its energy.
- **Transmission:** Radiation can pass through one object and reach another, known as transmission.

The extent to which radiation is reflected, absorbed, or transmitted depends on the specific physicochemical characteristics of the objects involved. However, for object identification purposes, our primary interest lies in the reflected light or radiation at different wavelengths. For instance, vegetation exhibits low reflectance in the visible range, but the presence of chlorophyll in plants increases reflectance in the green channel. On the other hand, plants demonstrate the highest reflectance in the near-infrared region of the electromagnetic spectrum.

II.1.1. Index

Vegetation indices (VI) are extensively employed for monitoring and detecting changes in vegetation and land cover. These indices are created by considering the contrasting absorption, transmittance, and reflectance of energy by vegetation across the red and near-infrared portions of the electromagnetic spectrum. Numerous studies have demonstrated that the Normalized Difference Vegetation Index (NDVI) is particularly resilient against the influence of topographic factors. NDVI is commonly utilized as a broad indicator of photosynthetic activity in plants and the corresponding aboveground primary production.

The calculation of NDVI was performed using Sentinel-2 satellite images in the Google Earth Engine platform. Images with the less than 20% cloud cover was selected for each month. The assessment focused on the average monthly NDVI time series spanning from January 1, 2021, to August 13, 2023. The findings are presented in Figure 2, which covers both pre- and post-project implementation periods. To delineate the pre- and post-project implementation periods, it is important to note that the reforestation activities took place between January 2023 and May 2023. Consequently, all months prior to these dates are considered as the pre-project implementation period, while months after are regarded as the post-project implementation period for the purpose of this analysis. Analyzing the NDVI values within the plot reveals a mean NDVI spectrum ranging from 0.25 to 0.65 prior to the project's initiation. NDVI values oscillate in the project area seasonally, and the absence of any prior deforestation or degradation in this plot clarifies the absence of significant declines in NDVI during this timeframe. After the project implementation, mean NDVI trends begin to slightly increase, stabilizing around 0.5.

Given the known information that a healthy, dense vegetation canopy typically exhibits NDVI values above 0.5, while sparse vegetation generally falls within the range of 0.2 to 0.5, the current assessment indicates that the reforestation project has the potential to foster an increasing trend in the plot's NDVI as it transitions to a more densely forested area. With the project in place, it is anticipated that the NDVI will continue to rise further, eventually reaching a level indicative of a healthy and thriving vegetation cover.

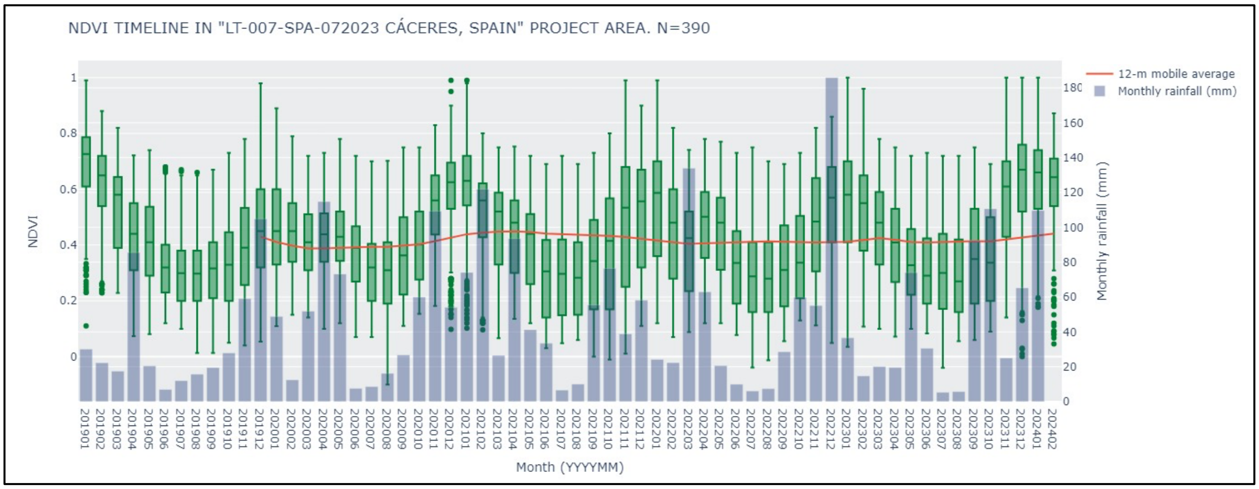


FIGURE 2 NDVI TIME-SERIES IN THE AREA OF INTEREST.

II.2. IMPACT ON THE LANDSCAPE

Prior to reforestation of the area, it experienced decreased biodiversity, and reduced ecosystem services. The ecological restoration effort, however, contributes to the conservation of plant and animal species by providing new habitats and restoring corridors for wildlife movement as healthy forests are crucial for the survival of many species. In addition, the reforestation contributes to the reestablishment of natural hydrological cycles, by slowing down runoff, enhancing water infiltration, and reducing soil erosion. This helps regulate water flow, improve water quality, and mitigate the impacts of flooding. An added advantage is the reforested landscapes offering aesthetic beauty and recreational opportunities. They can provide green spaces for leisure activities, such as hiking, wildlife observation, and eco-tourism, enhancing the well-being of local communities and visitors.

Furthermore, there are intentions to construct an eco-friendly hostel within the plot, aligning with sustainability principles. This establishment will serve as a hub for recreation and environmental education, where visitors will be immersed in the understanding of the plantation's advantages and have the opportunity to witness indigenous animal species in their natural habitat.

III. TECHNICAL SPECIFICATIONS

III.1. REFORESTATION

III.1.1. Reforested area

The project encompasses a plot with a total area measuring 38,3421.50 m^2 situated in Alía municipality, in the Cáceres province (Spain). Figure 3 shows the Project area in 2021, before project implementation.

