



LAYMAN'S REPORT

A novel approach for accounting and monitoring
carbon sequestration of tree crops and their
potential as carbon sink areas



REPORTING PERIOD
16/07/2015 – 30/10/2020

(LIFE14 CCM/GR/ 000635)



General information

The LIFE CLIMATREE project “A novel approach for accounting and monitoring carbon sequestration of tree crops and their potential as carbon sink areas” (LIFE14 CCM/GR/000635) is co-funded by the EU Environmental Funding Programme LIFE Climate Change Mitigation.

The LIFE CLIMATREE project is co-funded by the Green Fund of the Hellenic Ministry of Environment and Energy.



Implementation period

16.7.2015

until

30.10.2020



Project budget

Total budget

1,931,447 €

EU financial contribution

1,158,868 €



SPAIN

GREECE

ITALY

PARTICIPATING BENEFICIARIES



University Research Institute
urban
e nvironment
human
r esources Panteion University, Athens



AGRICULTURAL
UNIVERSITY OF ATHENS



TERRAnova
ΠΕΡΙΒΑΛΛΟΝΤΙΚΗ - ΤΕΧΝΙΚΗ - ΣΥΜΒΟΥΛΕΥΤΙΚΗ



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The LIFE CLIMATREE project

LIFE CLIMATREE aims at evaluating and demonstrating climate change mitigation potentials of tree crops' cultivations. This requires comprehensive and robust investigation of the link between orchards and atmospheric CO₂. This link is the target of LIFE CLIMATREE, attempting a holistic approach which takes into account what actually occurs within the farm. The annual change in CO₂ related biomass, the CO₂ storage in soil as well as the CO₂ emissions due to the applied cultivation practices are all systematically evaluated. In this context, the biological cycle of the trees is examined in combination with a Life Cycle Assessment of the currently applied as well as of alternative "green" agricultural practices. The mitigation rich cultivation practices are, then, identified and their CO₂ mitigation potentials are demonstrated.

This is an essential contribution to design coupled agricultural – climate policies. Such policies can be facilitated by the carbon farming schemes as defined within the new CAP. Furthermore, voluntary CO₂ markets and ecolabeling schemes can be also undertaken to exploit the mitigation potentials of orchards. To support such initiatives, LIFE CLIMATREE assigns economic values to the CO₂ sequestration by tree crop farms, considering that it is an essential ecosystem service provided by farmers. Finally, the benefits of sustainable tree cultivation are identified to demonstrate the total contribution of "green" cultivation practices. LIFE CLIMATREE defines the significance of the mitigation potentials of tree cultivation, which can significantly contribute to tackle climate change.



Estimating the CO₂ balance of tree cultivations

The estimation of the actual CO₂ balance of tree cultivations is a necessity for identifying the mitigation potential of tree cultivations. This is partially addressed by GHGs Inventories, within the LULUCF sector.

GHGs inventories incorporates two characteristics inhabiting the exploitation of mitigation potentials:

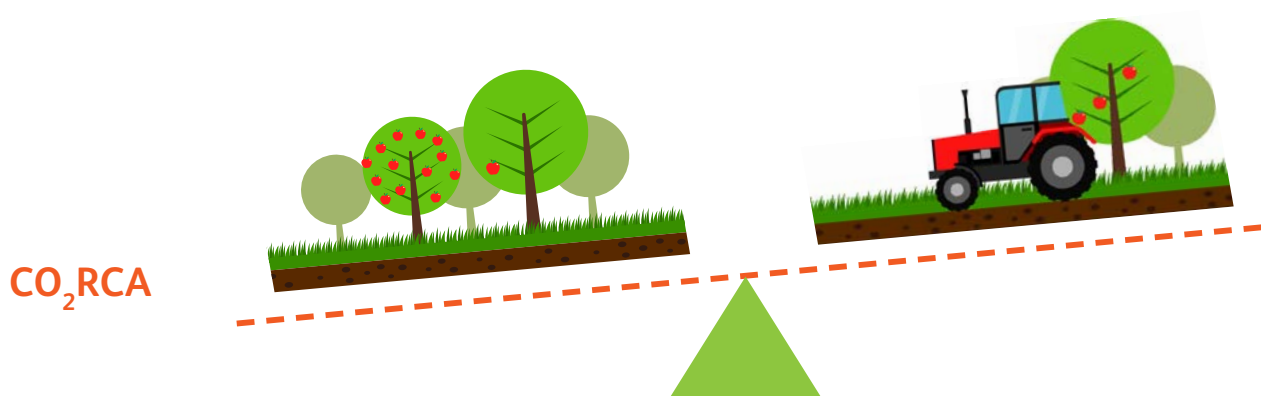
- GHGs inventories involve high uncertainty, at least in the Southern European countries, where tree cultivations occupy a relative high percentage of land use; estimates are largely based on default coefficients resulting in rough predictions.
- GHG inventories serve accounting purposes, consider CO₂ emissions induced by the cultivation practices (tractors use, energy for irrigation, fertilization etc.) as part of the Energy sector; these emissions are not reflected in LULUCF inventories where tree crops are reported.

