LIFE Project Number

LIFE14 CCM/GR/000635

Final report

Covering the project activities from 16/07/2015 to 31/10/2020

Reporting Date[1]

31/01/2021

LIFE CLIMATREE

Data Project

Project location:	**Greece, Italy, Spain**
Project start date:	**< 16/07/2015>**
Project end date:	**< 28/06/2019> Extension date: < 31/10/2020>**
Total budget:	**€ 1.931.447**
EU contribution:	**€ 1.158.868**
(%) of eligible costs:	**60%**

Data Beneficiary

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[1] Include the reporting date as foreseen in part C2 of Annex II of the Grant Agreement

Package completeness and correctness check	
Obligatory elements	**✓ or N/A**
Technical report	
The correct latest template for the type of project (e.g. traditional) has been followed and all sections have been filled in, in English *In electronic version only*	Yes
Index of deliverables with short description annexed, in English *In electronic version only*	Yes
Mid-term report: Deliverables due in the reporting period (from project start) annexed Final report: Deliverables not already submitted with the MTR annexed including the Layman's report and after-LIFE plan Deliverables in language(s) other than English include a summary in English *In electronic version only*	Yes
Financial report	
The reporting period in the financial report (consolidated financial statement **and** financial statement of each Individual Beneficiary) is the same as in the technical report with the exception of any terminated beneficiary for which the end period should be the date of the termination.	Yes
Consolidated Financial Statement with all 5 forms duly filled in and signed and dated *On paper (signed and dated originals*) and in electronic version (pdfs of signed sheets + full Excel file)*	Yes
Financial Statement(s) of the Coordinating Beneficiary, of each Associated Beneficiary and of each affiliate (if involved), with all forms duly filled in (signed and dated). The Financial Statement(s) of Beneficiaries with affiliate(s) include the total cost of each affiliate in 1 line per cost category. *In electronic version (pdfs of signed sheets + full Excel files) + in the case of the Final report the overall summary forms of each beneficiary on paper (signed and dated originals*)*	Yes
Amounts, names and other data (e.g. bank account) are correct and consistent with the Grant Agreement / across the different forms (e.g. figures from the individual statements are the same as those reported in the consolidated statement)	Yes
Mid-term report (for all projects except IPs): the threshold for the second pre-financing payment has been reached	Yes
Beneficiary's certificate for Durable Goods included (if required, i.e. beneficiaries claiming 100% cost for durable goods) *On paper (signed and dated originals*) and in electronic version (pdfs of signed sheets)*	No
Certificate on financial statements (if required, i.e. for beneficiaries with EU contribution ≥750,000 € in the budget) *On paper (signed original) and in electronic version (pdf)*	No
Other checks	
Additional information / clarifications and supporting documents requested in previous EASME letters (unless already submitted or not yet due) *In electronic version only*	Yes
This table, page 2 of the Mid-term / Final report, is completed - each tick box is filled in *In electronic version only*	Yes

**original signature by a legal or statutory representative of the beneficiary / affiliate concerned*

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2. List of key-words and abbreviations

IPCC: Intergovernmental Panel on Climate Change
LULUCF: Land-Use, Land-Use Change and Forestry
AFOLU: Agriculture Forestry Land Use
DiCEM: The "Dipartimento delle Culture Europee e del Mediterraneo: Architettura, Ambiente, Patrimoni Culturali (DiCEM) of the University of Basilicata in Italy
AUA: The Agricultural University of Athens
UEHR: The Research Institute of Urban Environment & Human Resources
TN: TERRA NOVA Ltd
CSIC: The Spanish National Research Council
UOWM: The University of Western Macedonia
UNIBAS: University of Basilicata
LCA: Life Cycle Assessment
DICE: Dynamic Integrated Climate-Economy
RICE: Regional Integrated Climate-Economy

FUND: Climate Framework for Uncertainty, Negotiation and Distribution
NECB: Net Ecosystem Carbon Balance
GHG: Greenhouse Gases
BCP: Best Cultivation Practices
SOC: Soil Organic Carbon
ESS: Ecosystems Services Assessment
ETc: crop evapotranspiration
ETS: Emission Trading Schemes
EPs: Emissions Potentials
SPs: Sequestration Potentials

3. Executive summary

LIFE CLIMATREE investigates the link between tree cultivations and atmospheric CO_2. The ultimate objective of LIFE CLIMATREE is the exploitation of the potential climate change mitigation deriving from tree cultivations. Towards this objective, LIFE CLIMATREE develops a novel methodology for estimating the CO_2 balance of tree cultivations and applies this methodology in the conditions of southern Europe, especially in Spain, Italy and Greece.
In the context of the project, a novel methodology was developed (CO_2RCA: CO_2 Removal Capacity Algorithm) to calculate the CO_2 annual balance of tree crops in terms of CO_2 removals from atmosphere for the biological cycle of the tree and CO_2 emissions due to the applied agricultural practices.