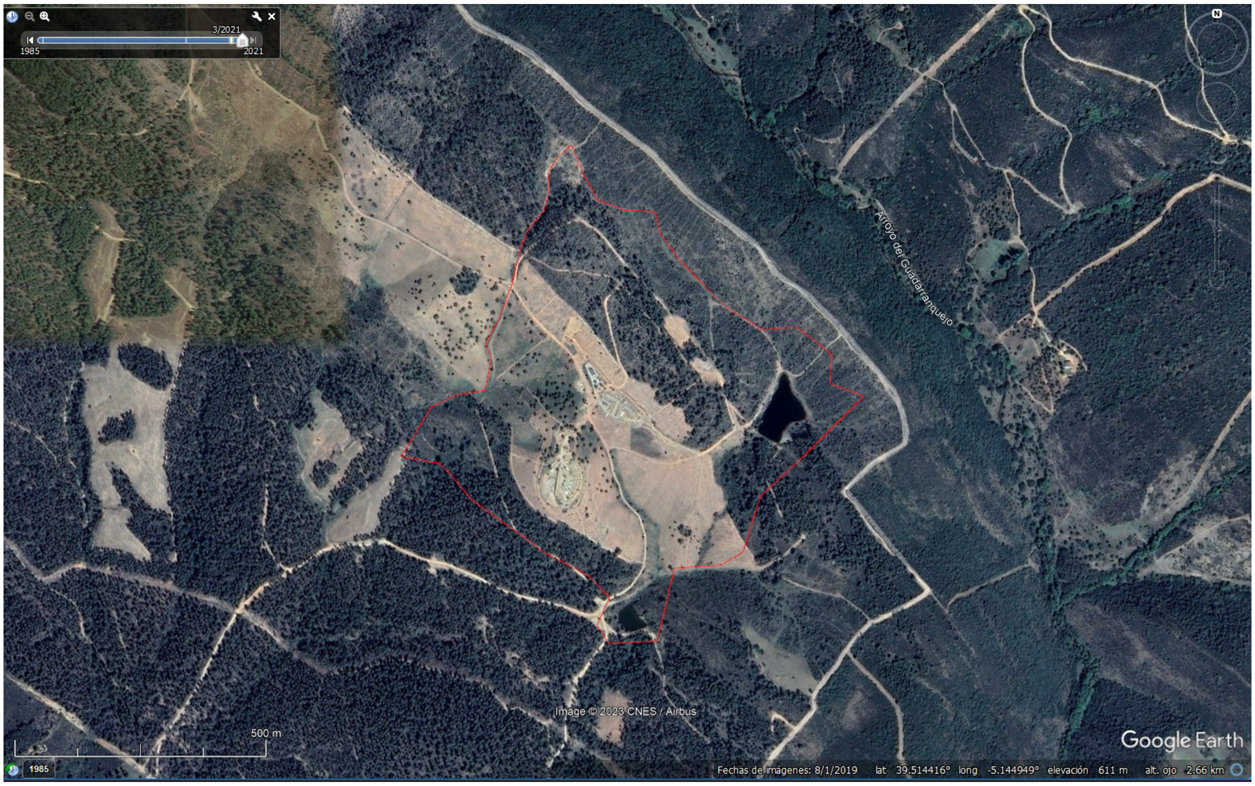


FIGURE 3 SATELLITE IMAGE OF PROJECT AREA BEFORE REFORESTATION ACTIVITES (2021).

III.1.2. Species

The reforestation project successfully planted a total of 60,717 trees, encompassing nineteen different species. The number of individuals of each species is shown in Table 2. The selection of species was based on a preliminary assessment of the region, considering available bibliographic information, as well as the prevailing climatic, vegetational, and meteorological conditions. All species chosen are indigenous to the area and well-suited to the local climate and environmental conditions.

Out of the total number of trees planted (60,717), the percentage by species is presented in Table 2 and in figure 4.

TABLE 2. NUMBER OF TREES BY SPECIES

Species	Number of trees	Percentage (%)	Origin
Acer monspessulanum	600	0.99	Native
Acer pseudoplatanus	135	0.22	Introduced
Castanea sativa	40	0.07	Introduced
Cupressus arizonica	14040	23.12	Native
Cupressus sempervirens	15266	25.14	Introduced
Ficus carica	135	0.22	Introduced
Genista cinerea	2640	4.35	Native
Genista scorpius	1026	1.69	Native
Genista umbellata	3360	5.53	Native
Lavandula angustifolia	7020	11.56	Native
Lavandula stoechas	2025	3.34	Introduced
Morus nigra	225	0.37	Introduced
Populus nigra	540	0.89	Introduced
Prunus avium	12000	19.76	Native
Prunus dulcis	90	0.15	Introduced
Prunus mahaleb	270	0.44	Native
Quercus pyrenaica	675	1.11	Native
Quercus rubra	540	0.89	Native
Taxus baccata	90	0.15	Native
Total	**60,717**	**100%**	Native=11 Introduced=8

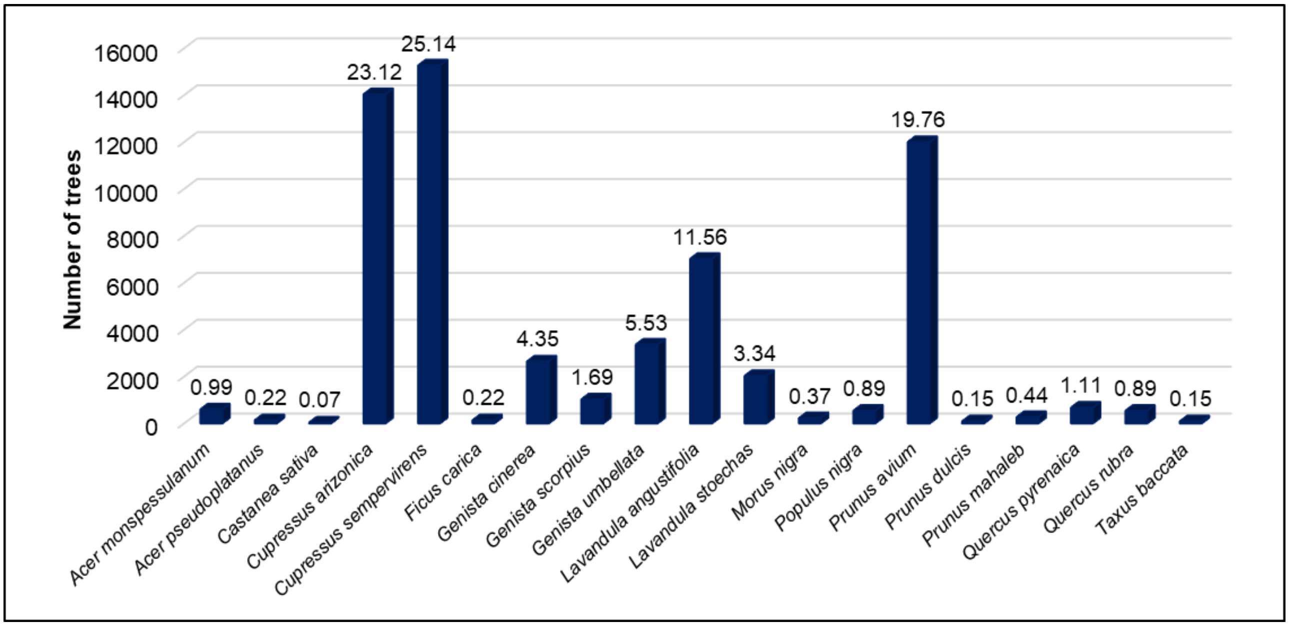


FIGURE 4. NUMBER OF TREES BY SPECIES (THE NUMBERS OVER EACH BAR REPRESENT THE PERCENTAGE).

III.1.2.1. Distribution Of The Species Selected For Reforestation

The distribution of plant species is influenced by a variety of abiotic and biotic factors, including:

- Climate
- Soil
- Topography
- Hydrology
- Competition between plants for resources
- Seed dispersal

These factors interact in complex ways to determine the distribution of plant species across a landscape.

Understanding and knowing the distribution of the flora species that have been selected for reforestation is important to ensure the adaptation of the new trees and their survival, to secure the long-term benefits of the project, and to avoid altering the ecosystem balance by introducing non-adapted species.

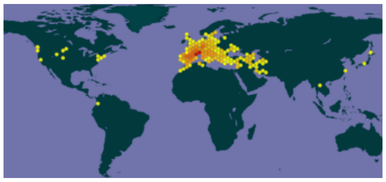
To achieve this, each species was consulted in the Global Biodiversity Information Facility GBIF (https://www.gbif.org). This database allows you to know the species classified as introduced in each country, their EUNIS habitat, their native range, and observation records.

The Global Register of Introduced and Invasive Species (GRIIS) presents validated lists of introduced (alien) and invasive alien species at the country, territory, and associated island level. The International Union for Conservation of Nature (IUCN) describes an introduced/alien and invasive alien species as follows:

- *Introduced/alien species:* A species, subspecies, or lower taxon occurring outside of its natural range (past or present) and dispersal potential (i.e., outside the area, it could occupy without human intervention) and which has been transported by human activity; this includes any parts, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce.
- *Invasive alien species:* A species that becomes established in natural or semi-natural ecosystems or habitats, is an agent of change, and threatens native biological diversity. This includes widespread species, rapidly expanding, or present in high abundance and that hurt biodiversity.

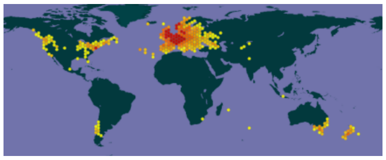
According to the aOCP's eligibility criteria, species classified as invasive alien species cannot be counted towards the project's benefits.