To address these deficits, LIFE CLIMATREE developed a novel methodology investigating for this purpose the existing know-how of the GHG Inventories and taking into account the Life Cycle Assessment principles.



Algorithm (CO₂RCA) & Tool (CO₂RCCT)

Within the LIFE CLIMATREE project, a specialized algorithm was designed and developed [**CO₂ Removal Capacity Algorithm - CO₂RCA**] aiming at the efficient and accurate calculation of the tree crops' capacity to remove CO₂ from atmosphere.



THE ALGORITHM
CO₂RCA WAS
DESIGNED TO
CALCULATE THE
BALANCE BETWEEN

the mass of CO₂ which is
removed from atmosphere
by tree crops to produce
new biomass, and

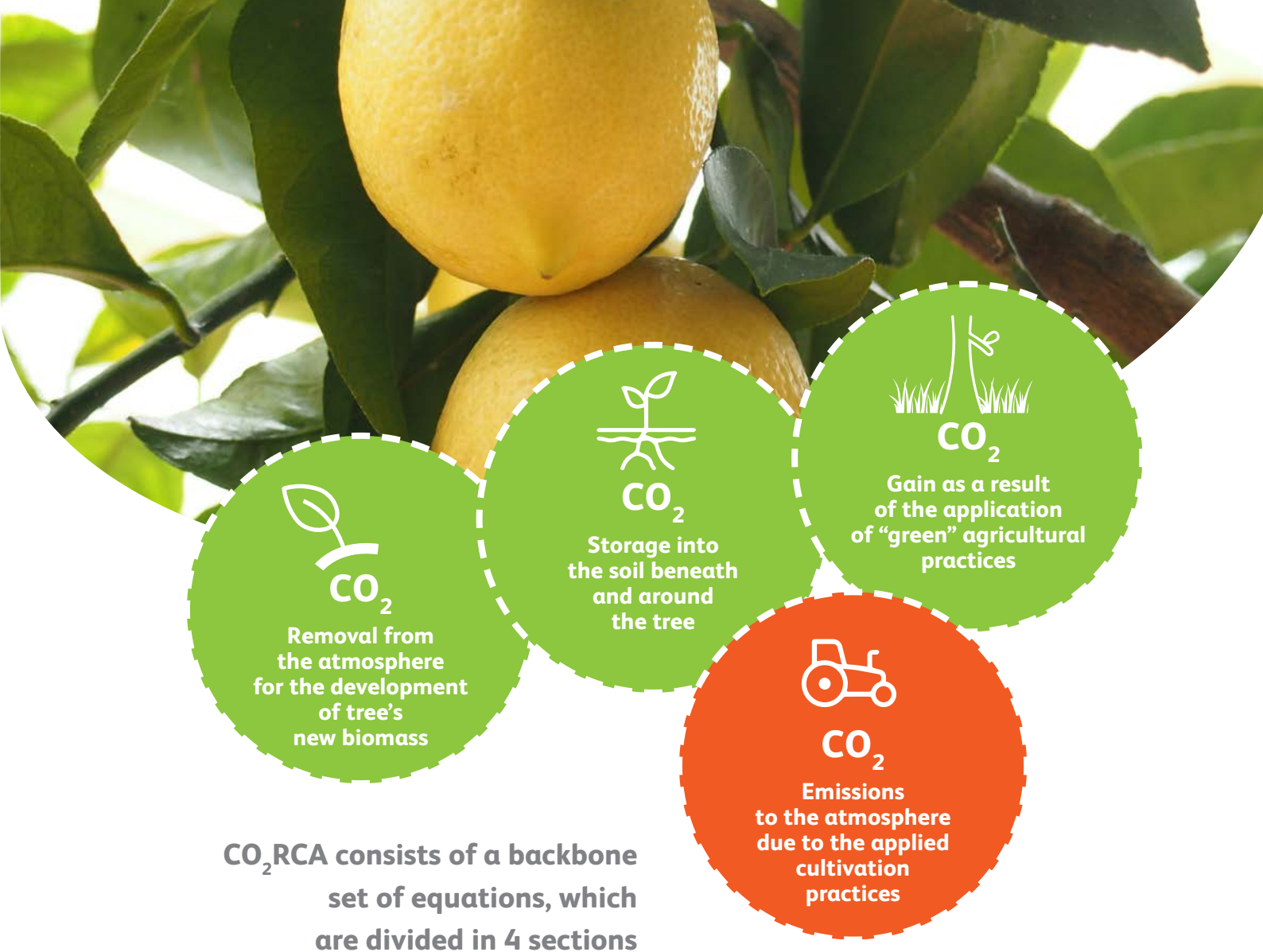
the mass of CO₂ which
is emitted to atmosphere
by the applied agricultural
practices.

