



With support of:



**LIFE+ SUBER: Integrative
management for an improved
adaptation of cork oak forests to
climate change
07/2014 - 06/2018
Layman report**

The cork oak grove, a multifunctional ecosystem...

Cork oak (*Quercus suber* L.) forests are a typical Mediterranean ecosystem that provide productive, environmental and socio-cultural functions of major interest.



Productive functions

Cork oak groves have been used for millennia to generate firewood, fruit (acorns) and grasslands. However, the most relevant product of these forests is clearly the cork, a light material with technological unique properties. The cork is used in multiple applications, ranging from bottle stopper to aeronautical, automotive or chemical industries, as well as in building and decoration materials.



Environmental functions

Cork oak groves are home to extensive biodiversity, with an important representation of Mediterranean endemic species. Due to this interest, the cork oak forests are considered Habitat of Community Interest (HCI-9330) for the EU.

Moreover, these forests accomplish essential functions of hydrologic regulation, soil protection and fixation of atmospheric CO₂.



Cultural and social functions

The cork oak grove is a characteristic forest of the Mediterranean landscape. The current appearance of these forests is the legacy of thousands of years of interaction with humans. Nowadays, this species appears predominantly in relatively open forest structures, which arise the maximum singularity in the *Dehesa* and *Montado* areas.

...and vulnerable

This unique heritage is recently in a high vulnerability stage, due to a multiple variety of concurrent hazards:



Reduced distribution area

Cork oak has a relatively small worldwide distribution area (25.000 km aprox.), which more than a half is distributed between Spain and Portugal.



Vulnerable areas to climate change

The Mediterranean basin is one of the most critical areas related to the climate change. It is expected that in the following decades there will be an increase of temperatures and a higher irregularity in the precipitation pattern. The main consequence is an increase of the hydric stress of the ecosystems, which may involve a decrease of the forests vitality and production, particularly in the densest stands.



Pests and diseases

The negative impact of the climate change may induce an increase of the sensibility of forests against pests and diseases. Moreover, in the last years there have been identified new pests accidentally introduced. One of the most relevant pests, which depreciate significantly the cork, is the cork woodworm (*Coraebus undatus*).



Wildfires

Wildfires are an intrinsic phenomenon in the Mediterranean conditions, and the native species are well-adapted with diverse methods. This is the natural function of the cork (bark), which allow the cork oak (tree) to resist the fire. However, high intensity fires may produce severe damages to cork oak groves, especially if they occur the following years after the cork extraction, when the tree is not protected.



How can be recovered the degraded cork oak groves?

The recovery of the degraded cork oak groves is complex and expensive. It is necessary to promote the vitality of the trees, limit the shrub development and foster the regeneration. In addition, in order to accelerate the densification is suggested the sowing or planting of new cork oaks, always protected against the potential predators.

The Life+SUBER project

The partners

The complex problematic of cork oak forests makes necessary to address it in a multidisciplinary approach and involving different actors. Therefore, in Life+SUBER are represented: the private ownership (*Consorci Forestal de Catalunya*), the transformation and business industry (*Amorim*), the public administration (*Centre de la Propietat Forestal* and *Forestal Catalana*) and research sector (*Centre de Ciència i Tecnologia Forestal de Catalunya*).

In addition, three public and private entities participate as co-financers: *Diputació de Barcelona*, *Amorim Forestal Mediterráneo SL* and *Institut Català del Suro*.