- ***Acer monspessulanum***

Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	• Africa • Europe • Temperate Asia • Eastern Asia • Eastern Europe
Georeferenced records	

- ***Acer pseudoplatanus***

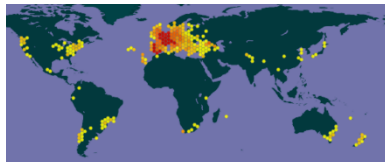
Recorded as introduced in Spain	☒ Yes ☐ No
Habitat EUNIS	• Broadleaved deciduous woodland (G1 level 2) • Constructed, industrial and other artificial habitats (J level 1)

	• Cultivated areas of gardens and parks (I2 level 2) • Domestic gardens of villages and urban peripheries (X25 level 2) • Mire, bog and fen habitats (D level 1) • Mixed deciduous and coniferous woodland (G4 level 2) • Regularly or recently cultivated agricultural, horticultural and domestic habitats (I level 1) • Riverine and fen scrubs (F9 level 2) • Surface running waters (C2 level 2) • Woodland and forest habitats and other wooded land (G level 1)
Native range	• Asia-Temperate • Europe • Middle Europe • Siberia • Southeastern Europe
Georeferenced records	

The species *Acer pseudoplatanus* with the taxon identifier number 125517, is not classified as an invasive alien species according to the GRIIS database of Spain: https://www.gbif.org/species/160951038/verbatim. **Therefore, its integration and counting in the project is accepted.**

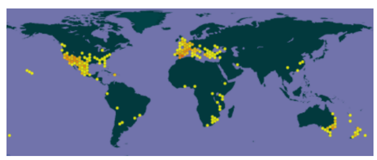
- ***Castanea sativa***

Recorded as introduced in Spain	☒ Yes ☐ No
Habitat EUNIS	• Broadleaved deciduous woodland (G1 level 2) • Cultivated areas of gardens and parks (I2 level 2) • Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice (G5 level 2) • Woodland and forest habitats and other wooded land (G level 1)
Native range	• Africa • Asia-Temperate • Asia-Tropical • Europe • Malesia

	• Western Asia
Georeferenced records	

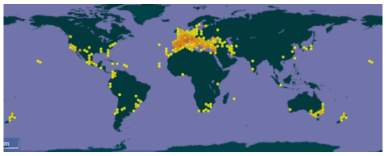
The species *Castanea sativa* with the taxon identifier number 125678, <u>is not</u> classified as an invasive alien species according to the GRIIS database of Spain: https://www.gbif.org/species/160950585/verbatim Therefore, its integration and counting in the project is accepted.

- ***Cupressus arizonica***

Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	• Buildings of cities, towns and villages (J1 level 2)
Native range	• Northern America • Southwestern Europe
Georeferenced records	

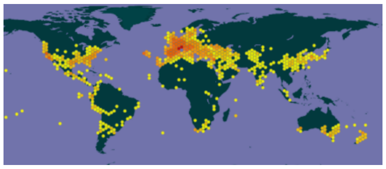
- ***Cupressus sempervirens***

Recorded as introduced in Spain	☒ Yes ☐ No
Habitat EUNIS	• Buildings of cities, towns and villages (J1 level 2) • Coniferous woodland (G3 level 2) • Transport networks and other constructed hard-surfaced areas (J4 level 2) • Woodland and forest habitats and other wooded land (G level 1)
Native range	• Asia-Temperate • Europe • Northern Africa • Southeastern Europe • Southwestern Europe

Georeferenced records	

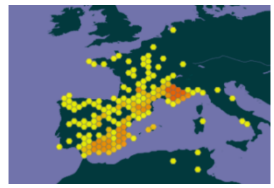
The species *Cupressus sempervirens* with the taxon identifier number 46289, is not classified as an invasive alien species according to the GRIIS database of Spain: https://www.gbif.org/species/160951038/verbatim. Therefore, its integration and counting in the project is accepted.

- ***Ficus carica***

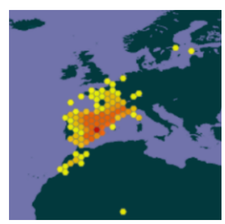
Recorded as introduced in Spain	☒ Yes ☐ No
Habitat EUNIS	• Constructed, industrial and other artificial habitats (J level 1) • Inland unvegetated or sparsely vegetated habitats (H level 1) • Low density buildings (J2 level 2) • Regularly or recently cultivated agricultural, horticultural and domestic habitats (I level 1) • Thermo-Atlantic xerophytic scrub (F8 level 2)
Native range	• Arabian Peninsula • Asia-Temperate • Asia-Tropical • Caucasus • Europe • Indo-China • Malesia • Middle Asia • Northern Africa • Southeastern Europe • Southwestern Europe • Western Asia
Georeferenced records	

The species *Ficus carica* with the taxon identifier number 46418, is not classified as an invasive alien species according to the GRIIS database of Spain: https://www.gbif.org/species/148785680/verbatim. Therefore, its integration and counting in the project is accepted.

- *Genista cinerea*

Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	Not specified
Georeferenced records	

- *Genista scorpius*

Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	Not specified
Georeferenced records	

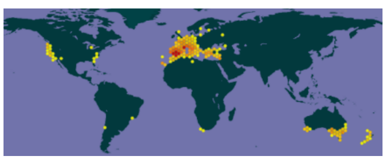
- *Genista umbellata*

Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	Not specified
Georeferenced records	

- ***Lavandula angustifolia***

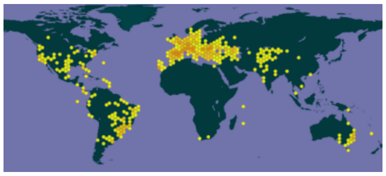
Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	• Constructed, industrial and other artificial habitats (J level 1) • Inland unvegetated or sparsely vegetated habitats (H level 1) • Low density buildings (J2 level 2) • Transport networks and other constructed hard-surfaced areas (J4 level 2)
Native range	• Africa • Asia-Temperate • Europe • Southwestern Europe • Eastern Asia • Eastern Europe
Georeferenced records	

- ***Lavandula stoechas***

Recorded as introduced in Spain	☒ Yes ☐ No
Habitat EUNIS	Not specified
Native range	• Northern Africa • Southeastern Europe • Southwestern Europe • Western Asia • Africa • Eastern Asia • Eastern Europe • Europe
Georeferenced records	

The species *Lavandula stoechas* with the taxon identifier number 46542, is not classified as an invasive alien species according to the GRIIS database of Spain: https://www.gbif.org/species/148786554/verbatim**. Therefore, its integration and counting in the project is accepted.**

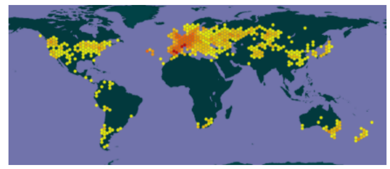
- ***Morus nigra***

Recorded as introduced in Spain	☒ Yes ☐ No
Habitat EUNIS	• Arable land and market gardens (I1 level 2) • Broadleaved deciduous woodland (G1 level 2) • Broadleaved evergreen woodland (G2 level 2) • Coastal dunes and sandy shores (B1 level 2) • Constructed, industrial and other artificial habitats (J level 1) • Littoral zone of inland surface waterbodies (C3 level 2) • Low density buildings (J2 level 2) • Woodland and forest habitats and other wooded land (G level 1)
Native range	• Arabian Peninsula • Asia-Temperate • China • Middle Asia • Mongolia • Northern America • Asia • Eastern Asia • Eastern Europe
Georeferenced records	

The species *Morus nigra* with the taxon identifier number 126023, is not classified as an invasive alien species according to the GRIIS database of Spain: https://www.gbif.org/species/148786554/verbatim**. Therefore, its integration and counting in the project is accepted.**

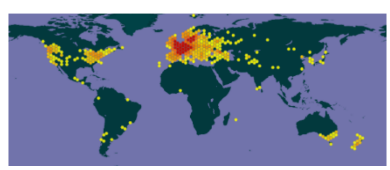
- ***Populus nigra***

Recorded as introduced in Spain	☒ Yes ☐ No
Habitat EUNIS	• Constructed, industrial and other artificial habitats (J level 1)

	• Cultivated areas of gardens and parks (I2 level 2) • Mixed deciduous and coniferous woodland (G4 level 2)
Native range	• Europe • Andes
Georeferenced records	

The species *Populus nigra* with the taxon identifier number 126169, is not classified as an invasive alien species according to the GRIIS database of Spain: https://www.gbif.org/species/148786554/verbatim. Therefore, its integration and counting in the project is accepted.