CO₂RCA
TAKES INTO
ACCOUNT

the biological cycle
of the tree

the practices applied
for its cultivation,
maintenance, protection
and harvesting.

It is underlined that CO₂RCA calculates the carbon balance which is strictly related to atmosphere's CO₂ (CO₂ related carbon).



Based on the CO₂ RCA, a detailed e-tool [**CO₂ Removal Capacity Calculation Tool - CO₂RCCT**] was designed and developed to calculate tree crops' CO₂ Removal Capacity. The operation of the CO₂RCCT is supported by an extended back-end database, which includes appropriate data and coefficients.

CO₂RCCT was developed in 2 versions: the scientific, open-source version in excel format (.xlsx) and the web-based, public use version. Both are available at the project's website [www.lifeclimatree.eu].

CO₂RCCT was developed at a pilot scale incorporating 5 tree species:

- Orange [*Citrus sinensis*]
- Apple [*Malus domestica*]
- Peach [*Prunus persica*]
- Almond [*Amygdalus communis* or *Prunus dulcis*]
- Olive [*Olea europaea*]

in 3 countries: Greece | Italy | Spain.

The tool is operational in 4 languages: English | Greek | Italian | Spanish.

Indicative Results extracted by using the CO₂RCCT

	TREE CROP	CO ₂ ANNUALLY REMOVED FROM ATMOSPHERE	CO ₂ EMISSIONS/ REMOVAL RATIO	CO ₂ ANNUAL REMOVAL CAPACITY
SPAIN	olive	17,433,350 tn CO ₂ /year	0.21315	13,717,511 tn CO ₂ /year
GREECE	peach	406,127 tn CO ₂ /year	0.31051	280,022 tn CO ₂ /year
ITALY	orange	812,169 tn CO ₂ /year	0.33019	544,000 tn CO ₂ /year

Regarding the specific 5 tree species, in Greece, Italy and Spain every year 28,994,370 tn of CO₂ is removed from atmosphere, 96.4% of which is used to create the tree's new wood biomass, while the 3.6% is incorporated into the soil beneath them.

A series of “green” alternative agricultural practices were examined by using the CO₂RCCT:

- use of cover crops
- use of Leguminosae cover crops
- application of mulching
- application of fertilizers via fertigation
- application of insects monitoring and/or mass trapping

- valorization of prunings as solid fuel instead of diesel
- use of Renewable Energy Sources,

and their impact on tree crops' “climate” performance was analyzed in depth.