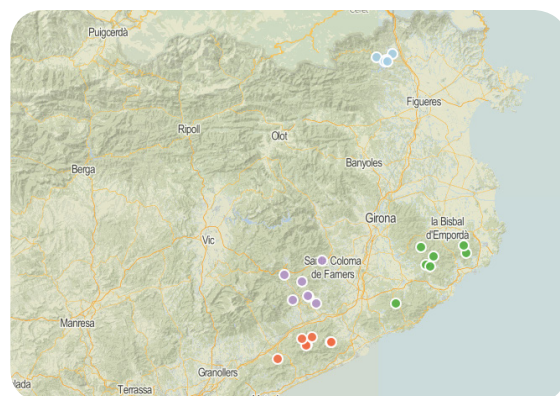
Project objectives

The main goals of Life+SUBER project are:

- Improve the **vitality** of cork oak forests and its **resistance** to reduced water availability, while increasing the **production** of cork.
- Improve the **structure** of cork oak forests against **wildfires**.
- Improve the **functionality** and **resilience** against climate change in degraded cork oak groves.
- **Reduce the damage** produced by *Coraebus undatus* through the biorational control (mass trapping).
- Develop **management tools** and foment the integration of the climate change adaptation in the catalan forestry **policies and regulations**.
- **Transfer** the implemented techniques and developed tools to local and European actors, and **sensitize** the society about the cork oak groves problematic and the necessity to maintain an economical sustainable activity which guarantee the forests conservation.

Action areas

The project is developed in four areas of Catalunya which are representatives of the different cork oak forests bioclimates: *Alt Empordà* (blue, in the map), *Gavarres* (green), *Montseny-Guilleries* (purple) and *Montnegre-Corredor* (red). In each action area, 7 demonstratives stands have been installed (4 in a high site quality and 3 in a low site quality), where the actions have been implemented.



Implementation action: forest management for climate change adaptation

Silvicultural treatments in order to improve the vitality and production and reducing the fire risk

Experience description

The innovative management guidelines implemented are based on the Regional guidelines and silvicultural models for sustainable forest management (ORGEST) for cork oak forests (Vericat *et al.*, 2013). These guidelines have a combined objective of improving the vitality, cork production and wildfire prevention, promoting multifunctionality through:

- **Selective fellings (irregular stands)**, of different intensities, but generally moderated (extracting up to 25% of initial basal area).
- **Selective shrub clearings**, in order to keep some shrub cover, from 0-10% to 30-40%. Species of interest for biodiversity are specially respected: strawberry tree (*Arbutus unedo*), laurestine (*Viburnum* sp.) or holm oak (*Quercus ilex*), and protected or rare species.
- **Slash and shrub residues management**, in order to avoid fire risk: cut up *in situ* to ease the decomposition and extraction or grind up in areas next to forest roads.

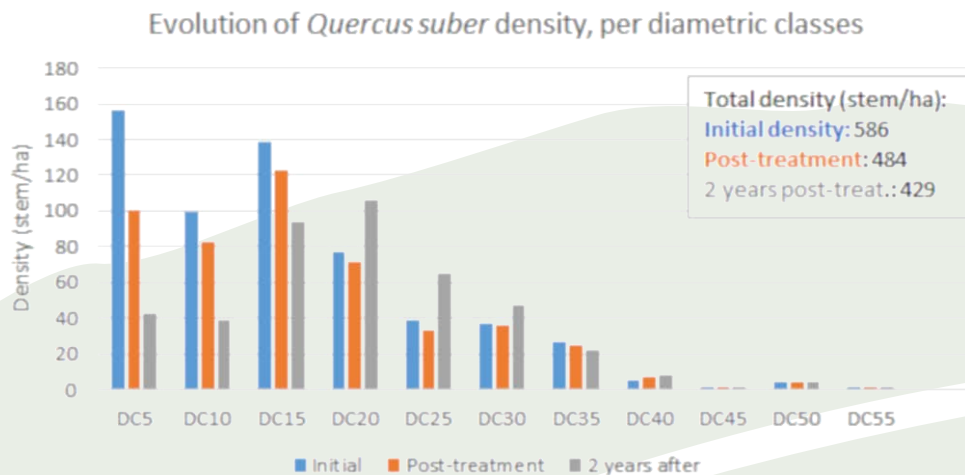
With these treatments, it is expected to reach a cork production up to 4.000 or 5.000 kg/ha, each 14 years.



Two demonstrative stands of Life+SUBER project, before (left side of each photo) and after (right side of each photo) the silvicultural interventions

Density reduction of small-sized trees, keeping the larger trees.

