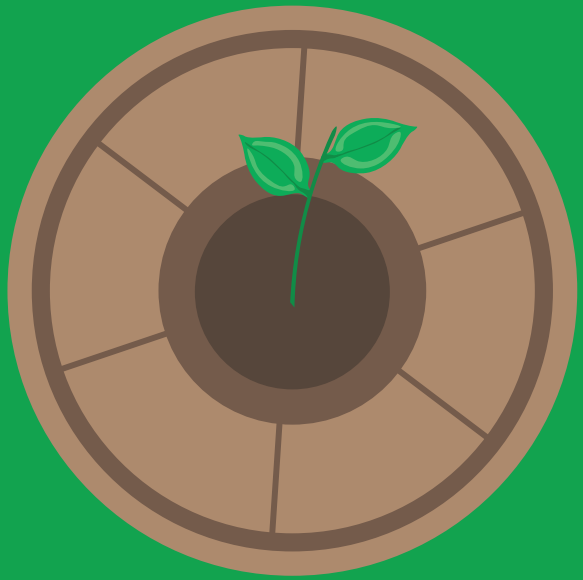


LIFE15 CCA/ES/000125

LIFE THE GREEN LINK

Restore desertified areas with an innovative tree growing method across the Mediterranean border to increase resilience

LIFE THE GREEN LINK

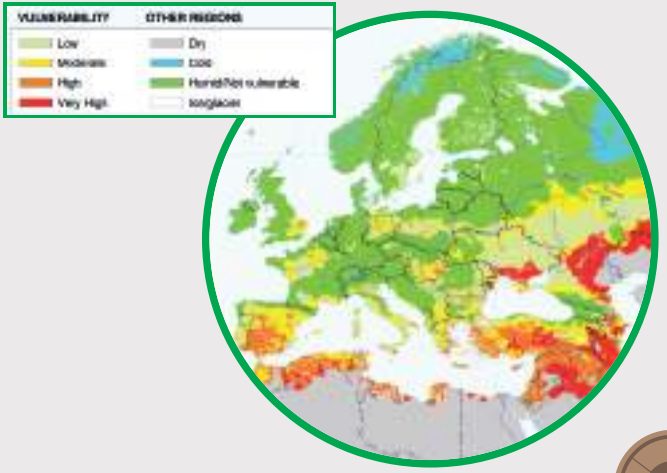
Restore desertified areas with an innovative tree growing method across the Mediterranean border to increase resilience.

1. Project motivation

Around the world, the impacts of climate change are becoming increasingly perceptible and severe. In Europe, the Mediterranean area, a semi-arid region, is suffering major declines in water availability along with significant temperature increases. These circumstances have led to faster desertification and more intense and frequent forest fires when compared to any other region in Europe.

The Green Link promoted an adaptation strategy for sustainable water management and to combat desertification, contributing also to nature conservation and biodiversity. The consortium implemented an innovative technology, the Cocoon, which is suitable as an adaptation measure for planting trees when water scarcity and high temperature prevail. The newly planted trees then help to reduce the vulnerability of the surrounding ecosystems.

The project demonstrated an innovative growing method in desertified areas where the failure rate of restoration can reach between 50% to 85%. The project trialled and validated the Cocoon technology, a water efficient, low-cost and biodegradable water bucket made of recycled carton that helps plants to survive and to establish deep root systems in poor soils.



2. Climate problems

Due to climate change part of the Mediterranean soils entered into a vicious cycle, where desertification intensifies extreme events (droughts, fires) and biodiversity loss that consequently result in more desertification and soil degradation. Approximately 45% of the soil in Europe is in a state of being vulnerable and 15% are considered extremely vulnerable – The Mediterranean area is by far the most affected by this phenomenon.