- ***Prunus avium***

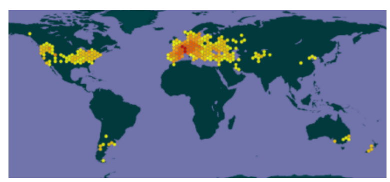
Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	• Broadleaved deciduous woodland (G1 level 2) • Coniferous woodland (G3 level 2) • Constructed, industrial and other artificial habitats (J level 1) • Cultivated areas of gardens and parks (I2 level 2) • Mixed deciduous and coniferous woodland (G4 level 2) • Woodland and forest habitats and other wooded land (G level 1)
Native range	• Asia-Temperate • Europe • Middle Europe • Southwestern Europe • Western Asia
Georeferenced records	

- ***Prunus dulcis***

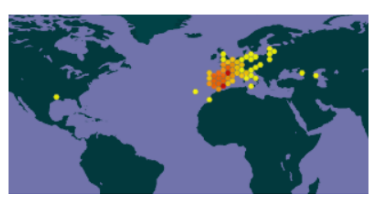
Recorded as introduced in Spain	☒ Yes ☐ No
Habitat EUNIS	• Arable land and market gardens (I1 level 2) • Broadleaved deciduous woodland (G1 level 2) • Broadleaved evergreen woodland (G2 level 2) • Buildings of cities, towns and villages (J1 level 2) • Coniferous woodland (G3 level 2) • Constructed, industrial and other artificial habitats (J level 1) • Cultivated areas of gardens and parks (I2 level 2) • Domestic gardens of city and town centres (X24 level 2) • Dry grasslands (E1 level 2) • Garrigue (F6 level 2) • Hedgerows (FA level 2) • Inland unvegetated or sparsely vegetated habitats (H level 1) • Maquis, arborescent matorral and thermo-Mediterranean brushes (F5 level 2) • Rural mosaics, consisting of woods, hedges, pastures and crops (X8 level 2) • Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation) (F7 level 2) • Transport networks and other constructed hard-surfaced areas (J4 level 2) • Woodland and forest habitats and other wooded land (G level 1)
Native range	• Arabian Peninsula • Asia-Temperate • Europe • Middle Asia • Northern Africa • Southeastern Europe • Southwestern Europe • Western Asia
Georeferenced records	

The species *Prunus dulcis* with the taxon identifier number 126188 , is not classified as an invasive alien species according to the GRIIS database of Spain: https://www.gbif.org/species/160950716/verbatim. Therefore, its integration and counting in the project is accepted.

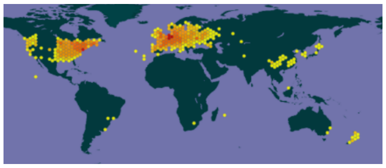
- ***Prunus mahaleb***

Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	• Broadleaved deciduous woodland (G1 level 2) • Coniferous woodland (G3 level 2) • Constructed, industrial and other artificial habitats (J level 1) • Cultivated areas of gardens and parks (I2 level 2) • Mixed deciduous and coniferous woodland (G4 level 2) • Woodland and forest habitats and other wooded land (G level 1)
Native range	• Europe • Middle Europe • Southeastern Europe • Southwestern Europe • Western Asia
Georeferenced records	

- ***Quercus pyrenaica***

Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	Not specified
Georeferenced records	

- *Quercus rubra*

Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	• Broadleaved deciduous woodland (G1 level 2) • Coniferous woodland (G3 level 2) • Constructed, industrial and other artificial habitats (J level 1) • Dry grasslands (E1 level 2) • Large parks (X11 level 2) • Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice (G5 level 2) • Mixed deciduous and coniferous woodland (G4 level 2) • Temperate and mediterranean-montane scrub (F3 level 2) • Temperate shrub heathland (F4 level 2) • Transport networks and other constructed hard-surfaced areas (J4 level 2) • Woodland and forest habitats and other wooded land (G level 1) • Woodland fringes and clearings and tall forb stands (E5 level 2)
Native range	• Eastern Canada • Northeastern U.S.A. • Northern America • Southeastern U.S.A.
Georeferenced records	

- *Taxus baccata*

Recorded as introduced in Spain	☐ Yes ☒ No
Habitat EUNIS	• Woodland and forest habitats and other wooded land (G level 1)
Native range	• Western Asia

Georeferenced records	

Of the 19 species planted, 11 are native and 8 are introduced. Since the introduced species are not classified as invasive alien species according to the GRIIS database for Spain, their inclusion in the project is accepted.

The technical data sheets providing detailed information about the species utilized for the reforestation project are included below, in Table 3. These sheets offer comprehensive insights into the characteristics, growth patterns, environmental requirements, and other relevant details of the selected plant species. These data sheets serve as valuable references for understanding the specific attributes and suitability of each species for reforestation efforts.

TABLE 3. TECHNICAL DATA SHEETS OF SPECIES USED FOR REFORESTATION

Acer pseudoplatanus • Also known as the sycamore is a large deciduous, broad-leaved tree, tolerant of wind and coastal exposure. It is native to Central Europe and Western Asia. • It can grow to a height of about 35 m with branches that form a broad, rounded crown. • It is tolerant of a wide range of soil types and pH, except heavy clay, and is at its best on nutrient-rich, slightly calcareous soils. • Roots of the sycamore form highly specific beneficial mycorrhizal associations with the fungus Glomus hoi, which promotes phosphorus uptake from the soil.	
Acer monspessulanum • Also known as the Montpellier maple, is a species of maple native to the Mediterranean region. • A medium-sized deciduous tree or densely branched shrub that grows to a height of 10-15 meters and a trunk diameter up to 75 cm. • Insensitive to limestone soils but does not support excess water. Thrives exclusively in hot and very dry contexts.	
Castanea sativa • Also known as the sweet chestnut or Spanish chestnut is a long-lived deciduous tree. • it produces an edible seed, the chestnut, which has been used in cooking. • It attains a height of 20–35 meters with a trunk often 2 meter in diameter. • The tolerance to wet ground and to clay-rich soils is very low however, it is a heat-loving tree which needs a long vegetation period. it may tolerate temperatures as low as -15 °C.	
Cupressus arizonica • A coniferous evergreen tree with a conic to ovoid-conic crown which grows to heights of 10–25 m and its trunk diameter reaches 55 cm. • It is widely cultivated as an ornamental tree. • It has proved highly resistant to cypress canker, hence growth is reliable where this disease is prevalent.	