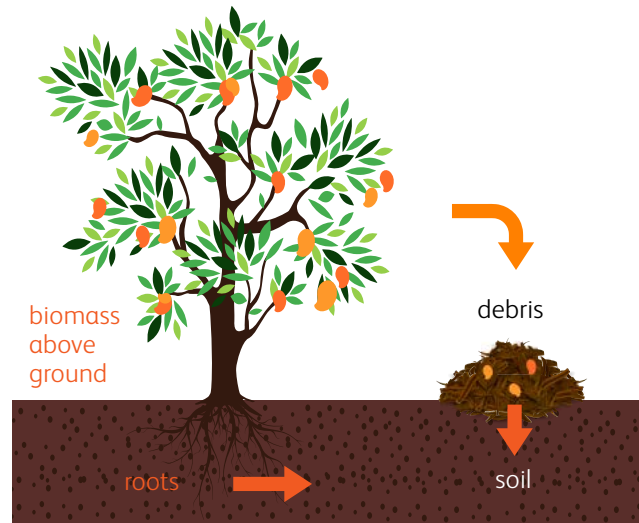
By applying a combination of “green” alternative agricultural practices a total reduction of approximately 80% is estimated that can be achieved regarding the current CO₂ emissions, leading in this way to an estimated total CO₂ Annual Removal Capacity of approximately 24,500,000 tn for the 5 tree species, in Greece, Italy and Spain.

Specifically concerning Greece, the 5 examined tree crops are illustrated, based on the results of the CO₂ RCCT, by the following figures regarding the CO₂ Annual Removal Capacity (ARC) and its constituting parameters:

GREECE		orange	apple	peach	almond	olive
ARC	CO ₂ ANNUAL REMOVAL CAPACITY	218,437 tn CO ₂ /year	9,768 tn CO ₂ /year	280,022 tn CO ₂ /year	70,437 tn CO ₂ /year	3,047,921 tn CO ₂ /year
AR _{BW}	CO ₂ ANNUAL REMOVAL DUE TO THE PRODUCTION OF WOOD BIOMASS	300,878 tn CO ₂ /year	58,443 tn CO ₂ /year	403,408 tn CO ₂ /year	101,011 tn CO ₂ /year	4,549,120 tn CO ₂ /year
AS _s	CO ₂ ANNUAL STORAGE IN SOIL AS CARBON OF THE FALLEN BIOMASS	7,224 tn CO ₂ /year	2,069 tn CO ₂ /year	2,719 tn CO ₂ /year	2,305 tn CO ₂ /year	54,879 tn CO ₂ /year
AE _F	CO ₂ ANNUAL EMISSIONS DUE TO THE USE OF FERTILIZERS	37,063 tn CO ₂ /year	15,213 tn CO ₂ /year	32,746 tn CO ₂ /year	9,047 tn CO ₂ /year	635,916 tn CO ₂ /year
AE _p	CO ₂ ANNUAL EMISSIONS DUE TO THE USE OF PESTICIDES	25,353 tn CO ₂ /year	5,981 tn CO ₂ /year	32,739 tn CO ₂ /year	11,609 tn CO ₂ /year	492,126 tn CO ₂ /year
AE _{FF&E}	CO ₂ ANNUAL EMISSIONS DUE TO THE USE OF FOSSIL FUELS & ELECTRICITY	27,248 tn CO ₂ /year	29,550 tn CO ₂ /year	60,620 tn CO ₂ /year	12,223 tn CO ₂ /year	428,037 tn CO ₂ /year
ARC _{AREA}	CO ₂ ANNUAL REMOVAL CAPACITY PER UNIT OF CULTIVATED AREA	6.44625 tn CO ₂ /year	0.87465 tn CO ₂ /year	7.12835 tn CO ₂ /year	5.29610 tn CO ₂ /year	3.73945 tn CO ₂ /year
ARC _{PRODUCT}	CO ₂ ANNUAL REMOVAL CAPACITY PER UNIT OF HARVESTED FRUITS	0.27844 tn CO ₂ hectare/year	0.03866 tn CO ₂ hectare/year	0.45389 tn CO ₂ hectare/year	2.29570 tn CO ₂ hectare/year	0.89183 tn CO ₂ hectare/year
ARC _{TREE}	CO ₂ ANNUAL REMOVAL CAPACITY PER TREE UNIT	0.01446 tn CO ₂ of yield/year	0.00118 tn CO ₂ of yield/year	0.01623 tn CO ₂ of yield/year	0.01899 tn CO ₂ of yield/year	0.02157 tn CO ₂ of yield/year
TAE/TAR	CO ₂ TOTAL ANNUAL EMISSIONS CO ₂ TOTAL ANNUAL REMOVALS	0.29102 tn CO ₂ tree/year	0.83857 tn CO ₂ tree/year	0.31051 tn CO ₂ tree/year	0.31824 tn CO ₂ tree/year	0.33798 tn CO ₂ tree/year