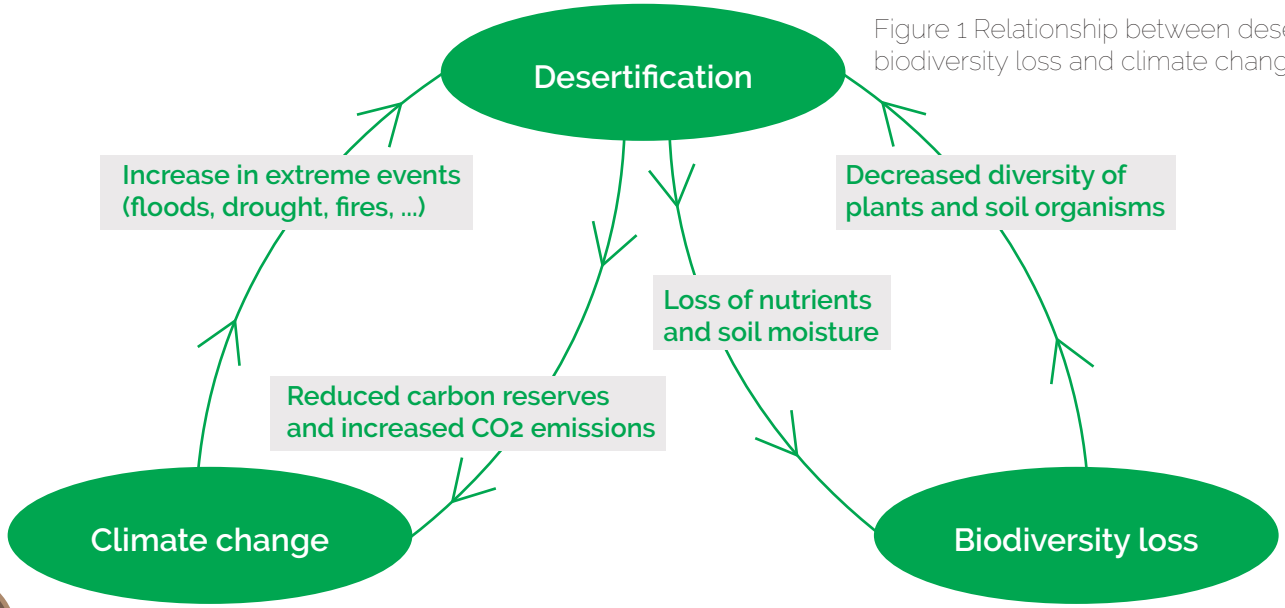


Figure 1 Relationship between desertification, biodiversity loss and climate change

Project objectives

Combat climate change and desertification

Demonstrate Cocoon technology

- Technical improvements
- Economical feasibility

Demonstrate adaptation strategies

- Improve soil health and water balance
- Increase biodiversity

Transfer of technology

- Large scale replication in Europe
- Enhance ecosystem services

3. How was the project carried out?

The project started by making improvements in the Cocoon technology, then trials tested all new features and some novel tree planting techniques when combined formed an adaptation strategy to restore degraded land. After that, strategies and technology were largely replicated and transferred through 4 countries in the Mediterranean.

Figure 2 Action plan

Cocoon improvements
- built-in animal repellents
- improved lid & tree shelter
- more efficient capillarity

Cocoon evaluation & validation
- economical feasibility
- technical feasibility

Tree planting & replication
- 7 demo areas across 3 countries
- massive replication in other areas

Adaption strategy
- better use of water
- increase soil quality and biodiversity
- improve ecosystem services and its perception

3.1 Cocoon improvements & trial areas

The developer of the Cocoon Technology together with the consortium developed 3 new/ improved features to be incorporated into the Cocoon and tested during project's trials:

Animals repellent

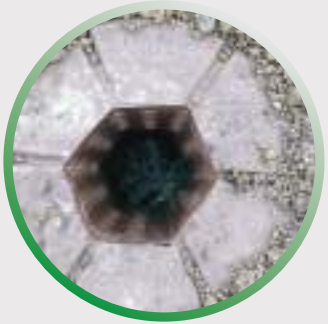
- A repellent additive could not be added into the wax as it jeopardised material integrity/quality. Also its fumes caused serious health issues for the workers

Lid and Tree protector

- A new and more resistant Lid version was tested (previously developed in Horizon 2020 project FTI Cocoon)
- A new, improved, robust and higher version of the tree protector was developed and tested