Cupressus sempervirens • Also known as the Mediterranean cypress is a medium-sized coniferous evergreen tree which grows to 35 m tall. • Has been widely cultivated as an ornamental tree.	
Ficus carica • Also known as Fig is a decidious species of small tree in the flowering plant family Moraceae, native to the Mediterranean region, together with western and southern Asia. • Large shrub which grows up to 7–10 meters tall. • They tolerate moderate seasonal frost and can be grown even in hot-summer continental climates. • It prefers relatively porous and freely draining soil, and can grow in nutritionally poor soil.	
Genista cinerea • An ornamental shrub for banks and landscaping that can reach 1.5m. • It likes limestone, poor and well-drained soils.	
Genista scorpius • Genista scorpius is a species of shrub with compound, broad leaves and dry fruit. Individuals can grow to 2 m. • It can be used to create defensive hedges. • It generally grows in scrub in dry places, on clay, gypsum, limestone or marl substrates.	
Genista umbellata • Ornamental shrub for landscaping, Prefers poor stony and dry soils. • It reaches a size of up to 1.5 m in height.	

Lavandula angustifolia • It is a strongly aromatic shrub native to the Mediterranean growing as high as 1 to 2 metres tall. • Commonly grown as an ornamental plant. with its ability to survive with low water consumption. • It does best in Mediterranean climates • It tolerates acid soils but favours neutral to alkaline soils,	
Lavandula stoechas • Also known as the Spanish lavender native to several Mediterranean countries. • An evergreen shrub that usually grows to between 30 and 100 cm tall and occasionally up to 2 m. • it is associated with hot, dry, sunny conditions in alkaline soils.	
Morus nigra • Also known as black mulberry is a deciduous tree growing to 12 metres tall by 15 m broad. • The fruit is edible and the tree has long been cultivated for this property.	
Populus nigra • Commonly known as Black poplars are medium- to large-sized deciduous trees, reaching 20–30 m, and rarely 40 m tall and their trunks achieve up to 1.5 m in diameter, • Used in industrial areas and for row and landscape planting. • This tree is very resistant to cold, can live 400 years.	
Prunus avium ● Commonly called wild cherry, or sweet cherry, is a species of cherry. ● It is a deciduous tree growing to 15–32 meters tall, with a trunk up to 1.5 m in diameter. ● It is often cultivated as a flowering tree.	

Prunus dulcis • Commonly known as Almond is a species of tree native to Iran and surrounding countries however prospers in a moderate Mediterranean climate with warm, dry summers and mild, wet winters. • A deciduous tree growing to 4 –12.2 meters in height with a trunk of up to 30 centimeters.	
Prunus mahaleb • Also known as the mahaleb cherry is a species of cherry tree native to central and southern Europe, Iran and parts of central Asia. • It is a deciduous tree or large shrub, growing to 2–10 m (rarely up to 12 m) tall with a trunk up to 40 cm diameter. • The species is grown as an ornamental tree for its strongly fragrant flowers,	
Quercus pyrenaica • Also known as Pyrenean oak, or Spanish oak is a tree native to southwestern Europe and northwestern North Africa. • A tall deciduous tree, often marcescent in immature individuals, up to 25 metres tall, and has an average lifespan of 300 years. • It is adapted to survive in hot local temperatures.	
Quercus rubra • Also known as the northern red oak native of North America, which grows to to 28 meters tall with a trunk, up to 2 m in diameter. • It prefers good soil that is slightly acidic.	

Taxus baccata • Known as European yew is a species of evergreen tree in the family Taxaceae, native to Western Europe, Central Europe and Southern Europe. • Grows to 10–20 m (exceptionally up to 28 m) tall, with a trunk up to 2 m (exceptionally 4 m) in diameter. • The entire yew bush is poisonous with the exception of the aril (the red flesh of the berry covering the seed).	

III.1.3. Reforestation technique

The reforestation technique implemented is the Dense Planting/ Intensified Planting technique. Dense planting technique, also known as high-density planting or intensive planting, refers to a method of crop cultivation where plants are spaced closely together in order to maximize productivity and yield. Instead of the traditional practice of leaving significant spaces between plants, dense planting involves reducing the interplant spacing, resulting in a higher number of plants per unit area. The goal of this technique is to optimize the use of available resources, such as sunlight, water, and nutrients, by creating a more efficient growing environment. By reducing the space between plants, several benefits can be achieved which include enhanced resource utilization, weed suppression, and increased yield. Nonetheless, it is important to note that the success of dense planting depends on various factors, such as the specific plants being grown, local climate conditions, soil fertility, and management practices. Adequate irrigation, nutrient management, and careful monitoring of tree health are crucial to ensure optimal growth and prevent issues such as overcrowding, nutrient deficiencies, or increased disease susceptibility.

III.1.3.1. Methodological process

The operational phase is divided into three steps shown in Figure 5.

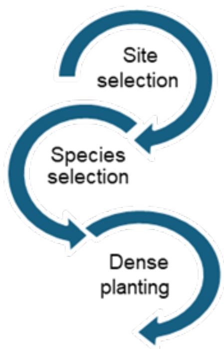


FIGURE 5 METHODOLOGICAL PROCESS

The reforestation process involved a well-defined series of steps. Firstly, a thorough evaluation was conducted to select the most suitable reforestation area, taking into account restoration needs, climatic and soil feasibility, permit requirements, and cost considerations. It ensured that the chosen location was conducive to successful reforestation. Previous individuals of Pinus spp. and Eucalyptus globulus were removed to make space for the new selection of species. To preserve the ecological integrity of the region, afforestation was not carried out on scarified ground. This approach aimed to leverage the existing ecosystem to facilitate the growth and development of the newly planted trees, promoting biodiversity and increasing the chances of successful reforestation. Local community stakeholders were actively involved in the process, fostering a sense of ownership and sustainability in the reforestation initiative.

The assessment revealed an average planting density of one tree per 5.4 square meters, equivalent to an average of 1,861 trees per hectare in the plot. This high-density approach offers several ecological, environmental, and economic advantages. The increased tree density, combined with the implementation of various tree species, will foster biodiversity and enhance ecological resilience within the restored ecosystem. Moreover, the high density will expedite canopy closure, creating a continuous cover as the tree canopies interlock. This canopy closure plays a crucial role in weed suppression, creating improved microclimates, and moisture retention, and reducing soil erosion. However, it's important to note that high planting densities can also lead to competition for resources among trees, which may result in stunted growth, reduced health, and increased mortality of some trees. In addition, the close proximity between trees can facilitate the rapid spread of diseases and pests. Controlling and managing these issues becomes more complex in densely planted areas.

As a result of this high-density planting strategy, the reforestation project is well-positioned to maximize carbon sequestration potential, promote wildlife habitat, and provide essential ecosystem services. The management of this densely planted plot will be critical to ensure the continued success and long-term sustainability of the reforestation efforts.

III.1.4. Geolocalization of planted trees

Using Spatial Analyst tools in ArcGIS Pro environment, a detailed count of geolocalized trees was conducted within the project plot. The results indicate the distribution of 60,717 trees within the reforested plot spaced at approximately 3.6 meters intervals for larger tree species and 0.3 meter intervals for smaller shrubs. Figure 6 shows the geolocation of planted trees within the plots, each tree is represented by a dot symbol.

