# Coniferous forests in the Mediterranean: an ecosystem of vital importance, threatened by forest management deficit

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DISSEMINATION LIFE FOREST CO2

**Forests constitute a fundamental piece of the territorial mosaic, homogenising and embellishing our landscapes and representing the main green infrastructure for the rural and urban population. These surfaces, whose main function in the Mediterranean environment is protection, are positioned as the main generators of ecosystem services with which both the rural environment and the cities are sustained. These include the supply of raw materials, protection of settlements and infrastructures, the regulation of the hydrological cycle and the purification of water for human supply, or its role as a source of employment and fixation of the population in rural areas. It stands out for its special relevance in the context of the climate crisis that humanity is facing, the role that forests play in mitigating climate change, being the main terrestrial carbon sink of the Land Use Sector, Changes in Land Use and Forestry (LULUCF).**

But for us to enjoy these services, the mere existence of forest masses is not enough. Forests must be in optimal quality conditions so that the benefits offered are maximum and that they can be maintained in the long term, especially with the threat posed by climate change in the Mediterranean. In this geographical context, it is expected that, in the predicted climatic scenarios, atmospheric conditions, especially droughts, will notably affect the forest masses, increasing their vulnerability to climatic inferences and other associated risks such as forest fires.

Forest management is the tool that makes it possible to adapt these ecosystems and reduce their vulnerability to climate change. For this, the contribution that forest owners make through forestry is essential. However, this is increasingly difficult in this context, with an important part of the mountains in the Mediterranean basin lacking proper management. This situation is clearly represented in the south of France and the east and the south of Spain, where forests have a protective function and little productive purpose.

The main reason for the lack of management is purely economic. The low profitability of products, or in the case of protective forests, the large investment necessary to carry out actions with little return on income, leads to owners and managers abandoning management programmes due to financing problems.

*Example of a Pinus halepensis forest mass in the Region of Murcia, Spain, affected by climate change. There are numerous dry and dead trees due to droughts.*

*Forest in the southeast of the Iberian Peninsula, whose management has been burdened for years by the lack of financing. A high density of trees is observed, which makes the mass a vulnerable system to forest fires and droughts, and if it is not treated, it will disappear.*

For this reason—given the urgency to protect forests, the opportunity that their management offers in the fight against climate change, and as a form of recognition for the role that forest owners play—it is essential to integrate this work into the increasingly growing demands of payment for environmental services.

The voluntary carbon markets (VCMs) are currently postulated as the most interesting option as companies, especially those whose greenhouse gases (GHGs) are unregulated, find the commitment to these tools appealing within the framework of corporate social responsibility. In this way, the forestry sector would serve as a springboard to promote the achievement of emissions reduction targets while promoting the potential for removals through land use, especially forestry, to achieve the proposed EU climate neutrality goal for the year 2050.

## Starting point: knowledge gap as the main driver for climate problem targeted

LIFE FOREST CO2 project was created with the premise of promoting forest management as a climate change mitigation tool, rewarding forest owners and involving companies and organisations to attract private investment to the forest sector.

To achieve these objectives, the analysis of the problems to be addressed leads to a common problem: lack of knowledge. This limitation affects the project approach internally and externally, presenting challenges from a technical perspective and for stakeholder involvement.

At the beginning of the project, payment for the environmental service involved in forest management was expected to be a challenge. Even though there is already a voluntary market for carbon, forestry and forest management are marginalised with respect to more popular options, such as reforestation. This lack of integration displaces forestry as a quality alternative in the fight against climate change, with