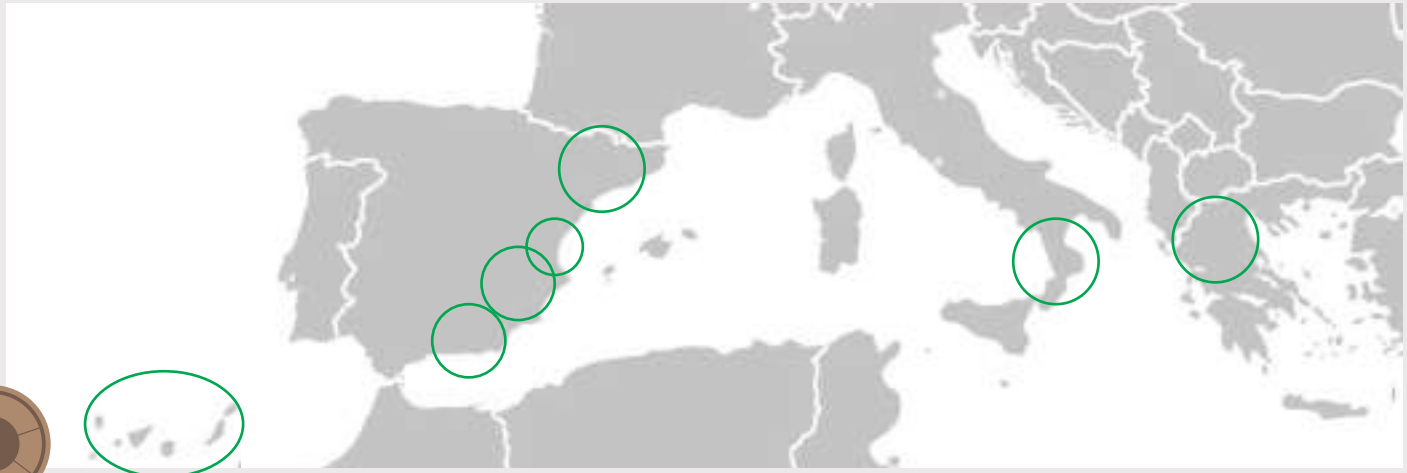
Capillarity improvements

- Increase the water transport efficiency from the cocoon to the soil.



The trials were carried out in 7 different areas of 4 to 25ha. All areas were divided in distinct plots in order to allow the comparison of performance between the new and the old Cocoon version, as well as different planting conditions. Additionally, in every plot a control group was spread along the area to avoid location bias.

Spain, El Bruc	Spain, Jijona	Spain, Tous	Spain, Almeria	Greece, Ptolemais	Italy, San Marco Argentano	Spain, Tifaracás
4150 trees 24,1 ha	1452 trees 4,04 ha	1874 trees 5,12 ha	4000 trees 13 ha	4080 trees 5,61 ha	3025 trees 10,65 ha	3209 trees 10,7 ha



3.2 Cocoon evaluation and validation

During the trials, the consortium continuously evaluated the technical effectiveness of the Cocoon. Parameters like the Lid and body strength, water retention, tree protector resistance and easiness to apply/install were considered.

Additionally, an economical evaluation was carried out during trials in order to assess the feasibility of carrying large scale reforestation projects using the Cocoon technology. Instead of focusing on total hectares planted (conventional methods), we considered the costs per survived tree, with the aim to offer a cost effective solution to long lasting land restoration projects.

Figure 3 Advantages of cover cropping

3.3 Adaptation strategy

As already mentioned, The Green Link implemented adaptation strategies specifically designed to restore degraded land typically found in Mediterranean countries. The strategy consists of 3 main pillars:

• Better use of water: use of the Cocoon technology to increase survival rate of newly planted trees (preference of indigenous species)

• Improve soil quality and biodiversity: Use of cover crops in order to increase soil's organic matter content, improves water retention capacity and increase the amount of insects, earth worms, bacteria and fungus (soil biota). The application of cover crops reduces the need of applying nitrogen, phosphorus and potassium fertilizers.

• Improve ecosystem services and social perception: a social assessment through questionnaires offers an overview of the different social perceptions regarding the capacity of each plantation and the variety of ecosystem services perceived as important to sustain human well-being.

3.4 Replication

After trialling and validating the adaptation strategy developed in the first two years, The Green Link set an ambitious goal to replicate and transfer this strategy to as many stakeholders as possible covering other parts of the Demo countries and beyond.

The consortium prepared a replication approach in order to make a swift and efficient technology transfer. After first contacts of a project partner with a potential replication agent, suitability of the initiative was checked and a quick training was offered on how to use the Cocoon and other measures of the adaptation strategies, incorporating the lessons learned from project´s trials.

Subsequently, the responsible project partner followed the execution of the plantations and supported with materials and expertise. Project partners contributed with Cocoons and helped where possible during plantations, while the replication agent provided saplings, water, machinery and the land to be restored and committed to report results achieved.