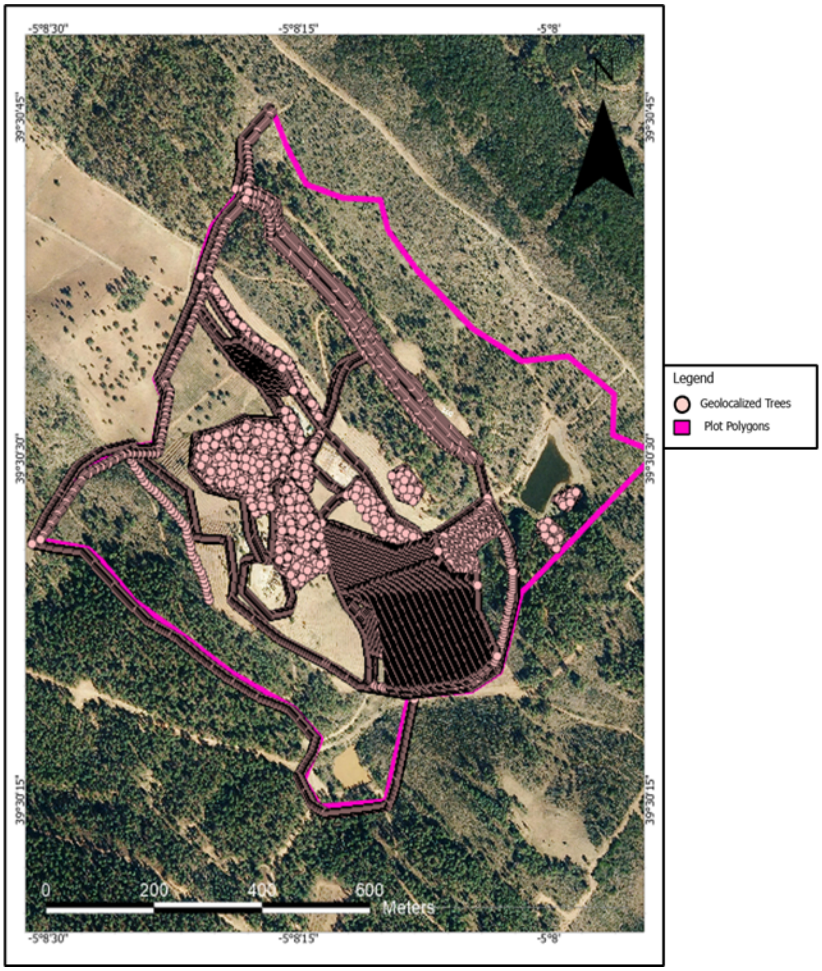


Figure 6. Tree planting distribution.

This analysis provides valuable insights into the spatial relative abundance of trees within each plot. The distribution percentages highlight the varying densities and concentrations of trees, indicating areas with higher and lower tree populations in cases where the reforested plots are segmented. These findings help understand tree distribution and estimate the project's carbon absorption capacity. The number of trees and their carbon sequestration capacity are crucial for the estimation of the Project’s carbon sequestration potential. The count of geolocalized trees provides an overall measure, serving as a basis for estimating carbon sequestration. Combining tree count with species-specific data allows the estimation of biomass and carbon capture potential. This provides a quantitative assessment of the project's capacity to absorb and sequester CO_2.

III.2. GROUNDWATER RECHARGE

The project area was assessed using the *aOCP Methodology for the Assessment of Groundwater Recharge Restoration*, which employs the Soil Conservation Service Curve Number (SCS-CN) Method to estimate infiltration. The infiltration estimates were then integrated into the Thornthwaite-Mather water balance model to calculate groundwater recharge. This methodology enables the tracking of restoration project outcomes over time by leveraging high-resolution satellite imagery from Sentinel-2, which offers a temporal resolution of five days.

The assessment was implemented within Google Earth Engine (GEE), following a structured workflow to calculate groundwater storage (GWS). The key steps are outlined below:

1. Land Cover Classification: The Dynamic World Cover dataset was used to classify land cover types, which informed the selection of appropriate Curve Number (CN) values for different surfaces.
2. Calculation of Composite Curve Number (CNc): The composite Curve Number (CNc) was computed as a weighted average, following Fan et al. (2013), using:
   a. Soil CN: Based on the hydrologic soil group, determined from soil texture classification. Values were taken from Li et al. (2018), using sand and clay content retrieved from OpenLandMap (Tomislav Hengl, 2018; Tomislav Hengl., 2018).
   b. Impervious Surface CN: Assigned a fixed value of 98, according to literature (USACE Hydrologic Engineering Center, n.d.).
   c. Vegetation CN: Derived from NDVI classes and the percentage of vegetation cover within each pixel, as per Bera et al. (2022).

   *The weights for each CN component were assigned based on the proportion of each land cover type, obtained using the Dynamic World Cover.
3. Slope-Corrected Curve Number (CNsc) Calculation: CN values were adjusted for slope using the method proposed by (Huang et al. (2006).
4. Runoff and Infiltration Estimation: Surface runoff was computed based on precipitation inputs, CNsc values, and initial abstraction (Ia). Infiltration was derived as the difference between precipitation and runoff.
5. Evapotranspiration (ET) Retrieval: Evapotranspiration estimates were obtained from the MOD16A2 Version 6.1 dataset (Running et al., 2021) in the GEE catalog.
6. Precipitation Data and Time-Series Analysis:

- Pre-project and monitoring period: Daily rainfall data were sourced from the CHIRPS Daily Climate Hazards Group InfraRed Precipitation with Station Data (Version 2.0 Final) dataset (Funk et al., 2015).
- Runoff, infiltration, and groundwater recharge were calculated on a daily basis using CHIRPS rainfall data for the evaluation period. Daily values were aggregated to compute annual totals for each year.
- For Future projections, annual rainfall estimates were retrieved from NASA GDDP-CMIP6 models (Thrasher et al., 2012) to simulate infiltration and groundwater recharge under projected climate conditions.

7. Groundwater Storage (GWS) Calculation: Groundwater storage was estimated by integrating runoff (from Step 4), evapotranspiration (from Step 5), and precipitation (from Step 6) into the Thornthwaite-Mather water balance model.

The groundwater recharge analysis covered three distinct periods:

- Pre-Project Phase – Baseline conditions before restoration interventions.
- Monitoring Phase – A period following project implementation to evaluate initial impacts.
- Future Projections (Year 40) – Long-term estimates of groundwater recharge under future climate conditions.

TABLE 4. ASSESSMENT PERIODS

Period	Date range
Pre-project	January 2022 to December 2022
1st year monitoring	January 2024 to December 2024
Year 40 projection	January 2063 to December 2063

NDVI, land cover fractions, and precipitation are key independent variables that significantly vary over time. Tables 5 presents the combination of these factors used to compute GWR for the assessed periods.

TABLE 5. COMBINATION OF DATASETS USED TO REPRESENT THE SCENARIOS FOR GROUND WATER STORAGE (GWS) MODELLING

Scenario	NDVI	Land cover fractions (LCF)
Before Project	Mean annual NDVI from pre-project period	Unmixing on S-2 image from 2022-01-01
After Project Year 1	Mean annual NDVI from monitoring period	Unmixing on S-2 image from 2024-01-01
Year 40 projection	Monitoring & Maximum*	Based on LCF from monitoring: • Impervious: unchanged • Vegetation: Multiplied 2x and limited to 1.0 Soil: computed as 1-impervious-vegetation

* For future scenarios, the mean annual NDVI was assumed to remain constant at monitoring period levels for the rest of the microbasin, while in the project area, it was projected to reach the maximum mean annual NDVI observed within the microbasin.

III.2.1. GroundWater Recharge Results

The results presented in Table 6 are derived from hydrological modeling and provide estimates of groundwater recharge (GWR) and infiltration across the Project Area, Counterfactual Area, and Microbasin over different time periods: Pre-Project, Monitoring Period, and Year 40 (Projected Future Scenario). These estimates are based on model simulations rather than direct field measurements, incorporating observed rainfall data for past and present conditions and climate model projections (NASA GDDP-CMIP6) for future scenarios.

Prior to the implementation of restoration activities, model simulations indicate that groundwater recharge and infiltration levels were comparable between the Project and Counterfactual Areas, with estimated GWR values of 560.47 m³/ha and 548.96 m³/ha, respectively, and infiltration rates around 5604.73 m³/ha and 5484.97 m³/ha, respectively. These baseline estimates suggest that, in the absence of interventions, both areas exhibited similar hydrological characteristics.