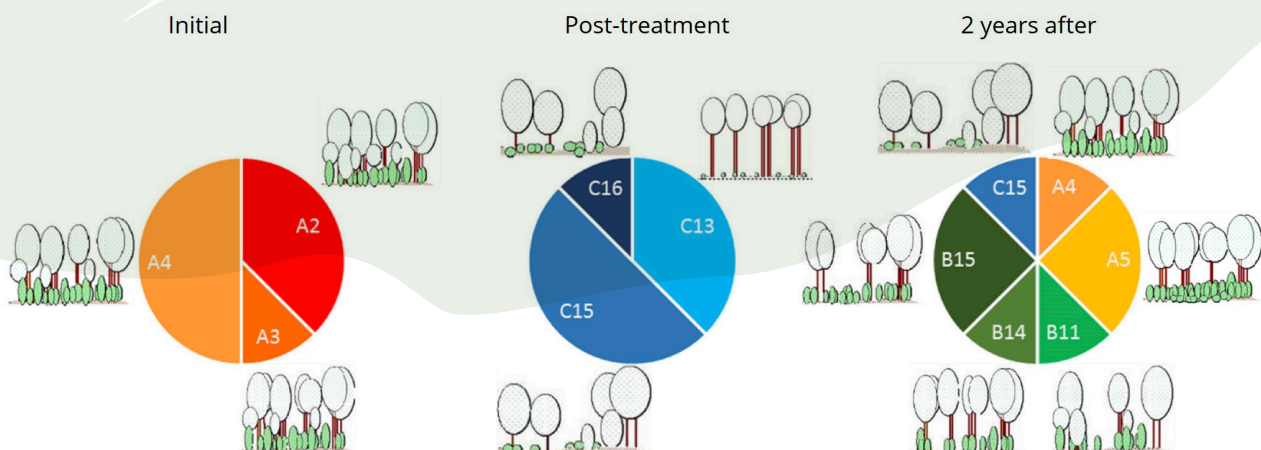
Results summary of 16 stands (action B1). Irregularized structures are promoted, with more presence of trees of Diameter Classes 20, 25 and 30. The stand are prepared to embrace new regeneration, by patches.



Two years after the treatments, the small trees grow and shift to greater Diameter Classes.

Large forest fires prevention in terms of a reduction of structural vulnerability.

Summary of results of 8 demonstrative stands (Action B2). The treatments generate less vulnerable forest structures against wildfires. This improvement generally is maintained during the following two years.



The most vulnerable stand structures are those coded as "A", while medium-vulnerable are the "B" type and low-vulnerable structures are the "C" type



Dehesa-type structures

In special areas considered strategical in the defence and behaviour of large forest fires, low-cover stands were created instead of applying selective cuttings. Basal area was until 8-10 m²/ha, so low-vulnerability structures with a potential use of pastures were generated.