4. Results

4.1 Cocoon technology

Bio repellent
The Green Link has tested several type of animal repellents, both with a chemical and natural basis. Eventually the use of the repellent was found to be much more effective if directly applied to the sapling, and not on the Cocoon or tree shelter. The material Trico (oil in water emulsion with sheep fat at active substance) turned out to have the best results. Whereas Trico may deter animals by its smell, it doesn't deter people. Moreover, Trico remains effective also after rain events (doesn't flush off). This effect was both observed in some of our trial and replication areas. It is important to apply in autumn for newly planted trees and at the end of spring/early summer when due to drought less vegetable material is available for wild animals.

Tree shelter and Lid
The old shelters trialled in the project until 2016 showed physical imperfections, being too susceptible to the elements of rain and high temperatures. This resulted in wrinkling, suffocating trees, or premature loss of shelters by strong winds. The new shelter version, based on heavy grade kraftliner, were used in The Green Link's spring plantings 2017 showing a remarkable improvement with much more resistance to strong winds and small animals.

Additionally, the Cocoon lid showed to be very weak and often collapsing because of soil weight, heavy rain or intense winds. The design changes (FTI Cocoon) resulted in extra stifness due to the extra ribs. The testing in The Green Link of this new lid also demonstrated that it allowed to concentrate run-off and rainwater to the central hole, so that the seedling could have more water available.

Water delivery system

To improve the environmental footprint of the Cocoon, the developer tried to substitute its nylon wick for a Tencel fibre, which is bio-degradable with similar water transport characteristics. Still, the use of wicks requires extra process handling and the additional use of fast curing glue. Hence, an alternative production method was developed to do without wicks completely, using differential coating techniques resulting in controlled seepage, directed to the tree seedling. This new wickless version has thus decreased manufacturing costs and made the Cocoon 100% biodegradable (nylon wicks and glue were not fully biodegradable).

Figure 4 Old tree shelter version / New tree shelter and Lid version

Figure 6 Old Lid version / New Lid version

Figure 5 Old nylon wick / New wickless version

4.2. Demonstration trials

A characterization of all the trial sites has been done in all sites between autumn/winter 2016/2017. Hereafter, two plantation events were performed according to a standard monitoring protocol defined at the beginning of the project by all partners. Cover crops were sown between spring 2017 and 2018. The main evaluated parameters were survival rate, biodiversity, vegetation structure, cocoon device conditions, edaphic parameters (physical, chemical, and biological properties of soil), root growth and soil carbon stock.

Survival rate was determined through an evaluation of the physiological state of the seedlings. As can be seen in the graph on the next page (Figure 8), important differences were found between controls and Cocoon treatments. Globally, after 2 years, the control group had a survival rate of only 40%, meanwhile the Cocoon plants had a higher survival rate of averagely 58%. The results varied a lot, depending on local climatic conditions, quality of the sapling and experience of the worker installing the Cocoon.

Figure 7 Different degradation states of the Cocoon after two years at field: highly degraded Cocoon (left) and Cocoon retaining surface runoff water in 2nd year, showing additional longer term post-planting aftercare (right)

Nevertheless, in general, the use of Cocoon showed better results when compared with traditional methods. Results vary according to the rainfall regime and, as expected, in drier zones the Cocoon presented to be more effective than in more humid zones.

A Cocoon device assessment was carried out in order to analyse different Cocoon versions and treatments. The new lid and shelter are more resistant than the old versions, preventing the premature collapse, reducing water loss and seedling damages. Moreover, the Cocoon degradation is highly controlled by climatic conditions. Cocoon becomes highly degraded after two years in the most humid regions while in semi-arid and arid climates Cocoon could rest almost intact in the same period, conserving its capacity to retain run-off and rainwater (Figure 7).