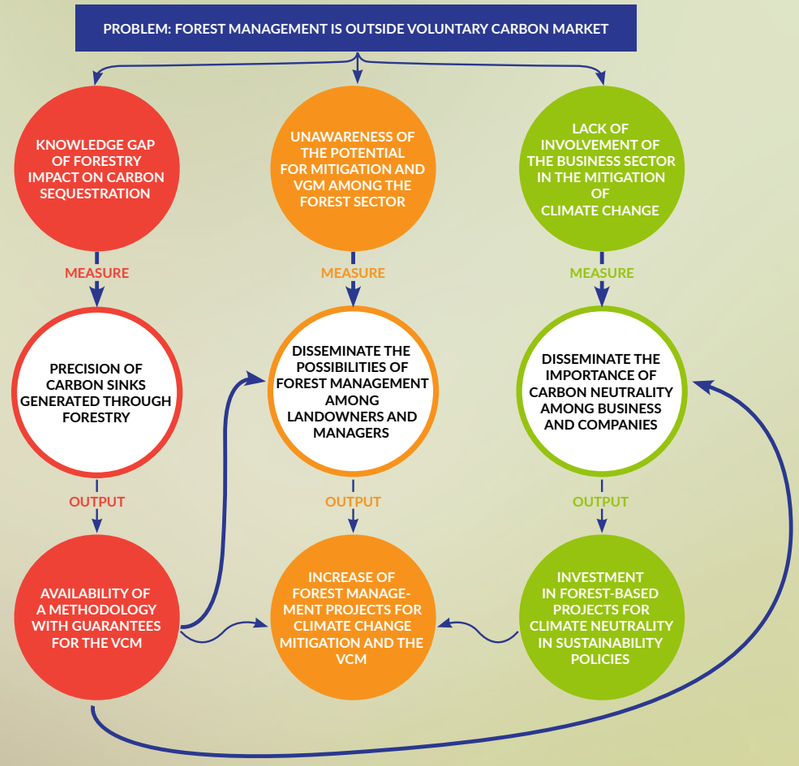



*Figure 1: LIFE FOREST CO2 problems, solutions and output expected to achieve with LIFE FOREST CO2 project.*

the examples of forest management projects in the VCM being scarce and limited for forest owners.

The shortage of demand and supply of $CO_2$ credits in the market is hampered by three main reasons:

- a **knowledge gap** regarding the impact of forestry on carbon sequestration.
- a **lack of awareness** of the potential for mitigation and VCM among the forestry sector
- the **lack of involvement** of the business sector in the mitigation of climate change.

## Knowledge gap: forestry, forest management and $CO_2$ absorption

Until the project proposal date, studies relating to the mitigation potential of forestry were focused on the development of mathematical models for estimating wood production. The absorption of $CO_2$ from the atmosphere as a consequence of forest management interventions until then is limited to that related to the production of biomass, and therefore, to the part of the above-ground system. Forest soils and their capacity to store carbon had also been extensively studied, but the complexity of the methodologies made it difficult to integrate them in a simplified way in the calculations.

This complexity is postulated to be a limiting factor, as is the lack of data and methodology needed to guarantee requirements, e.g. additionality versus non-intervention, long-term permanence, avoidance of double-counting, and adherence to the accountancy rules. In summary, the lack of data and agile, precise methodologies which guarantee





that the $CO_2$ sequestered as part of human intervention in the forest hinders its integration into voluntary markets.

## Lack of awareness: the potential for mitigation and VCM a within the forest sector

Carbon forestry aims to enhance the absorption of GHG by forest masses. Among forest project owners and technicians, awareness is low. The practice is largely unknown within the sector. This is mainly due to the fact that the management and maintenance of forest lands focuses on uses such as logging, hunting, or the prevention of fires and maintenance of habitats. The capture or sequestration of carbon is a non-priority objective when tackling silvicultural work. This means missing out on an opportunity both for mitigation and for providing added value to sustainably managed forest lands. Together with the under-financing suffered by the protective forests due to their low profitability, the potential for mitigating climate change via forest masses and the development of interventions is limited.

## Lack of involvement: the business sector and the mitigation of climate change

Within the business sector, especially the activities of the non-regulated sector, voluntarily offsetting emissions requires incentive. Carbon forestry projects need to be economically and commercially viable compared to other land use and management types.