The dynamic model

LIFE CLIMATREE created a dynamic model in order to investigate the long run-trends of the CO₂ balance of tree cultivations. The model permits the evaluation of carbon changes in the three major pools (biomass, dead organic matter, soil) under different conditions including climate change scenarios and cultivation practices. The model can facilitate needs of the National GHGs Inventories. The long run trends indicate that soil carbon pool can play a significant mitigation role while cultivation practices result in substantial differentiated CO₂ impacts on all carbon pools. Cultivation practices matter and their impacts have been evaluated and ranked.



Economic benefits

CO₂ sequestration emerges as a significant ecosystem service and the actors that create such a service could be rewarded with the economic value of the service. LIFE CLIMATREE attempted the economic valuation of the CO₂ sequestration by using novel methods. The olive cultivations are the playground for this study because of the broad use of olive oil by citizens. Olive cultivation occupies a significant

land use in the Mediterranean: around 9% of the cultivated land in Spain and Italy and 20% in Greece. The study estimated a value around 1,270 Euros per hectare of olive cultivation adopting cultivation practices maximizing CO₂ sequestration. This is a significant value which can be used to underline the development of incentives to induce farmers to explore mitigation potentials.



Economic benefits induced by carbon storage in olive trees



VALUE PER
HECTARE
ADOPTING BEST
MITIGATION
PRACTICES

1970
€/ha

1163
€/ha

1270
€/ha



ADDITIONAL
ANNUAL CARBON
SEQUESTRATION
INDUCED BY
BEST PRACTICES

7.92
million tn

1.12
million tn

0.78
million tn



ADDITIONAL VALUE
OLIVE OIL
CERTIFIED FOR
MITIGATION RICH
PRACTICES

1.79
€/liter

1.91
€/liter

1.59
€/liter



ANNUAL AGGREGATE
ECONOMIC VALUES
OF ADDITIONAL CO₂
ABSORPTION IN
OLIVE TREES

9.263
million €

2.166
million €

995
million €

Emerging potentials from calculating the tree crops' CO₂ Removal Capacity

A series of rising potentials from using the tree crops' CO₂RCA and CO₂RCCT appear to be significantly promising regarding the expected impacts on the climate, the sustainable agricultural development and the economy.

The quantified results regarding the tree crops' CO₂ Annual Removal Capacity as well as its constituting parameters, can provide the necessary data:

- to the farmers, as well as to the consulting agronomists, towards the improvement of the “climate” performance of their tree crop farms through the adoption of best/ “green” agricultural practices.
- to the policy/decision makers towards the improvement of the relevant agricultural climate change indexes through the effective planning, organization and promotion of the appropriate required policies, strategies and measures (e.g., financial incentives, “green” subsidies, supporting infrastructure, etc.) to enhance the development of the agricultural sector in a sustainable and simultaneously viable way.
- to the financial institutions to develop “green” banking products for the agricultural sector that will be based on a CO₂ reduction incentive concept (e.g., lower “green” interest rate) by taking into account the “climate” performance of the specific tree crop farm for which the farmer requests financing.
- to a voluntary carbon off-setting market through which the farmers themselves will be able to financially exploit the CO₂ credits of their own tree crop farms.

The above potential uses of the CO₂RCA and the CO₂RCCT can result to a series of significant advantages:

- Financial support to the European Union's agricultural sector.
- Development of financial incentives (e.g., “green” subsidies, “green” loans, etc.) for the farmers towards the adoption of “green” agricultural practices, which can lead to less CO₂ emissions and consequently to increased CO₂ Annual Removal Capacity of their orchards.
- Avoidance of currency export to third, non-EU countries for purchasing CO₂ credits in the case of the voluntary carbon off-setting market.
- Development of a new market of services within EU that will provide:
 - consultation to the farmers for “greening” the applied agricultural practices
 - calculation of the CO₂ Annual Removal Capacity of the orchards
 - certification of the calculated CO₂ credits
 - brokering of the certified CO₂ credits.