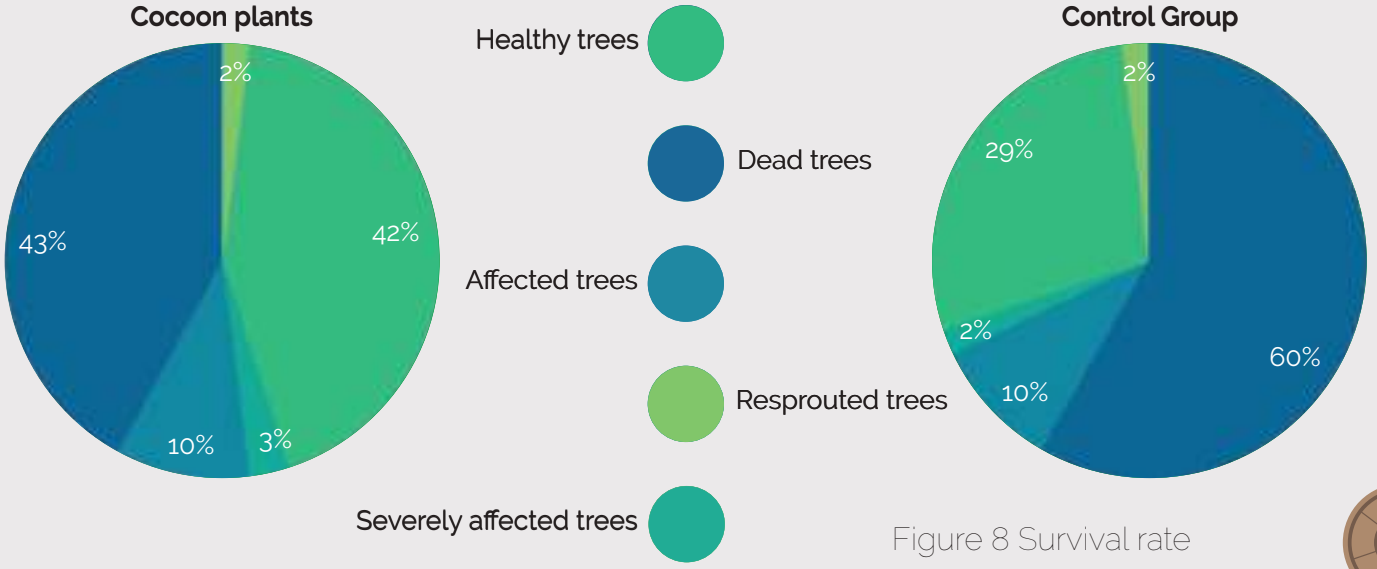


Figure 8 Survival rate

Regarding the whole restoration of the areas, spontaneous revegetation progresses and is mainly dominated by herbaceous cover, mainly grasses, especially in the areas with deeper soils. Woody species are re-sprouting and growing, progressively covering more surface.

Soil content

Soils of plantation sites are, in general, alkaline (pH>7.1), with a cation exchange capacity controlled mainly by Ca and Mg, a water retention capacity medium to high, and a similar β-glucosidase activity. At the beginning of the project (2017) soils showed low contents of organic matter (Calabria, Jijona, Almeria and Gran Canaria) as well as low phosphatase activity (Catalonia and Ptolemais). Because of the short time elapsed until the project's end significant differences were not found for most of the characteristics analysed. However, increasing trends were observed in the contents of total C and N and enzymatic activities (e.g. phosphatase).

Figure 9 Spontaneous revegetation of the areas restored in Catalonia (left) and Ptolemais (right)

4.3 Replication

Originally the consortium had estimated to replicate the planting experience in 6 locations with 6.000 Cocoons. But already in 2016 many interested parties contacted us with demand for replication activities. Thanks to the continuous development of the Cocoon and its lower cost price due to improved production capacity (FTI Cocoon project) the consortium decided to advance and expand the Replication activities. An additional 1.500+ Cocoons were offered by the consortium. In total 50+ locations in Spain, Italy, Greece and Portugal now have incorporated this innovative reforestation technique.

In total partners provided more than 7.511 Cocoons to replication. In order to guarantee the right use and optimal results at replication locations, almost all Cocoons were also monitored by the partners. As in the demonstration trials, the adaptation strategy had outstanding results in most replication sites.

Figure 10 Replication reach

5. Economic analysis

The Green Link project demonstrated that Cocoon trees are generally performing better than conventionally planted trees, especially under drier conditions (lower rains or sandier soils with low water retention). Hence, under such conditions it will pay off to deploy Cocoon technology: despite the initially higher investment, higher tree survival rates will result in lower costs per survived trees (in some cases by a factor 2 less). Moreover, when conventionally planted trees receive multiple irrigations in remote areas, increased tree survival still appears substantially more costly than using Cocoon technology (e.g. extra effort in water transport to hilly regions in Green Link's Gran Canaria project). Additionally, preliminary results of the Green Link project also suggest positive carry-over effect longer term. In wetter areas added Cocoon advantage is currently limited. However, considering future climate change, even these areas may benefit from Cocoon eco technology in future years.