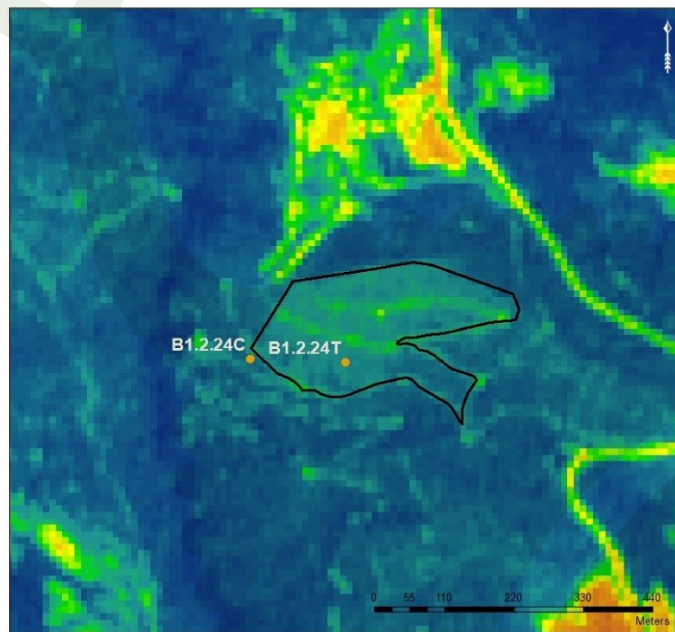
Individual tree marking



Thinned stand



Selective clearing done



Legend

- Inventory plots
- Action stands
- NDVI_SENTINEL**
- Maximum: 1
Minimum: -1

The monitoring of demonstrative stands includes the evaluation of vitality through teledection. Thinnings and clearings initially reduce vegetal activity. Then, the standing trees progressively respond to the competence regulation by improving their vitality with a greater individual vegetal activity.



Implementation action: techniques against *Coraebus undatus*

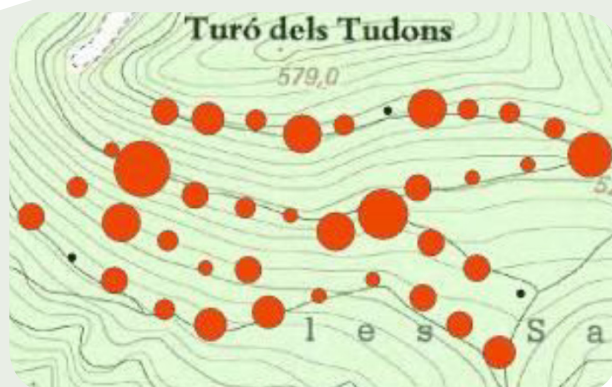
This plague affects the cork production as limit that high quality products could be obtained, like natural stopper. Cork is depreciated and involves a loss in the profitability which hinder or preclude the forest management.

Experience description

- Installation of traps according to the type and the height that best results offered in previous experiences (720 traps in total).
- Trapping in managed and control stands, during 3 monitoring sessions: 2015, 2016, 2017.
- Gallery counting in managed and control stands, with and without installed traps.



Images of purple triangular prism trap



Map of the captures in a stand. Black spots: traps without captures, Red spots: traps with higher dimension as higher number of captures have done

Experience conclusions

- The best results are obtained with the purple triangular prism trap, using 8 traps/ha, at 170 cm from ground, using luring substances diffuser, clearing the undergrowth in about 25 m² around the trap and keeping it free of foliage.
- The number of captures is very variable from one year to another. A great variety of implied factors exists, including the biology and population dynamics of the insect and the meteorology of previous years. A possible relation between the low precipitation of the year before the laying and the increase of the presence of the plague have been suggested.
- If the trapping is able to reduce in an effective way the insect population and the effect of the undergrowth clearing on the plague incidence cannot be determined in a relevant way. However, the knowledge of the insect biology has been improved, in terms of behavior, distance and flying season.



Larva of Coraebus and gallery



Adult of Coraebus undatus

Implementation action: recovering of degraded cork oak groves

A cork oak grove is considered degraded when it presents a low vitality and scarce or non-existent natural regeneration, mainly due to its senescence, inadequate density (excessive or defective), wildfires damages, drought, snow storms, plagues or illness.

Experience description

- Silvicultural treatments to revitalize the stands: pruning, thinning and clearing of the undergrowth, fostering the most vigorous trees and promoting the existent vital regeneration.
- When the density of the cork oak groves is low: densification sowing, where the efficiency of different innovative protector models for acorns to avoid the predation of insects, little rodents and especially wild boar has been demonstrated. The sowing has been carried out in Sant Feliu de Buixalleu and Llança (Girona).

Conclusiones de la experiencia

- The "SEEDSHELTER" protectors have a low price of purchase, assembly and installation (84 € / 100 units), in comparison with the model "Universidad de Valladolid" (500 € / 100 units).
- The protection systems evaluated can have little impact if the sowed plot is small and is located in a forestry environment with a high density of wild boars. In this case, it is necessary to complement the individual protectors with a more resistant protection and even increase the sowing density.