Incentives and policy frameworks

LIFE CLIMATREE traces and delineates frameworks of incentives to promote the mitigation potentials. The new CAP can incorporate a system of incentives under frameworks entitled as eco-schemes and especially carbon farming. Carbon farming schemes aim at exploiting the mitigation potentials of farms in Europe. LIFE CLIMATREE has created a systematic and operational know-how to identify and evaluate the mitigation potentials of orchards. This know-how can directly feed the design of carbon farming incentives with certification methods and robust estimates of the economic incentives. In addition, the LIFE CLIMATREE's know-how can support the design of private initiatives promoting and enhancing mitigation potentials. Ecolabeling schemes and CO₂ voluntary markets can facilitate the mitigation prospects and induce farmers to apply the best management practices.

Overall, LIFE CLIMATREE creates the necessary knowledge for close-to-market initiatives exploring mitigation potentials. This knowledge has been communicated to decision makers and stakeholders and seems to inspire actual actions. The perfect timing defined by the design of the new CAP, as well as with the new stringent climate targets of EU, creates the best setting for action.

Coupled agricultural-climate policies can now be a reality with their benefits enhancing the sustainability of rural areas. A nature-based mitigation has been demonstrated with its co-benefits to stand important for the environment, economy and society. Let us explore the mitigation potentials of trees. They cannot be any more an issue of “how” and “if” but an issue of “when”.



Publicity & Dissemination

The Dissemination strategy of LIFE CLIMATREE focused on two groups of relevant stakeholders:

- Decision and policy makers at the European and National level in relation to climate and agricultural policies,
- Farmers and stakeholders from the sectors of agriculture and crop cultivations.

Overall, the project's dissemination Activities reached a high peak in the last year, making use of its extension until October, 31 2020. Both categories of stakeholders have been approached, systematically informed, and finally influenced. Decision makers at the national and European level as well as farmers and their unions have participated in the dissemination activities.

Networking

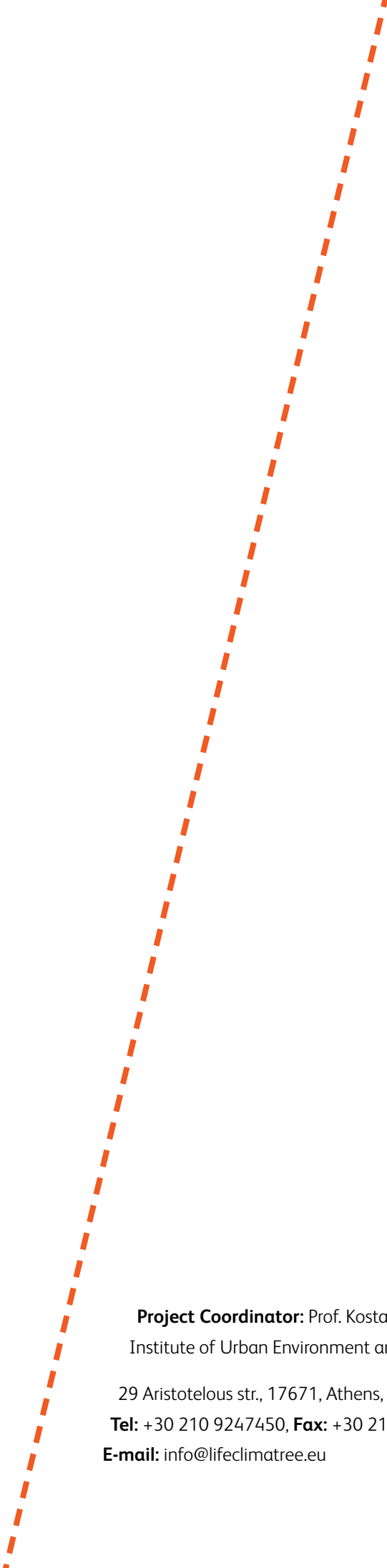
An extensive network with other projects, public organizations, farmer's associations as well as private companies has been established during the LIFE CLIMATREE implementation. This network was established in order to facilitate

the LIFE CLIMATREE successful implementation, to exchange information regarding cultivation practices and to communicate similar efforts.



Overall Result

Tree crops are proved to be of significant importance for the regulation of the climate, acting as a Climate Change mitigation measure.



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