El Bruc, Catalonia, Spain

6. Socio-economic analysis

At the beginning and nearly at the end of the project all partners contributed to establish whether the socioeconomic situation and perception of ecosystem services was enhanced due to the project execution. In total, 774 questionnaires (35 in IT, 119 in GR, 620 in SP) were answered by stakeholders around the areas where the trials were being carried out. The overall goal was to test if local residents perceive diverse benefits after the tree plantations of specific varieties across all The Green Link sites. Five specific questions allowed to evaluate the social perception:

- Change in perception of capacity of each site to provide ES?
- Change in ES perceived as the most important?
- Change in perceived vulnerability of ES?
- Change in human wellbeing components supported by ES?
- Which crop do locals perceive as most beneficial?

Overall, an improvement was found in the capacity of each site to provide ES, being considered agriculture production as the most important service and climate regulation and freshwater supply as those services that require more attention due to their vulnerability. This overall positive perception allowed peace and mental wellness to be the most supported components of wellbeing.

The crop identified as most beneficial to locals and their wellbeing, possibly due to its millenary use throughout the arid Mediterranean, was the olive tree (a common variety and an endemic variety from the Canary Islands), followed by the almond tree and the Macedonian oak.

Social survey pre-cultivation

Social survey post-cultivation

7. Market Uptake

Thanks to the success of the Cocoon and high media interest (see Dissemination results) many commercial parties approached the consortium with requests for reforestation projects. Some companies are attracted to the idea of reforestation as a way to offset their carbon emissions, others are motivated by the idea of restoring nature for example after a forest fire. In all cases, the land owners (often public authorities with modest forestry budgets) are more than willing to commit their land to such projects. This win-win concept took off in Matamorisca (Castilla y León, Spain) in spring 2018 where Leaseplan, a Dutch leasing company, contributed to a 25 ha reforestation project including 1.000 Cocoons. Its success paved the way for further projects, ever larger in scale (Burgos, 100 ha, Fontecha 50 ha, etc), always including a number of Cocoons that were installed in the most critical parts of the terrain (i.e. slopes, eroded areas).

Thanks to The Green Link project and the growing demand for Carbon Compensation and Nature Restoration projects, partners have managed to develop significant new reforestation projects in Spain and other EU countries. For the 2020 winter period a total of 1.500 ha are expected to be reforested in Spain and Portugal, equivalent to 1.5 million trees, thanks to the success of LIFE The Green Link. Partners have managed to position themselves as leaders in the reforestation sector in Spain with 500 ha planted in Winter 2019-Spring 2020. For the 2020 winter period both companies expect to plant a total of 1.500 ha in Spain and Portugal, equivalent to 1.5 million trees which will generate substantial sales and green job creation for both companies.

Plantations in Fresno de Rodilla, Spain

8. Dissemination

The project also directed a lot of effort to dissemination activities that helped create awareness about the importance of restoring degraded land in the Mediterranean countries, and how the European Commission has been supporting such activities through the LIFE Programme. Overall, the project generated the following impact:

- Reach almost **15.000 different users** across the world through its website
- **10 presentations at national and international conferences** regarding topics such as: land restoration, climate adaptation strategies and reforestation
- More than **40 awareness events**, including local governments, schools, universities and civil society in general
- **2 Technical Seminars** to which 100 public stakeholders, agricultural and forestry technicians, volunteers and researchers attended
- Recognition by international press with more than **157 articles published** (80 about the COP25 event) in 6 languages
- Project's videos reached more than **1.200 views**
- Meetings and contacts made with more than **14 other LIFE projects**
- **1 final conference**, gathering 85 participants

Among the many awareness and replication events organized during the project, The Green Link had the privilege of hosting the official COP25 planting event in December 2019. This event was held in Las Rozas, Madrid during the conference as part of the #6D campaign.

The event had more than 140 attendees, standing out the number of children present, who planted about 1.000 trees. A small ceremony was held where Gonzalo Muñoz, high-level Climate action Champion of the COP25, gave a symbolic certificate to José de la Uz, Las Rozas Mayor, ensuring the fixation of 200 CO_2 tons in the next 40 years. Additionally, directors of Spanish NGOs, members of the Dutch government and Chilean delegation were also present.