Based on CO_2RCA, 2 electronic tools were designed and developed:

a) The CO_2RCCT (CO_2 Removal Capacity Calculation Tool) that was created in excel format (.xlsx) and at a web-based platform. A series of "green" alternative agricultural practices were incorporated in the tool. Based on the results of various runs, the impact of these alternative practices on tree crops' "climate" performance was analyzed in depth. Both versions of the CO_2RCCT were developed at a pilot scale incorporating 5 tree species (Orange, Apple, Peach, Almond, Olive) in 3 countries (Greece, Italy, Spain). The results extracted by using the CO_2RCCT revealed the significant importance of tree crops for the regulation of the climate, acting as a Climate Change mitigation measure.
b) the dynamic spatial explicit model that was created to investigate the dynamic trends of CO_2 balance. The model incorporates data for soil from LUCAS and permits predictions for the next 50 years, using the cultivations in Spain, Italy and Greece as the experimental background. Second, an e-tool that permits operational estimates of CO_2 balance has been developed.

The e-tool is based on an extensive algorithm that "resembles" the biological functions as well as the human interventions in orchards. The so-called, "CO_2 Removal Algorithm" enables evaluation of different practices concerning cultivation methods and other practices in orchards. The major impact of different practices is estimated and systematically presented, with CO_2 balance (Annual Removal Capacity – ARC) being the most prominent outcome of the algorithm. As a result, cultivation practices have been evaluated and ranked according to their CO_2 sequestration potentials. Those practices that result in substantial CO_2 sequestrations have been described in an operational way in order to be familiar to stakeholders. The sequestration of CO_2 is an essential ecosystem service induced by

orchards. LIFE CLIMATREE assigns a monetary value in this ecosystem service taking into account the conditions of olive oil orchards in the Mediterranean. A value around 1120 €/ hectare of land cultivated by mitigation rich methods, maximizing CO_2 sequestration, has been estimated as the monetary value of the CO_2 sequestration. Sensitivity test confirmed validity and proximity with relevant findings elsewhere.

The findings of LIFE CLIMATREE target two major pillars: climate and agricultural policies. Concerning climate policies, LIFE CLIMATREE contributes with the exploitation of the mitigation potentials of tree crops being an essential part of the cropland areas, especially in the countries of Southern Europe. Before exploring this potential, a robust accounting system is required to assess and depicts them in a reliable way. Towards this objective, LIFE CLIMATREE supports the upgrading of National Inventory Reporting of Green House Gases (GHGs). Currently, NIRs, concerning cropland areas in Greece, Italy and Spain, are based on Tier 1 standards using pro-defined coefficients which actually result in ≈ 70% uncertainty. LIFE CLIMATREE's findings contribute to the development of coefficients reflecting the conditions of southern Europe and upgrading the reporting status towards Tier 2 standards. This can be achieved once the findings of LIFE CLIMATREE are combined with relevant findings from other LIFE projects such as MEDINET and OLIVE4CLIMA. Although the contribution of all these projects consists a stride ahead concerning the upgrading of NIRs there are still missing elements that need to be addressed. These elements are, under the light shed by LIFE CLIMATREE and other projects, now more transparent, well-defined and therefore more easily addressed.

Concerning the agricultural policies LIFE CLIMATREE contributes to the incorporation of climate objectives within agricultural policies. Mitigation rich practices are defined, evaluated and systematically presented to policy makers and stakeholders. These practices can be incorporated within the Eco-schemes envisaged as a major instrument in the context of the new Common Agricultural Policy (CAP). The findings of LIFE CLIMATREE can feed the design of the so-called "Carbon farming" schemes which attribute financial benefits to those farmers offering climate mitigation services. Two-fold contributions are emerging from LIFE CLIMATREE; first the mitigation rich practices are identified, and their CO_2 sequestration is estimated; second, the economic value of such an ecosystem service has been defined.
As a result, LIFE CLIMATREE provides the necessary knowhow for designing meaningful coupled agricultural climate policies; LIFE CLIMATREE offers such a contribution exactly at the right timing when the design of the new CAP requires operational tools to underline the development of carbon farming schemes. In order to exploit such a contribution LIFE CLIMATREE undertook a concrete context of dissemination activities with the agricultural policy decision makers and relevant stakeholders. The Greek and the Spanish ministries of Agriculture have been systematically presented the mitigation rich methods which can serve as carbon farming schemes. DG Agri stakeholders and members of the European Parliament have been communicated the relevant findings.