TABLE 6. ESTIMATED GWR IN THE PROJECT AREA (32.60 HA), COUNTERFACTUAL (16.86 HA) AND MICROBASIN (1,337.18 HA) AT THE ASSESSED PERIODS

Period	Average GWR (m^3/hec)			Average Infiltration (m^3/hec)		
	Project Area	Counterfactual	Microbasin	Project Area	Counterfactual	Microbasin
Pre-project (2022)	560.47	548.50	586.96	5604.73	5484.97	5869.57
Monitoring	1038.60	1022.44	1137.63	5193.01	5112.20	5688.16
Year 40	3509.28	2313.29	2504.44	10719.97	10332.45	11220.70

Results for the monitoring period after restoration suggest a notable increase in groundwater recharge in the Project Area, with estimated values rising to 3509.28 m³/ha, compared to 2313.29 m³/ha in the Counterfactual Area. These results suggest that restoration activities including soil works implemented have improved soil infiltration capacity, leading to enhanced water retention and potential groundwater recharge.

Long-term projections, based on future climate model data, estimate that groundwater recharge in the Project Area could reach 3509.28 m³/ha, significantly higher than the 2313.29 m³/ha projected for the Counterfactual Area. This suggests that restoration efforts may contribute to sustained improvements in groundwater recharge over time. Similarly, projected infiltration estimates for the Project Area are 10,719.97 m³/ha, slightly exceeding the 10,332.45 m³/ha estimated for the Counterfactual Area. These differences indicate that, over time, the cumulative benefits of land restoration could lead to substantial improvements in water infiltration and recharge potential.

Figure 7 illustrates the modeled evolution of cumulative groundwater recharge in the Project and Counterfactual Areas. The diverging trajectories in the projections highlight the potential long-term benefits of restoration activities, with the Project Area showing significantly higher recharge estimates compared to the Counterfactual Area.

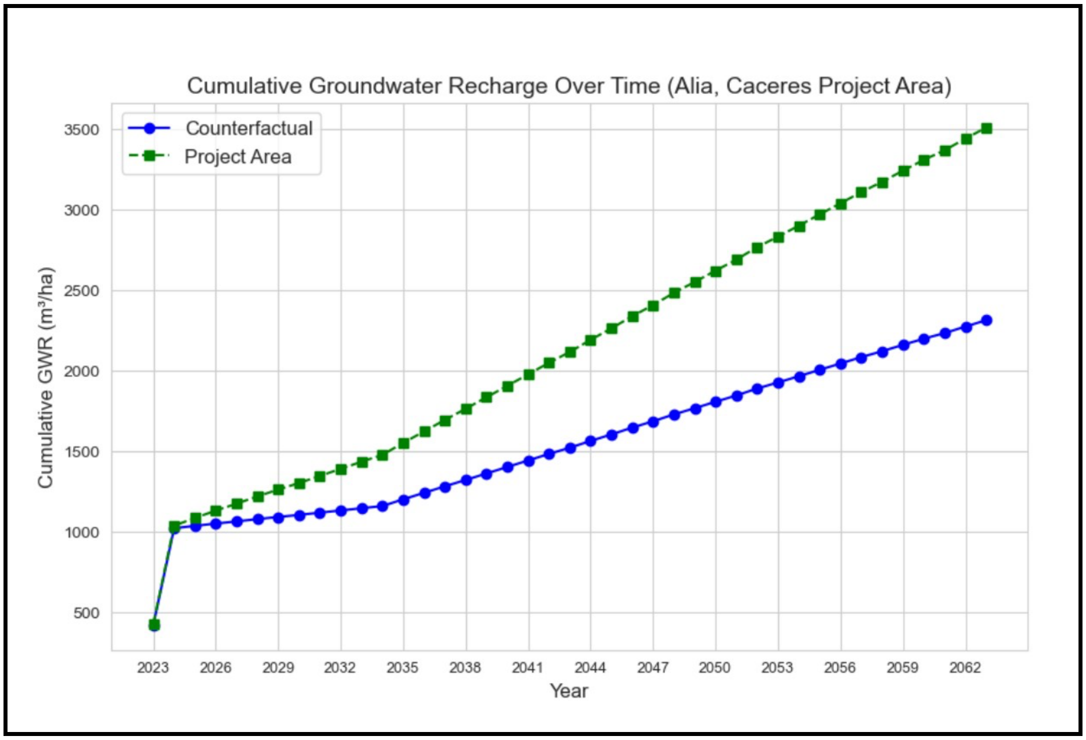


FIGURE 7. PROJECT AND COUNTERFACTUAL AREAS MODELLED INFILTRATION OVER TIME

III.2.2. Water credits calculation

The additional groundwater recharge (GWR) and infiltration resulting from restoration activities are quantified by comparing the Business-As-Usual (BAU) scenario, represented by the Counterfactual Area, with the implemented Project scenario. The difference between these two scenarios reflects the incremental water retention benefits directly attributable to the restoration interventions. By Year 40, model estimates indicate an additional 1,195.99 m³/ha of infiltrated water in the Project Area compared to the Counterfactual Area. Given the total surface area of the Project (32.60 ha), this translates to an estimated 38,986.02 m³ of additional infiltrated water over the long term.

Since 1 water credit is equivalent to 1 m³ of additional water infiltrated, the Project has the potential to generate approximately **38,966** water credits by Year 40 (Figure 8). These results highlight the substantial hydrological benefits of restoration activities, demonstrating their role in enhancing water infiltration and recharge capacity compared to a scenario without intervention.

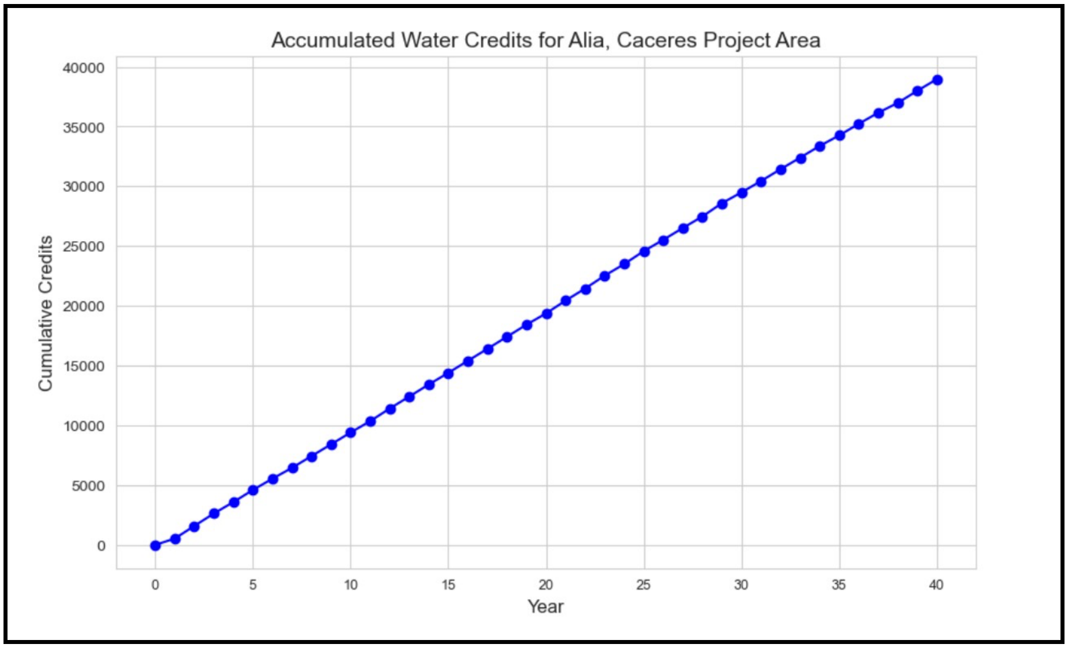


FIGURE 8 YEARLY ACCUMULATED NUMBER OF WATER CREDITS FOR ENTIRE PROJECT AREA

It is important to emphasize that these estimates are based on hydrological modeling and climate scenario projections, incorporating key assumptions about precipitation patterns, soil retention capacity, and land cover dynamics. As such, actual field conditions may vary due to uncertainties in future climate variability and land-use changes. To ensure the accuracy and reliability of these estimates, periodic monitoring and empirical data collection will be conducted. Such validation efforts would enhance confidence in the projected water credits and support adaptive management strategies for long-term sustainability.