9. Conclusions

• Seedlings planted with Cocoon have shown higher survival ratios and better physiological state than controls obtaining results from 40 up to 80% such as in extreme dry areas like those in Canary Islands.

• The Cocoon devise has been improved in order to obtain better results and solve some problems detected in the field such as reinforced lid and protector, improved water retention capability and wick suppression.

• Production costs of Cocoons decreased during the project, due to achievements in both projects, The Green Link and FTI Cocoon (Horizon 2020) implying a halving of the costs.

• The estimation of tree and herbaceous biomass carbon stock was based on the guidelines provided by IPCC, resulting in the total carbon stock amounts of 38.54 ton per year, which corresponds to 141 ton CO_2 that has been absorbed by trees and low vegetation biomass during project.

• Increased awareness among several stakeholders about the importance of ecosystem services and the importance of restoring degraded land.

• Achieved a massive replication reach in 4 different countries, more than 50 locations and more than 7.500 trees planted with Cocoons and many more thousands without.

10. After LIFE

Given the success of the project, several activities to continue replicate and disseminate the developed strategy are already planned. Some examples include:

• Planting in collaboration with public bodies trying to include the Cocoon as a tool to be used in civil works (restoration of road slopes, brownfields, quarries etc.).

• Planting in El Bruc with 90 schoolkids in the age of 9-10 years old from Infant Jesús School in Barcelona. Together we expect to plant 300 Cocoons at the terrain of one of the participating farmers of the project.

• Demonstration of the Cocoon Technology during the 'Open Doors Day of the European Commission' in Brussels.

• Cocoon presentation in different technical seminars in collaboration with NGOs (Riudarenes, Fundació Emys).

• Cocoon presentation in international conferences (SER Europe, Alicante; QuarryAlive, Brussels).

• Edit of a summary video for Cocoon promotion.

• Planting in Estany de Sils (Girona) in collaboration with Fundació Emys in 2020. We expect to plant 330 Cocoons for forest river restoration.

11. The LIFE Programme

LIFE is the EU's financial instrument supporting environmental and nature conservation projects throughout the EU as well as in some candidates, acceding and neighbouring countries. Since 1992, LIFE has co-financed some 4,600 projects, contributing approximately 6 billion euros to the protection of the environment.

http://ec.europa.eu/environment/life/

LIFE15 CCA/ES/000125 THE GREEN LINK

Restore desertified areas with an innovative tree growing method across the Mediterranean border to increase resilience.

This Project is co-financed by the European Union through the LIFE Programme.

Total budget 2,891,702.00 €
EU contribution 1,725,719.00 €
Duration 01/07/2016 – 31/03/2020

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Tous, Valencia, Spain

LIFE The Green Link's contribution to European Policy

European Green Deal Creates synergies with main "green" policies, from ambitious emissions reduction to investment in research and vanguard innovation, with the goal of preserving Europe's natural environment

EU Forest Strategy Implementation of a multifunctional sustainable forestry management plan which connects rural populations to forested areas, among others

EU Biodiversity Strategy Improved ecosystem protection, better use of green infrastructure and supports the fight against biodiversity loss

12. Partners

CREAF (Research Institute)
Overall project management. Technical and Scientific coordination. Execution of trials in Catalonia. Monitoring and control for measurements above ground.

Biopoplar s.r.l. (Private company)
Technical Assistance. Execution of trials in Calabria, Italy.

CERTH (Research Institute)
Technical Assistance. Execution of trials in Greece. Biomass assessment and mycorrhiza infestation.

Cabildo de Gran Canaria (Regional Government)
Technical Assistance. Execution of trials in Gran Canaria, Spain.

GESPLAN (Private Company)
Technical Assistance. Execution of trials in Gran Canaria, Spain.

CSIC-CIDE (Research Institute)
Technical and Scientific Assistance. Monitoring.and control for measurements below ground. Execution of trials in Valencia.

Land Life Company (Private Company)
Technical support and Cocoon Technology developer. Support and execution of trials in Valencia, Spain. Assessment of planting costs and savings.

University of Almeria – CAESCG (University)
Technical and scientific assistance. Execution of trials in Almeria, Spain. Assessment of ecosystems services and policy recommendations.

Van Leijen (Private Company)
Compliance Manager. Support to overall Project Management, financial management and reporting.

Volterra (Private Company)
Technical Assistance. Assessment of cover crops and mycorrhiza infestation. Execution of trials in Catalonia. Dissemination and replication coordinator.