"SEEDSHELTER" protector for acorn



"Universidad de Valladolid" protector for acorn and sapling

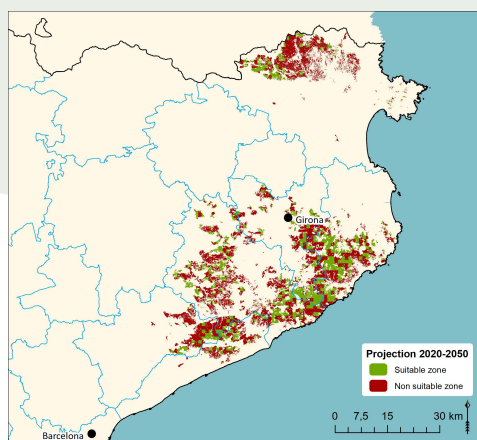
Divulagation and technical transference actions

During the project, several communication activities have been done. The following could be pointed out:

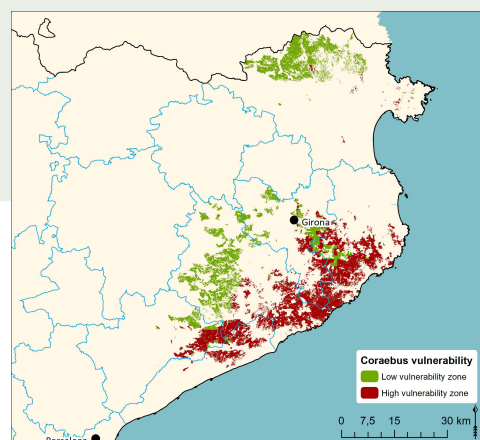
One press conference and three press invitation, nine TV and radio appearances and thirty printed press appearances.



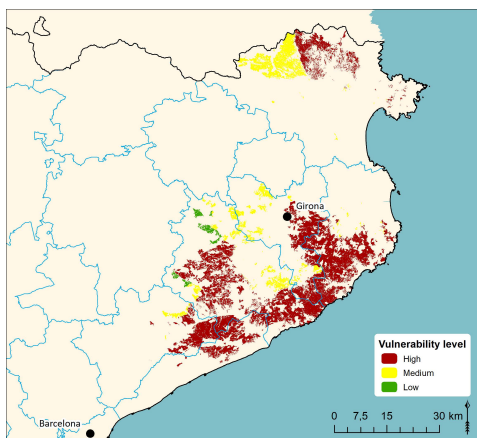
Generated cartography: ecological suitability of cork oak forests, vulnerability to *Coraebus undatus* and to wildfires



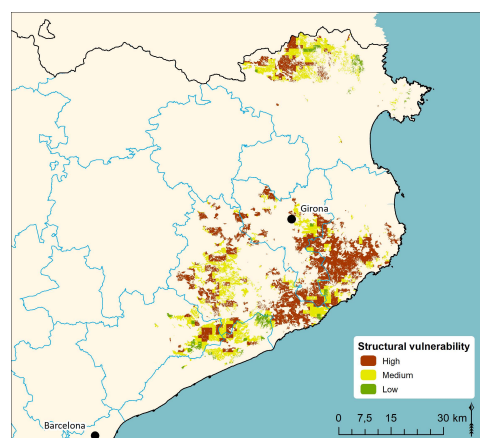
Ecological suitability expected for catalan cork oak forests in the period 2020-2050



Vulnerability of catalan cork oak forests to Coraebus undatus



Vulnerability to wildfires in terms of certain fires risk in catalan cork oak forests



Vulnerability to wildfires in terms of stand structure vulnerability to high intensity fires in catalan cork oak forests

Five technical seminars and one final seminar



Eight regular newsletters



Seven articles in technical journals and seven communications in technical-scientific congresses and seminars

Preparation of a memorandum of normative issues to be modified which affect the management of cork oak groves in order to ease the adaptation to climate change

Guideline of recommendations and measures of climate change adaptation in *Quercus suber* management



Fifteen exchange events with other projects, including technical trips



Two divulgative videos





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