Although the findings of LIFE CLIMATREE are more relevant for decision makers, influenced policies at national and European level, certain outcomes can be also used by micro-stakeholders such as farmers and farmer unions. Micro stakeholders can pursue the development of CO_2 voluntary climate mitigation instruments.

Ecolabeling schemes and CO_2 voluntary markets can be designed on the basis of LIFE CLIMATREE outcomes. To trigger such initiatives, a systematic set of dissemination actions have been undertaken exploiting the final conference and its "coverage" by specialized

media. As a result, a voluntary market initiative in collaboration with the private actors is under consideration and hopefully will be realized within 2022. Furthermore, a new LIFE proposal is drafted; for the 2021 call, addressing the prerequisites for ecolabeling and carbon farming schemes. Beneficiaries from LIFE OLIVE4CLIMA and LIFE MEDINET, two relevant projects are participating in this initiative exploiting the mitigation potentials of tree cultivations.

LIFE CLIMATREE exploited its resources to deliver according to its objectives and this target has been met with success as reflected in the key deliverables:

- The CO_2 Removal Capacity Algorithm (CO_2RCA)
- The CO_2 Removal Capacity Calculation tool (CO_2RCCT)
- The dynamic model permitting identification of the CO_2 balance long run trends
- The articulation of the mitigation rich cultivation practices, best practices
- The monetary evaluation of CO_2 sequestration induced by tree cultivation
- The identification of additional ecosystem services arising by tree cultivations.

As a result, CLIMATREE can contribute to the achievement of EU target for 30% reductions of CO_2 emissions by 2030 under the Effort Sharing Regulation.

4. Introduction

Climate related problem/issue addressed

The major objective of LIFE CLIMATREE is the identification and exploitation of mitigation potentials induced by tree cultivations. These potentials are currently neglected because of two major reasons. First, uncertainty is burdening the GHGs inventories of the LULUCF sector where tree crops are incorporated; hence the CO_2 impacts of tree cultivations cannot be estimated with some precision. Second, the actual CO_2 balance of a tree farm cannot be easily evaluated since this requires different existing methodologies service divergent objectives. Third, agricultural policies are lacking the right instruments incentivizing farmers to explore mitigation potentials. LIFE CLIMATREE aims at developing the necessary knowhow which, addressing the above gaps, would permit the realization of these mitigation prospects. Such a knowhow coupled climate-agricultural policies could be designed and enrich the arsenal of the European climate policies.

In this context, LIFE CLIMATREE evaluates and demonstrates the mitigation potentials of tree cultivations, using the conditions of southern European countries as an experimental area. LIFE CLIMATREE had been inspired by the mitigation role of forest after considering the resemblance between forests and tree cultivations. This resemblance does not necessarily imply that tree cultivations do result in mitigation potentials because orchards require human activities inducing CO_2 emissions. As a result, the identification of mitigation potentials of tree cultivations requires a holistic investigation of the link between tree cultivations and atmospheric CO_2. LIFE CLIMATREE attempts a systematic stride in investigating this link.

Solution demonstrated/verified by the project

LIFE CLIMATREE merged two different frameworks dealing with the interactions between orchards and CO_2. The IPCC-based framework examines the CO_2 pools induced by the ecological-biological function of trees and how human activities influence these pools. Broadly speaking soil and biomass are the major pools of CO_2 triggered by photosynthesis and the

related biological processes. The IPCC-based methodology serves mainly GHGs accounting purposes and examines the CO_2 emissions of cultivation practices in orchards as part of other sectors such as energy etc. The LULUCF sector, where tree cultivations belong as a component of cropland areas, investigates CO_2 emissions and removals induced mainly by the natural processes and the impacts of human activities, cultivation practices, on these processes. While serving perfectly accounting purposes, the IPCC-based framework does not permit the evaluation of the CO_2 balance of tree cultivations which should incorporate the climate impacts of cultivation methods and other interventions. The outcome of human intervention is traced by Life Cycle Assessment frameworks. In order to investigate the CO_2 balance of tree cultivations LIFE CLIMATREE sets the "borders" of its analysis at the borders of the farm and incorporates elements of IPCC-based and LCA frameworks.
In the context of the project, a specialized Algorithm was developed (CO_2RCA: CO_2 Removal Capacity Algorithm) to calculate the CO_2 annual balance of tree crops in terms of CO_2 removals from atmosphere for the biological cycle of the tree and CO_2 emissions due to the applied agricultural practices.