At the start of the project, most of the voluntary offsets were tied to the LULUCF sector. It is estimated that numerous emission rights from forestry projects remain annually. Achieving an efficient and low-carbon economy requires reducing the carbon footprint, which implies carrying out complete management consisting of calculating, reducing and compensating for any surplus that cannot be reduced.

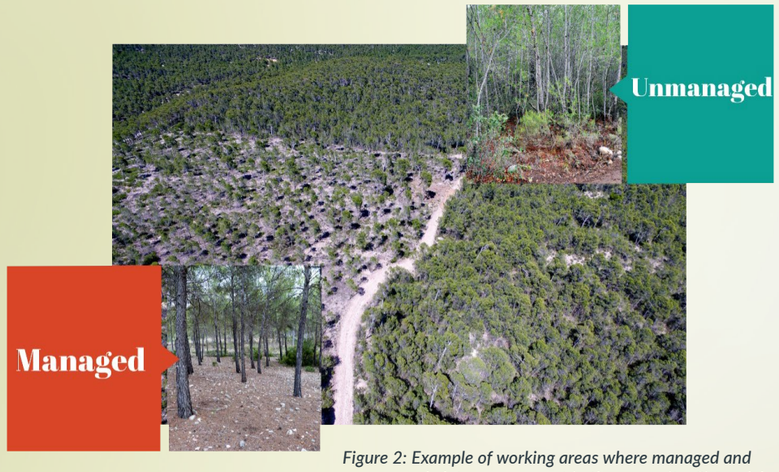



*Figure 2: Example of working areas where managed and unmanaged plots were present in the same site. Sierra del Gigante, Lorca (Region of Murcia, Spain).*

## Action blocks and results

### Modelling of the carbon sink increase in the different forest stocks

Through the LIFE FOREST CO2 project, it has been possible to quantify and model the $CO_2$ absorption in forest masses when sustainable forest management interventions are carried out. These models, developed considering all the forest carbon stores (living, aerial and root biomass, deadwood and litter on the ground and organic carbon in soils) and their interrelationships, have been developed for easy application by owners and forestry technicians. To date, sustainable management has been carried out on two species of conifers widely distributed in the protective forests in the Mediterranean basin: Aleppo pine *(Pinus halepensis)* and maritime pine *(Pinus pinaster)*.

This task was accomplished through three phases of work:

- data collection in the field
- data integration and modelling using computer software
- parameterisation and data synthesis in an easily understood output.

The first phase, data collection in the field, took into account the criterion of **additionality** to account for the carbon sink generated by forest management. To consider an action as a sink, it is necessary to demonstrate that the absorption of $CO_2$ is greater as a result of anthropic intervention than it otherwise would be. To do this, geographical areas with unmanaged plots were located, and managed plots were identified as work zones. Thus, under identical geographical, climatic and soil conditions, the explanation for the differences between the accumulated $CO_2$ in both sites would be anthropic intervention through management.

Work took place in four areas of the Spanish and French territories where the target species are found: Region of Murcia, Soria, Andalusia and Occitania. A total of 48 plots were worked in which soil samples were extracted to analyse the soil organic carbon, litter samples and deadwood on the soil, and the carbon in living biomass was measured using LIDAR. These data fed into the CO2FIX program, in which other variables such as precipitation, site index and final destination of the extracted forest products were introduced, offering a series of results that indicated the difference between the $CO_2$ stored in both managed and unmanaged systems. The difference is considered as $CO_2$ credits, and they are calculated for two complete management shifts.

