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THE GREEN LINK PROJECT: RESTORING DESERTIFIED AREAS WITH AN INNOVATIVE TREE GROWING METHOD ACROSS MEDITERRANEAN BASIN TO INCREASE RESILIENCE

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INTRODUCTION

Desertification is defined as “land degradation in arid, semiarid and sub-humid areas resulting from various factors, including climatic variations and human activities” (UNCCD, 2013). In this sense, soil degradation is one of the most threatening consequences of climate change. Approximately 45% of soils in Europe are in a vulnerable state and 15% even being considered extremely vulnerable. Some southern parts of the EU, including Spain, Greece, Portugal, Italy and France (Corsica) are significantly affected (EEA, 2008). Soil degradation problems not only have environmental implications: more and more agricultural land are degrading and their cultivation becoming unprofitable, adding serious economic problems to rural areas already weakened by depopulation. This project aims to compensate impacts of climate change and contribute to increase resilience of Mediterranean ecosystems, specifically in Spain, Greece and Italy.

There is a huge number of studies on the potential impacts of climate change on water resources which involve many different approaches. A common element is the reduction of water availability for forest ecosystems and for irrigation purposes across all regions (EEA, 2012). Reforestation and afforestation efforts in the Mediterranean region cannot be called cost-efficient currently, since the percentages of growth failure and seedling mortality rates are extremely high, mainly when broad-leaved resprouting species (e.g. *Quercus* species) where planted (Vallejo et al 2012).

METHODS

The Green Link is a collaborative LIFE project (LIFE15 CCA/ES/000125) that aims to demonstrate the environmental and economic benefits of an innovative tree growing method that has the potential

to restore desertified areas across the Mediterranean basin. This consists of replacing traditional planting techniques with the "Cocoon". The Cocoon ecotechnology consists of a water reservoir, combined with mycorrhizal fungi inoculum, and a tree shelter (see figure 1). The Cocoon is put into a small hole of 60 cm wide and 30 cm deep made into the soil. In the middle of the hole, a seed or a sapling is planted first, and then the Cocoon device is put around it. The water reservoir is made of recycled paper pulp sealed with a biodegradable coating to ensure water tightness during the first year. It is only water filled once at the moment of planting. Water is slowly transported to the tree using wicks. As the reservoir degrades and empties over time, the remaining shallow pits will serve as a micro-catchment to collect surface runoff during rain events. Additionally, the degraded reservoir becomes an organic amendment ameliorating the soil. Mycorrhizal fungi are added to the soil surrounding the plant roots, increasing the absorbing surface of roots 100 to 1000 times, thanks to a very efficient symbiosis between roots and fungi by very fine mycelia. This improves soil moisture availability as well to the soil nutrients. Mycorrhizal fungi also release enzymes into the soil that dissolve hard-to-capture nutrients, such as organic nitrogen, phosphorus and iron, commonly fixed on to the soil complex. These fungi are present in 90% of natural forests and woodlands and form a characteristic symbiotic association with the roots. A cylindrical shelter is placed around the tree to protect the seedling against the sun, desiccating winds and smaller animals feeding on the young plant. The Cocoon practically eliminates evaporation of water from the adjacent soil and prevents the growth of weeds near the saplings, which would otherwise compete for water, nutrients and light. Hence, all available resources are directed towards tree establishment.

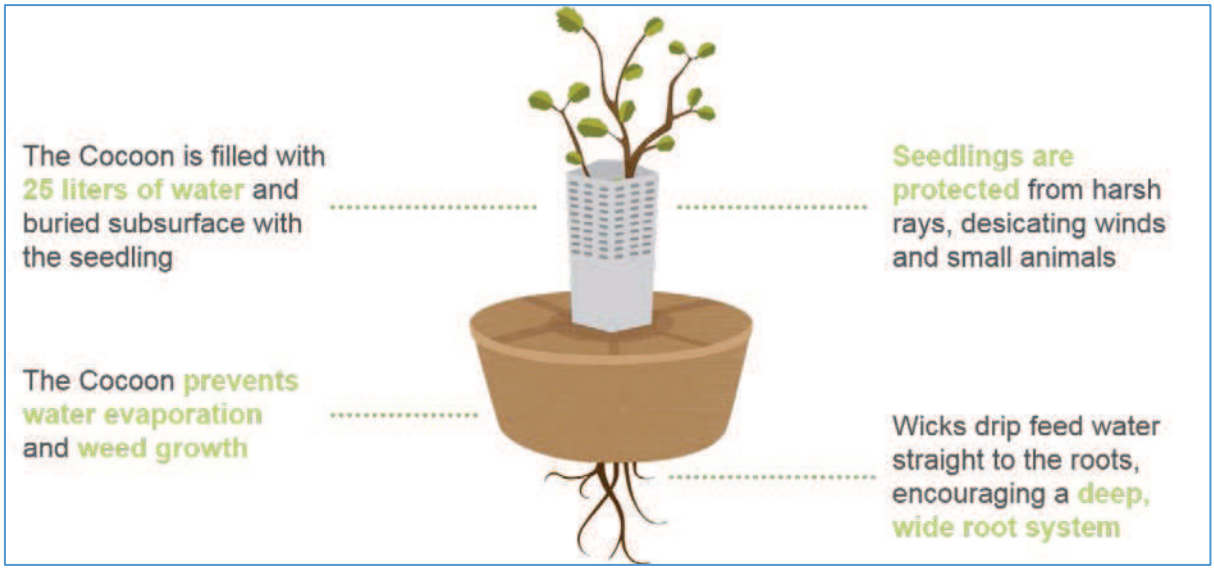

Figure 1. Scheme of the Cocoon device.