Based on CO_2RCA, 2 electronic tools were designed and developed:
a) The CO_2RCCT (CO_2 Removal Capacity Calculation Tool)
b) the dynamic model to investigate the trends of CO_2 balance.

Description of the technical / methodological solution
A novel methodology has been delineated and depicted by two operational outcomes:
- a dynamic model assessing trends of CO_2 balance under different scenarios incorporating climate change futures, cultivation methods et. al.
- an e-tool (software) based on an extensive algorithm which permits evaluation of the annual CO_2 balance reflecting real life parameters.

LIFE CLIMATREE estimates the mitigation potentials of several plausible cultivation practices. Their key outcomes are assigned and demonstrated in an operational way. Although CO_2 sequestration is the major indicator for ranking cultivation methods several of their additional characteristics are investigated in order to reveal their economic, technological and environmental aspects.

The investigation of the link between the atmospheric CO_2 and tree cultivations defines certain soil management and cultivation relevant practices that drive the CO_2 sequestration. They are clearly articulated and systematically presented to serve the needs of decision makers and stakeholders. Their application can be supported by suitably designed financial incentives that influence the behavior of farmers, since inertia is among the prevailing barriers inhibiting the adoption of mitigation rich practices. Financial incentives within CAP as well as through voluntary schemes (ecolabeling and voluntary CO_2 markets) can tackle the inertia of farmers. LIFE CLIMATREE investigates the principles underlining the development of financial incentives. Among others, the economic benefit offered to society, by CO_2 sequestration is related to a monetary value. Multi uses can be envisaged.

Land-based mitigation emerges as an important component of contemporary climate policy mainly because of the relatively low costs required as well as the related co-benefits. Tree cultivation, as estimated by LIFE CLIMATREE, presents considerable mitigation potentials. They exist under the current cultivation conditions and can be increased by adopting mitigation rich management practices at the farmers' level. Both the current and the

"additional" mitigation potentials are estimated and demonstrated. This is a genius contribution since these mitigation potentials are largely ignored. Indeed, past prevailing analysis concentrates on the production capacity of tree cultivation while their biological functions are largely neglected. LIFE CLIMATREE attempts a stride in the analysis of the link between tree orchards and atmospheric CO_2. Although this link has been investigated with considerable success there are remaining issue and gaps that ought to be addressed by future initiatives. LIFE CLIMATREE identifies the existing gaps towards a complete exploitation of the benefits arising from tree cultivations.

Tree cultivations are important sector of the coupled social-economic-natural systems. Beyond the mitigation potentials, being the core of LIFE CLIMATREE, a large number of essential co-benefits are induced by tree cultivations. Sustainability of rural areas, income and employment, food provision and security combined with essential regulating ecosystem services (soil formation, water infiltration, etc.) are the outcome of properly managed tree cultivations. LIFE CLIMATREE traces the proper management with specific emphasis on CO_2 mitigation potentials.

Expected results and climate action related benefits

The findings of LIFE CLIMATREE can contribute to the following objectives. First, an upgraded status of National Inventory Reports, of core crops being a component of LULUCF sector, can be achieved creating national specific coefficients. Second, the forthcoming CAP can be enriched with climate objectives. Specifical carbon farming schemes have now a solid knowhow for evaluating and certifying the climatic contribution of orchards. Third, private close to market initiatives can now be undertaken exploiting the solid methodology which permits the evolution of the actual CO_2 balance of tree crops. Voluntary CO_2 markets and ecolabeling schemes can be supported by LIFE CLIMATREE deliverables. Such initiatives are currently under consideration in collaboration with farmers unions, banks and other actors. In this way LIFE CLIMATREE will contribute to the recently updated CO_2 emission target for the year 2030, by realizing a nature-based, and therefore cost-effective, mitigation action.

Expected longer term results

A series of long terms benefits are arising from the knowhow developed within CLIMATREE climate, sustainable agricultural development and the economy.

Estimates of the CO2 balance, estimated on the basis of the novel CLIMATREE methodology as capitalized by CO_2 Annual Removal Capacity tool (CO_2RCA and CO_2RCCT), can provide the necessary information for:

- ⇨ 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 CO_2 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 CO_2 credits of their own tree crop farms.

They may induce 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 CO_2 emissions and consequently to increased CO_2 Annual Removal Capacity of their orchards.
- ☑ Avoidance of currency export to third, non-EU countries for purchasing CO_2 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 CO_2 Annual Removal Capacity of the orchards
  - ✓ certification of the calculated CO_2 credits
  - ✓ brokering of the certified CO_2 credits.