The results were simplified into guidance tables, as follows, that enable the $CO_2$ to be quantified quickly and easily, knowing the terrain variables.

| PRECIPITATION (mm) | SITE INDEX | *Pinus halepensis* PRODUCTS | CREDITS $CO_2$ / ha | AVERAGE |
|---|---|---|---|---|
| 200 | 20 | Bioenergy | 227,77 | 157,24 |
| | | Soil | 181,76 | |
| | | Board | 62,19 | |
| | 17 | Bioenergy | 128,70 | 74,56 |
| | | Soil | 88,73 | |
| | | Board | 6,23 | |
| | 14 | Bioenergy | 91,23 | 56,17 |
| | | Soil | 65,16 | |
| | | Board | 12,14 | |
| | 11 | Bioenergy | -29,66 | -49,65 |
| | | Soil | -43,38 | |
| | | Board | -75,90 | |
| 350 | 2 | Bioenergy | 227,19 | 139,76 |
| | | Soil | 146,73 | |
| | | Board | 45,37 | |
| | 17 | Bioenergy | 131,76 | 68,91 |
| | | Soil | 72,84 | |
| | | Board | 2,15 | |
| | 14 | Bioenergy | 92,52 | 52,06 |
| | | Soil | 54,68 | |
| | | Board | 9,01 | |
| | 11 | Bioenergy | -19,26 | -40,74 |
| | | Soil | -36,78 | |
| | | Board | -66,19 | |
| 550 | 20 | Bioenergy | 226,42 | 116,47 |
| | | Soil | 100,03 | |
| | | Board | 22,95 | |
| | 17 | Bioenergy | 135,85 | 61,40 |
| | | Soil | 51,66 | |
| | | Board | -3,30 | |
| | 14 | Bioenergy | 94,23 | 46,59 |
| | | Soil | 40,70 | |
| | | Board | 4,84 | |
| | 11 | Bioenergy | -5,39 | -28,87 |
| | | Soil | -27,98 | |
| | | Board | -53,24 | |

*Table 1: Summary of $CO_2$ credits generated through forest management projects in Pinus halepensis stands according to the variables.*





| SITE INDEX | BIOENERGY ACCOUNTING | *Pinus pinaster* PRODUCTS | CREDITS $CO_2$ / ha | AVERAGE | AVERAGE |
|---|---|---|---|---|---|
| 12 | No | 100% 25 year board | 164,93 | 173,43 | 200,49 |
| | | 50% board 50% saw | 173,43 | | |
| | | 100% saw | 181,94 | | |
| | 50% trunk and 50% branches | 100% 25 year board | 223,30 | 227,55 | |
| | | 50% board 50% saw | 227,55 | | |
| | | 100% saw | 231,81 | | |
| 15 | No | 100% 25 year board | 93,39 | 104,85 | 99,28 |
| | | 50% board 50% saw | 104,87 | | |
| | | 100% saw | 116,31 | | |
| | 50% trunk and 50% branches | 100% 25 year board | 87,96 | 93,70 | |
| | | 50% board 50% saw | 93,68 | | |
| | | 100% saw | 99,44 | | |
| 18 | No | 100% 25 year board | 58,59 | 74,47 | 64,27 |
| | | 50% board 50% saw | 74,47 | | |
| | | 100% saw | 90,35 | | |
| | 50% trunk and 50% branches | 100% 25 year board | 46,13 | 54,07 | |
| | | 50% board 50% saw | 54,08 | | |
| | | 100% saw | 62,00 | | |
| 21 | No | 100% 25 year board | -6,07* | 24,56 | 14,48 |
| | | 50% board 50% saw | 29,41 | | |
| | | 100% saw | 50,34 | | |
| | 50% trunk and 50% branches | 100% 25 year board | -10,92 | 4,39 | |
| | | 50% board 50% saw | 6,83 | | |
| | | 100% saw | 17,27 | | |
| 24 | No | 100% 25 year board | -44,04 | -17,83 | 27,76 |
| | | 50% board 50% saw | -17,82 | | |
| | | 100% saw | 8,36 | | |
| | 50% trunk and 50% branches | 100% 25 year board | 60,24 | 73,35 | |
| | | 50% board 50% saw | 73,33 | | |
| | | 100% saw | 86,46 | | |

*Table 2: Summary of credits generated through forest management projects in Pinus pinaster stands according to the variables.*

** Cells with the text in red indicate that with the intervention, CO2 is not sequestered but released into the atmosphere*

The availability of these results was a great milestone for the project, but the final step was still lacking; the elaboration of a methodology that would allow the integration of forest management in the VCM with guarantees. For this reason, a Methodological Guide was developed. It contains the conditions and requirements needed to consider the application of the methodology as valid and for the ex ante release of credits, their ex post monitoring or the creation of a stock exchange or fund of guarantee that covers possible deviations or external phenomena.