TABLE 7. MODELLED YEARLY INFILTRATION FROM PRECIPITATION IN THE PROJECT AREA AND ACCUMULATED NUMBER OF CREDITS PER HECTARE

Year	GWR Project (m^3/hec)	GWR Counterfactual (m^3/hec)	Project Impact (m3/ha)	Accumulated credits per Hectare
1	1038.60	1022.44	16.16	16
2	47.06	14.59	32.48	48
3	46.36	14.40	31.95	79
4	42.84	13.48	29.36	108
5	45.18	14.10	31.09	139
6	42.38	13.35	29.02	168
7	40.54	12.86	27.69	195
8	44.18	13.83	30.35	225
9	43.86	13.75	30.11	255
10	44.24	13.85	30.39	285
11	42.56	13.40	29.16	314
12	74.13	41.74	32.39	346
13	71.07	40.27	30.79	376
14	71.48	40.47	31.01	407
15	69.25	39.39	29.85	436
16	71.36	40.41	30.94	466
17	70.98	40.23	30.75	496
18	71.39	40.43	30.96	526
19	71.76	40.61	31.15	557
20	67.15	38.37	28.78	585
21	75.20	42.24	32.96	617
22	71.30	40.38	30.91	647
23	75.48	42.37	33.11	680
24	69.00	39.27	29.73	709
25	75.75	42.50	33.25	742
26	67.76	38.67	29.09	771
27	70.08	39.80	30.28	801
28	68.66	39.11	29.55	830

Year	GWR Project (m³/hec)	GWR Counterfactual (m³/hec)	Project Impact (m3/ha)	Accumulated credits per Hectare
29	77.48	43.31	34.17	864
30	65.09	37.35	27.74	891
31	67.86	38.72	29.14	920
32	70.27	39.89	30.38	950
33	68.66	39.11	29.55	979
34	69.76	39.64	30.12	1009
35	63.72	36.67	27.05	1036
36	69.17	39.36	29.82	1065
37	66.75	38.17	28.58	1093
38	60.18	34.88	25.30	1118
39	71.73	40.59	31.14	1149
40	69.02	39.28	29.74	1178

III.2.3. Contingent table of Verified Water Credits VWCs

The Verified Water Credits (VWC) for this project will be issued using a conservative and adaptive approach, integrating observed data and dynamic models to ensure accuracy and integrity.

For the 2023–2024 period, VWCs will be issued based on actual recorded precipitation data, ensuring they accurately reflect the project's contribution to water infiltration during this time.

From 2025 to 2063, water credits will be calculated annually using a dynamic baseline, which will be periodically adjusted to maintain the accuracy and verifiability of additional water infiltration benefits.

Only verified credits will be issued, meaning calculations will rely solely on real recorded precipitation data, rather than projections, ensuring a conservative and precise quantification of the project's impact.

As established in section *III.1.2.* of the *Procedures document version 2.3*[2], **25%** of the credits generated by the project will be withdrawn for the buffer pool as a measure to guarantee the permanence of the project benefits (9,741 credits), resulting in a total of **29,225 Verified Water Credits** to be issued according to the Contingency Table (Table 8).

[2] https://www.nat5.bio/wp-content/uploads/2025/03/I.3.-aOCP-Project-Procedures-V2.3.pdf

TABLE 8. CONTINGENT TABLE OF VERIFIED WATER CREDITS VWCS

Year	Number of VWCs issued on each year
After project implementation	0
2024	395
2025 – 2063	The VWC for these periods will be calculated annually in the dynamic Baseline Report.

CONSULTED REFERENCES

- Beaulieu, J., et al. (2015). Long-term survival of Quercus cerris in a fragmented landscape in the French Alps. Forest Ecology and Management, 336, 75-85)
- Bontemps, J.D., et al. (2003). Long-term dynamics of Quercus coccifera plantations in southwestern France. Forest Ecology and Management, 177(1): 49-60.
- Bouffier, L., Paillet, Y., & Ourcival, J. M. (2005). Long-term dynamics of a Quercus ilex L. plantation in France. Forest Ecology and Management, 209(1-3), 231-241. doi:10.1016/j.foreco.2005.01.039
- Briffa, K.R., Osborn, T.J., Schweingruber, F.H., Jones, P.D., Shiyatov, S.G., Vaganov, E.A. 2003. Reduced sensitivity of recent tree-growth to temperature at high northern latitudes. Nature, 411: 541-544.
- C. Lecomte, P. Gauquelin, J.B. Bessou, R. Roger, and F. Poumarat. "Long-Term Dynamics of an Acer campestre Plantation in Northeastern France." Forest Ecology and Management, vol. 220, no. 1-3, 2006, pp. 58–68., doi:10.1016/j.foreco.2006.01.017.
- Climaterra.org. (03 de 09 de 2022). Mini bosques para el cambio climático. Obtenido de climaterra: https://www.climaterra.org/post/mini-bosques-para-el-cambio-clim%C3%A1tico-akira-miyawaki-y-su-m%C3%A9todo
- Genty, P., Huc, R., & Guédon, Y. (2006). Long-term survival of blackthorn (Prunus spinosa L.) plants in southwestern France. Annals of Forest Science, 63(1), 41-46.
- Lefèvre, M., Chambon, C., & Burdet, H. (2003). Survival of Cercis siliquastrum in France over 40 years. Annals of Forest Science, 60(7), 715-719.
- INRA (2014). Inventaire forestier national - Résultats par région. https://www.ifn.fr/spip.php?article163
- Malle, J.C., Lecomte, J., Dury, J., 2004. Survival of Olea europaea in France over 40 years. Plant & Soil Environment 50, 447–452.
- Nargi, L. (24 de 07 de 2019). Una mejor manera de construir bosques ? Obtenido de Daily jstor: https://daily.jstor.org/the-miyawaki-method-a-better-way-to-build-forests/
- NORTH NORFOLK DISTRICT COUNCIL. (2022). Proyecto Forestal De Miyawaki. Obtenido de NORTH NORFOLK DISTRICT COUNCIL: https://www.north-norfolk.gov.uk/tasks/projects/miyawaki-forest-project/
- Long-term survival of Crataegus monogyna in a temperate climate: a 40-year study in France," by F. Lebourgeois, C. Stahl, P. Cailleret, et al., in Annals of Forest Science, vol. 65, 2008, pp. 1-10.
- Pistacia lent Forest Ecosystems Research Group, INRA, France.
- Source: Planfor, "Prunus mahaleb," https://www.planfor.fr/arbre/prunus-mahaleb.html.
- Tixier, P., Roussel, J., & Fournier, J. (2000). Conservation of Phyllirea angustifolia (L.) Desv. (Rhamnaceae): A long-term study in the south of France. Biological Conservation, 93(2), 183-189).

- Webber, D. S. (23 de 05 de 2022). El método Miyawaki para crear bosques. Obtenido de creating tomorrows forests: https://www.creatingtomorrowsforests.co.uk/blog/the-miyawaki-method-for-creating-forests.