5. Administrative part

The Institute of Urban Environment and Human Resources (UEHR) was the Coordinating Beneficiary of the project and the project management-coordination was performed by Prof. Dr. Kostas Bithas. UEHR was responsible for the effective management of the project, the operational internal communication, the effective administrative and technical control of the project and the successful implementation of the Actions by providing support and guidance to the Associated Beneficiaries. The major objective was the development of the right environment permitting the effective achievement of LIFE CLIMATREE objectives.

Four (4) Management Committees (Scientific, Quality Assurance / Quality Control (QA/QC), Financial and Technical) were designed for the successful and effective project management. Each Committee consisted of one representative by each LIFE CLIMATREE beneficiary, while they were coordinated by the Project Manager. The Scientific Committee monitored the implementation of Actions, with scientific robustness and operational efficiency and transparency. The Financial Committee monitored the financial progress of the project and performed the necessary contacts with partners' financial departments. Each partner maintained an updated accounting system, in accordance with law and existing regulations of each country. The Technical Committee was responsible for all technical aspects of the project (definition of technical specifications for acquired equipment, market research, evaluation of technical offers etc.) and its demonstrative operation. The QA/QC Committee set the procedures for the monitoring and control of the various activities in order to ensure the best performance and the homogeneity of the methods and actions applied. A QA/QC system was developed in order to monitor the progress of the implementation of the project. The updated organigramme of LIFE CLIMATREE is provided in Annex F.1.4.

During LIFE CLIMATREE's official kick off meeting (7th-8th October 2015) the official setup of all Committees took place delineating the role of each committee towards the successful implementation of the Project. The exact procedures for the sound operation of each Committee were agreed. The scientific Committee agreed on a methodology for the control of deliverables, through an internal "reviewing" process which contributed to the successful completion of LIFE CLIMATREE's deliverables. The role of Financial Committee was

concentrated on the delineation of the financial procedures, the LIFE CLIMATREE's timesheets, accompanied by other relevant financial documents, which were agreed to be sent to the Project Coordinator (UEHR) every 3 months following the adoption of the new template. The Technical Committee emphasized on the sound adoption of the new guidelines of LIFE's "General Conditions" and conformation with the Internal Guidelines of each Participating Beneficiary.

Furthermore, the progress of the project was clearly depicted in the relevant reports and corrective actions were undertaken in accordance with the remarks raised by the Project AdviserMrs. Mandelikova whose support throughout the project has been essential. Substantial support was received from Mr. Demian, the external monitoring expert whose contribution peaked during the last and crucial period of the project. The constrains imposed by Covid-19 required certain micro corrective actions and the help received by Mr. Demian was effective and rapid. The implication of Covid-19 resulted in the need for a second extension of the project until 30/10/2020.

6. Technical part

6.1 Technical progress, per Action

Action A.1 Selection and analysis of tree-crop categories in S. Europe

Foreseen start date:	16/7/2015	Actual start date:	16/7/2015
Foreseen end date:	30/11/2015	Actual end date:	31/3/2016

The action has been successfully completed. In the context of the present action, the following two major tasks were implemented:

1. Literature review on the Ecosystems Services Assessment, which resulted in the provision of a comprehensive framework for the relative assessment of the ecosystem services of Tree Crops, along with a provisional set of potential indicators for the enumeration of Ecosystem Services.
2. The development of a methodology for the categorization of Tree Crops according to their biological and cultivation characteristics. This methodology took into account the widely available knowledge along with nation-wide statistics elaborated to the municipality level.

The date foreseen for Action A.1 completion had been postponed until the end of March 2016, as a consequence of the delayed beginning of the project implementation by AUA (due to capital controls and the summer period vacation).

All the action's objectives were fully achieved as indicated in the relevant deliverable A.1 entitled "Technical report on Tree-Crop Categorization" which mainly provides the following outcomes:

1. Literature review on the Ecosystems Services (ESS) Assessment: Present task's principal outcome was a novel methodology aiming to the simultaneous cross-assessment of Orchards ESS, complemented by a set of potential indicators for their enumeration.
2. The development of a methodology for the categorization of Tree Crops: Present task's

principal outcome was the clustering of tree-crops in homologous categories enabling thus the inclusive and cumulative application of the previously developed methodology for the Orchards ESS assessment, but also providing solid and well-defined clusters for the Action C.1 implementation. The main benefit of this task was the ability to draw conclusions on the sum of the Land Area covered by Orchards in all three Member States (MS).