## Voluntary carbon market: working with stakeholders of a diffuse sector

The availability of $CO_2$ quantification models has catalysed a change of opinion in the forestry sector. The main result has

*Forest management work in one of the projects achieved with LIFE FOREST CO2 actions. With this forestry intervention, 2.303 $CO_2$ credits were generated.*

been the acceptance of climate change mitigation objectives among landowners and managers.

Some 186 sustainable forest management projects for the mitigation of climate change were created after we approached more than 900 stakeholders in the forestry sector throughout the Spanish and French territory.

The territory that encompasses the area managed by these owners and professionals covers more than 26,000 hectares, which, thanks to the lessons of the project, have long-term sustainable forest management planning. Of the totality of this planned area, more than 5,000 hectares have been managed with interventions aimed at improving $CO_2$ sequestration already carried out. The result is the absorption, throughout the management shift, of more than **120,000 tons of $CO_2$** in response to silvicultural treatments.

Some of these projects have already been included in the VCM—12 projects, which bring together almost 32,000 credits or $CO_2$ bonds, of which 23,800 are available for sale to companies, and 8,000 in a guarantee exchange to cover incidentals.

The credit market has managed to penetrate companies in diffuse sectors. Thanks to the project, they have learned what comprehensive management of the carbon footprint is and how it is possible to orient emissions neutrality by relying on the forestry sector to make effective offsets for non-reducible emissions. Thus, 115 companies have committed themselves within the framework of the project to calculate, reduce and offset their carbon footprint, and have received certification from the project beneficiaries.

*Signing of an agreement with a transport company (Disfrimur, Murcia, Spain) to implement actions toward climate neutrality.*

In this way, it has been possible to integrate carbon sinks into corporate social responsibility policies in companies and public bodies in Spain and France. Thus, **19,420 tons have been offset** with reforestation/land use change projects and **167 tons through forest management projects** launched on the VCM.

*Purchase and sale of credits generated with forest management between forest owners and companies. Left: Navantia and Mar Navarro Pino (forest owner in Moratalla, Murcia). Right: Eversia and Pérez Sáez C.B. (forest owners in Cehegín, Murcia).*





The most important milestone in the long term positive feedback in the LULUCF sector, since the development of forest management aimed at absorbing emissions will be strengthened by the demand for carbon credits from jobs in which the sequestered carbon is known exactly. In this way, forest owners have been rewarded for their work through payment for the environmental service of capturing atmospheric $CO_2$. At the same time, companies will benefit in a variety of ways from being linked to environmental, social responsibility initiatives.

## Participation and social impact

Dissemination and communication of the project's lessons has created a positive impact, with many key achievements.

- **More than 900 forest owners approached**

*Training session about $CO_2$ credits with forest owner in Nortwest Region, in Murcia.*

- **More than 700 stakeholders of the business sector informed**

*Training and dissemination activity for non-regulated companies in Segovia, Spain.*

- **1,000 professionals in the forestry sector informed**

*Training session with forest professionals in Almería, Spain.*

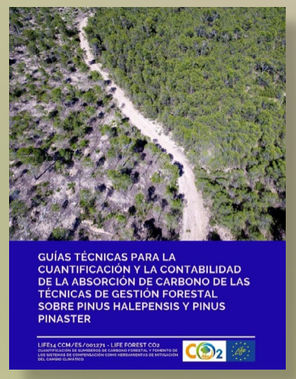
- **1,400 experts from the forestry sector and climate change approached**