In order to prove the viability of the Cocoon technology and demonstrate its potential, the project foresees planting a variety of woody species on different soil types located in areas on a climate gradient from semi-dry to extremely dry climates across the Mediterranean border. As a whole, 7 pilot areas located in Italy, Greece and Spain, covering 60 ha planted with 24.000 seedlings of 20 plant species, will be evaluated (see table 1).

Table 1. Pilot areas description.

Village / area	Tifaracás (Canary Islands, Spain) Population: 2,028 Municipal unit: 103,30 km^2 Included in the Biosphere reserve	Municipality of Almería (Natural Park de María Vélez, Spain) Population 191.443 Municipal unit: 296,21 km^2	Municipality of Jijona* (25 km north of Alicante, Spain) Population: 7.575 Municipal unit: 163,76 km^2	Municipality of El Bruc (10 km East of Igualada and 15 km West of Terrassa, Spain) Population: 254.217 Municipal unit: 47,21 km^2	Municipality of San Marco Argentano, province of Cosenza, in the Calabria region, Italy Population: 7.500 Municipal unit: 78 km^2	Ptolemaida (part of the municipality of Eordaia, Greece) Population: 32.142 Municipal unit: 217,901 km^2
Climate/Soil	Very dry, eroded soil, with steep deforested hills	Extremely dry, desertic in some areas	Very dry conditions with low levels of soil moisture due to the lack of rain (especially in summer)	Dry conditions, with soil vulnerable to erosion due to recent wildfires	Very eroded soil, frequent droughts and floods have led to land degradation	Very heterogeneous soils: clay, sandy and loam (black, brown, grey); partly rocky, intersected by lignite
Altitude	300-600 m	1200 m	453m	489m	200m	648m
Former use	Forest	Agriculture (almond orchards)	Agriculture (cereals)	Forest	Agriculture	Opencast mining
Current use	Part of a natural park and testing of new agricultural species	Part of a natural park and testing of new agricultural species	Abandoned farmland	In August 2015, 1.277 Ha. burned down in a forest fire	Farmland turned into disuse and the land has been abandoned	Lignite mining site owned and operated by PPC (Public Power Corporation)
Challenge	Enhance connectivity between the green patches in the park and provide safe haven for local and migrating birds	Enhance connectivity between green patches	Converting eroded soil into fertile soil, as well as to offer an economic alternative for land-owner and farmers.	Reforest part of damaged area using adaptive and economically interesting plant species	Converting eroded soils into fertile soils & Support plants in the first growth stages	Converting eroded soils into fertile soils & Support plants in the first growth stages

*The information about Tous, which is the second pilot area in Valencia (Spain), is not included on the table.

The potential benefits of Cocoon will be validated through monitoring of various objective indicators:

- Survival rate: monitoring of planted individuals and estimation of their physiological state. Tree height and stem base diameter will be measured in a selection of individuals.
- Biodiversity: flora inventories and key species abundance will be carried out in each zone before plantations and at the end of the project. Fauna recruitment and entrance (use) will be estimated through monitoring qualitative indicators: tracks, excrements, lairs, nests and direct observations.
- Vegetation structure and growth rate: vegetation structure will be measured in transects, identifying main species height and width, and vegetation cover.

- Biomass carbon stock: above ground carbon stock will be estimated with modelling tools according to vegetation structure data.
- Edaphic parameters: soil quality indicators will be analyzed at the beginning and at the end of the project: total organic carbon, particulate organic matter, soil pH, electrical conductivity, soil nitrate, microbial activity, microbial biomass, potentially mineralizable N, soil enzymes, soil respiration.
- Root growth and soil carbon stock
- Mycorrhizal infestation will be assessed, not only by microscopy observation, but also with innovative molecular techniques (DNA sequencing) to identify the type of mycorrhiza.

The socioeconomic perception of the actions by the local economy and population in all areas will be monitored during the project's lifetime. This action involves two rounds of interviews, at the beginning and at the end of the project.

EXPECTED RESULTS

The Green Link project expects to:

1. Demonstrate that the Cocoon technology allows planting trees in dry climates and on poor soils in response to combat desertification phenomena. It is expected to achieve over 80% survival rate after planting, for all the species selected.
2. Offer a competitive market solution to plant trees, without the use of irrigation with the Cocoon, by demonstrating that there will be significant savings of up to 30% for planters (taking into account lower maintenance and dead trees repositioning costs) vs traditional methods in these areas or alternatives.
3. Improve soil quality since water scarcity will be compensated; further green cover, microorganisms and mycorrhiza will enhance the association among roots and soil, planting along height lines will help prevent erosion while improving water retention in the area.
4. Enhance ecosystem services provision by increasing biodiversity and positive growth of soil carbon stocks over time.
5. Quantify and value the variety of ecosystem services provided by trial areas to promote potential for regional socio-economic development.
6. Increase awareness and dissemination of adaptation strategies on forest management and among other stakeholders (particularly on EU relevant legislation and objectives).

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