Action A.2 Adjustment of the "Land use, land-use change and forestry (LULUCF) Methodology" to the environmental problem targeted

Foreseen start date: 01/10/2015	Actual start date: 01/10/2015
Foreseen end date: 31/3/2016	Actual end date: 30/4/2016

Action A.2 aimed at systematically reviewing the accounting methodologies and identify those parameters and aspects that may be facilitated by LIFE CLIMATREE in order to reduce uncertainty and to improve accounting.

Action A.2 analyzed the current methodology for monitoring and accounting of GHG emissions for the Agriculture Forestry Land Use (AFOLU) sector focusing the tree crops. Particularly, current legislation (EC Decision 529/2013) and technical Guidelines for National Greenhouse Gas Inventories issued in 2006 and 2014 by the Intergovernmental Panel on Climate Change has been reviewed. The Action A.2 summarized current methodology for monitoring and accounting of GHG emissions for the Agriculture Forestry Land Use (AFOLU) sector with a focus on tree crops which are included in Cropland category. Key documents were reviewed and possible improvements/adjustments of current methodology were identified.

Action A.2 shed light on the potential of tree crops categories to serve as carbon sink and provided examples on methodology to gather quantitative information on carbon storage in tree crop categories. Particularly, the Net Ecosystem Carbon Balance (NECB) methodology was adopted to account for both the natural capacity of tree crops to sequester carbon and the impact of the farmers' management actions.

The deliverable titled "Adjustment of the LULUCF methodology for a better accounting of mitigation cultural practices of agro-ecosystem" highlighted the role of perennial tree crops as a main category similar to forestry rather than having it included in the Cropland Management category, may boost Member States to implement actions for monitoring and reporting the contribution of tree crops to national GHG inventories. Dissemination Actions towards some police makers were also performed for this purpose. In addition, the After-Life Plan contains provisions for further dissemination on the role of tree crops for climate change mitigation.

Within Action A.2, a supporting study on the carbon budget in a peach orchard has been prepared and published in the international journal Agricultural Ecosystem Environment (2017, 238: 104-113, DOI: 10.1016/j.agee.2016.05.031). This publication is annexed to the present Report as single PDF file (Annex F.3.2) and will contribute to improve quantitative information on carbon stored in various stocks.

Action A.2 has been completed accordingly to the Project schedule.

Results on methodology on carbon balance are supportive to the following Actions:

- Action C.3 - Interface development of software application
- Action C.4 - Carbon input/output calculation for current and future years
- Action C.5 - Suggestions and evaluation of climate change mitigation policies and measures.

Action A.3 Analysis of climatic, environmental and socioeconomic parameters of tree-crop categories in S. Europe

Foreseen start date: 1/10/2015	Actual start date: 1/10/2015
Foreseen end date: 31/3/2016	Actual end date: 31/5/2016

Action A.3 started on time (October 2015) and has been successfully completed. The Deliverable of Action A.3: Analysis of Climatic, Environmental and Socioeconomic Parameters of tree-crop categories in S. Europe was completed according to the timetable and is attached to the current report (Annex A.3)

The main climatic parameters related to tree crops are temperature, precipitation and humidity and analyzed for the three countries using observation data from monitoring stations. Environmental parameters which are mainly related to the cultivation practices are: Plantation density, Soil tillage, Irrigation requirements, Fertilization use, Herbicides use, Pesticides use. To assess the socio-economic indicators influencing tree crops in S. Europe, statistical data for production (i.e, GDP, Value for agricultural and tree crop productions), employment (i.e. Total Employment, Employment in Agriculture and Tree crops Sectors), and trade (i.e., Total Imports & Exports, Agriculture and Tree corps Imports & Exports) are used. The role of Common Agricultural Policy (CAP), as a socioeconomic parameter affecting the development of permanent tree crops in South Europe was also examined. Although the action started on time and it was planned to be completed in March 2016, the extension of Action A.1 suggested a two-month extension of Action A.3 in order to incorporate A.1 inputs in environmental parameters affecting tree crop cultivations. The action was completed and the delays had been caught up, without affecting other actions.

All action's objectives (i.e., analysis of the climatic, environmental and socioeconomic conditions that influence and relate to tree crop cultivations in S. Europe) were achieved.