*Technical day held in Madrid in 2019, for forests and climate change experts.*

- **4,600 students from the forestry sector educated and trained**

*Transmission of knowledge to University of Cordoba students in the context of LIFE FOREST CO2 project.*

- **2,000 followers on social media channels**
- **25,000 website visitors**
- **22 articles**
- **Several audiovisual resources, including four guidelines: https://lifeforestco2.eu/centro-de-prensa/**




*Cover of Technical Guidelines developed to quantify carbon absorption by managed forests.*

## Future perspectives and challenges

The methodologies and results developed are of great interest in regards to replication in other geographic contexts and forest species. That is why it is necessary to face the main challenges that arise to continue the lessons learned and the lines of work started by this project.

## What has been done to guarantee the post-LIFE period?

Work was carried out to guarantee the project's legacy beyond the LIFE programme, especially in maintaining the VCM for forest management.

- Regulations and competencies have been developed for the certification of forest management projects and responsible companies for their application by the pertinent regional administrations and $CO_2$ credit certification companies.
- A non-profit platform has been launched to manage the sale and purchase of the supply and demand of $CO_2$ credits. This platform has set up all the tools necessary for its operation, such as certification protocols, accounting updates or project monitoring.
- An app has been created to provide a meeting point between the supply and demand sides of the VCM. Owners use a simulator calculate the $CO_2$ credits that would be generated with an intervention in their forest territories. Companies can also consult the projects carried out and the availability of credits to offset emissions and contact these forest owners. No such resource previously existed. See: https://murciaforestal.es/lifeforestco2/visor/.

## Next challenges

The main objective of demonstrating the role of forest management as a climate change mitigation tool has been successfully achieved through the project. However, limiting it to two forest species clearly limits the potential of the project's lessons. Although during the final phase, the application has been extended to forest stands with the presence of chestnut (Castanea sativa) in France, it is necessary to specify the impact on the carbon sink in the same way.

For this reason, the support received from research centres and forestry associations in terms of replicability commitments is essential since they will allow the methodologies to be extended to other forest species. Contributing to the development of new methodologies and transferring the agents of the forestry sector with the project will be the main challenge in the short and medium term.

Likewise, the fact that forest management and carbon sinks for voluntary markets are only contemplated in their own market reduces the potential for the development of sink projects. The support of national administrations for this carbon footprint offset option would be an excellent catalyst for generating greater confidence among companies in diffuse sectors. The medium-term challenge for the post-LIFE period will be to achieve the integration of the methodologies in the national registers and markets of Spain and France.

Finally, the forestry sector's great challenge, especially in the Mediterranean environment, is to integrate payment for environmental services into the forestry economy. Only by guaranteeing minimum profitability for the forest owner will the quality of the forest stands be guaranteed through long-term management. $CO_2$ credits can lead the way in monetary compensation for other environmental services such as biodiversity, or the generation of water resources, thus benefiting the conservation of forest masses in the face of anticipated climate scenarios.

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CO2

## PROJECT SUMMARY

LIFE FOREST CO2—Assessment of forest carbon sinks and promotion of compensationsystems as tools for climate change mitigation—started in 2016, with a budget of €2,335,417 and a contribution from the LIFE programme of the European Union of €1,401,223 (60% funded), and is being developed, until its completion in June 2021, in Spain and France.

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## PROJECT PARTNERS

The Project is Coordinated by the General Directorate of Natural Environment of Murcia Region (Public Administration, Spain). As associated beneficiaries, the project includes AGRESTA (Private Company, Spain), CESEFOR (NGO, Spain), Centre National de la Propriété Forestière (CNPF, NGO, France), University of Córdoba (Public, Spain), Ingeniería del Entorno Natural (Private Company, Spain) and Xunta de Galicia (Public Administration, Spain).

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