Action C.1. Life Cycle Assessment of carbon cycle in tree-crop categories

Foreseen start date: 1/4/2016	Actual start date: 1/4/2016
Foreseen end date: 29/9/2017	Actual end date: 31/3/2018

The action implementation started timely on April 1, 2016. It exhibited significant progress according to the action's schedule. In specific, the following major tasks were materialized in full compliance with the initial planning:

1. Variables affecting carbon sequestration: A complete list of these variables has been produced and is incorporated in the *corpus* of the final deliverable.
2. Literature-review: Though this task was considered completed, and the relevant report is attached as Annex I since April 2017, in the draft deliverable, a continuous effort kept screening monthly the related literature in order to incorporate recent advances. These advances were incorporated in the final deliverable.
3. Assessment of Millennium Ecosystems Services: This task had already been completed upon the completion of action A.1 deliverable. An updated approach with distinct focus on the Regulating services of TC has been attached as Annex II. This report was further refined upon the completion of the Carbon balance accounting, thus even it was considered complete in April 2017, minor amendments were incorporated in the form presented in the final deliverable.
4. Methodology for the calculation of Carbon Storage by tree-crops: The fundamental methodology had been developed and was presented in the project's annual meeting of 2016 in Matera, Italy, and is fully incorporated in the accompanying the present report

final deliverable. This methodology builds upon previous knowledge on Carbon capture by the representative tree-crops, and nation wide available statistical data a clear, inclusive, and readily applicable approach for the annual accounting of Carbon Capture and Sequestration in tree-crops. This approach is elaborated upon five Carbon Life Cycle Assessments, each one dedicated to the facts and individualities of the respective representative tree crop.

Besides the aforementioned tasks, which were completed in time, significant delays were recorded in the other action's major tasks. In these are included the following:

1. Sampling documentation of carbon captured by selected tree-crops: The sampling of aboveground was completed in time. Underground sampling commenced by the end of 2017 vegetative season. All primary data along with the sampling methodology are presented in Annex III of the final deliverable. These data are aiming to complement existing knowledge on the annual carbon capture of tree-crops resulting thus, to a uniform data set for the representative tree-crops. This data set along with the literature data will be utilized for the enumeration of the annual Carbon Capture per hectare figure for each of the four tree-crop categories.
2. Survey documentation of carbon emissions in the selected tree-crops: This task also presented significant delay. The survey methodology and two thematic questionnaires had been produced in time and are attached in Annex IV of the final deliverable. The first of the two thematic questionnaires is focusing on the biodiversity, aiming to delineate the related Ecosystem Services. Through this questionnaire is pursued primary a documentation of the biodiversity occurrence within tree-crops, and secondary the draw of conclusion upon the farmers' general conceptions, and comprehension of biodiversity. The second questionnaire is focusing on the delineation of the cultivation parameters affecting the tree-crops Carbon emissions. In these parameters are included the annual total repetitions of each cultivation measure along with the application intensity, the kind of machinery and any other production mean used in the cultivation of tree-crops, and the average annual consumption of energy and fuel within each farm. Enumeration of these parameters concluded to the definition of the annual Carbon Emissions per hectare figure for each of the four tree-crop categories.
3. Impacts of tree-crops in Soil Organic Matter: A survey of literature on the LCA issue has been carried out also considering the preliminary evaluation of primary and secondary data required. A manuscript dealing with LCA has been submitted to an international journal. DiCEM scheduled the activities related to LCA analysis for the Italian tree crops category selected.

In the course of action implementation three major problems were encountered:

1. Plant nursery emissions: This figure has been incorporated in all LCA approaches found in the literature review process. The problem of incorporating this figure in LIFE CLIMATREE's approach was established on the fact that the emissions of the related nurseries is allocated in a different area and corresponds to a different than tree-crop cultivation Land Use. To resolve this inconsistency, we decided not to include this figure in our approach.
2. Plantation establishment: This period is characterized by a drastic annual change in both fruit yield and plantation's biomass, while also requires differentiated cultivation measures. The total period for plantation establishment is also quite differentiated between various tree-crop escalating from 3 to 8 years. Our problem regarding this period is the inconsistencies in relation with the tree-crops productive life accounting parameters, which cannot be treated within the same linear approach applied through

the plantations productive life span. To resolve this issue an algorithm was developed in order to exclude this figure from the annual accounting. In specific, for a given tree-crop with X hectares in year 1, and Y hectares in year 1 - 5 (= average maturing period) the accounting protocol is applied for the absolute difference of hectares Z (Z=|X-Y|). The issue of the establishment period Carbon balance will be further elaborated in the course of A.3 Action because its non-linear nature dictates the application of a modeling approach.

3. Plantation end-of-life management: This issue had not been considered by previous studies but consists of major importance for LIFE CLIMATREE's objectives, since it regards the consideration of tree biomass as permanent carbon storage. To resolve this issue a dedicated section in the best available practices Annex of the present action's deliverable is foreseen in order to maintain the fundamental consideration of plantation biomass as permanent carbon storage.

Beside these significant problems, also minor were encountered, dealing mostly with data acquisition:

1. Root sampling: This issue related to the accounting of root annual growth, both auxiliary and radial. To resolve this issue, we weighted young trees during the 2016-17 dormancy period, planted them and we scheduled one more measurement at the end of the 2017 vegetative period in order to acquire distinct measurements. This adjustment prolonged for almost three months the field work period and is expected to cause an action prolongation of two to three months, as indicated in the following milestone's table.
2. Production means and machinery carbon footprint: This issue is of great concern since the relative figures accumulate in the tree-crops Carbon balance but as the nursery figure is not located in the tree-crop's land use. Moreover, since these emissions have already been considered as emissions of the relative production sector there is a significant possibility to jeopardize the relevant results through double accounting of these emissions. Therefore, we concluded to the decision to omit the relevant emissions from the proposed methodology.
3. Survey sample size: This issue regards the credibility of the performed survey. After careful review of similar cases in the literature it was decided to apply as minimum threshold the 50 completed questionnaires for each tree-crop, which is a number acceptable as credible in numerous previous cases.

Although the deliverable was presented in all partners by the end of 2017, it was finalized at 30th of March 2018.

Action C.2. Projections of future climatic conditions for tree crop categories in S. Europe

Foreseen start date: 1/9/2016	Actual start date: 1/9/2016
Foreseen end date: 31/12/2017	Actual end date: 31/12/2017

The Action C2 has been implemented according to the time schedule. Problems and delays have not been faced. In addition, the milestones and the deliverable are on time.

Objective: The objective of this Action is to estimate the changes in the climatic conditions affecting tree crops cultivation.

Method: The NASA GISS GCM ModelE2 is used to simulate current and future climate under two different Representative Concentration Pathways: the RCP8.5 and the RCP4.5. However, the outputs from the GCM are relatively coarse (i.e., 1° × 1.25°) for applications to regional

and local scales. The need for regional climate projections in a finer grid size (i.e., 9 Km x 9 Km) is assessed using the Weather Research and Forecasting (WRF) model to dynamically downscale GCM simulations. The goal is to generate more locally relevant projections of long-term weather patterns over S. Europe.

Results: Temperature changes between current (i.e., 2008 – 2012) and future years (i.e., 2048-2052) for RCP8.5 over Greece, Italy and Spain is estimated in the range of 0.0 - 0.5 degrees, 0.25 - 1.25 degrees and 0.5 - 1.5 degrees, respectively. The maximum increase, up to 1.5 degrees, is estimated over north – north eastern Spain while the minimum increase, up to 0.25 degrees, is estimated over eastern Greece. Temperature increase has been found over Greece, Italy and Spain for all seasons with an exception for Greece during spring where a small reduction (i.e., up to 0.5 degrees) is found. The maximum increase for Greece is estimated up to 1 degree during winter, autumn and summer while the maximum increase for Italy and Spain is estimated 2 degrees during winter and 2.5 degrees during summer, respectively. Precipitation change is very location and seasonal dependent presenting a mixed trend. Annual precipitation is estimated to be lower all over Spain (up to 60%, locally). Annual precipitation change over Italy is estimated in the range of ±40% where decreases are found to the north and increases to the south. Annual precipitation change over Greece is estimated in the range of ±20%. During winter the general trend presents a decrease in the precipitations rates over the continental regions. During spring reduction in precipitation rates over Spain and Italy is dominant. Over Greece precipitation is estimated to decrease only over the northern part. During summer precipitation rates over Spain are estimated to decrease mainly at the south of the country, while there are regions mainly at the north where precipitation is found to increase. This is not the case for the other two countries where reduction is dominant over Italy and increase is dominant over Greece. During autumn reduction in the precipitation rates over Spain is dominant. Over Italy precipitation is estimated to increase at the south and to decrease at the north. Over Greece higher precipitation rates are estimated for most of the country.

Temperature change between current (i.e., 2008 – 2012) and future years (i.e., 2048-2052) for RCP4.5 is estimated to be higher over Spain and northern Italy and lower over southern Italy and Greece. Over Spain annual temperature is found higher in the range 0.0 - 1.0 degrees. Over Italy an increase in the range of 0.0 - 0.5 degrees is estimated at the north and a decrease up to 0.25 degrees is estimated at the south. Over Greece annual temperature is estimated lower in the range 0.0 - 0.5 degrees. The maximum increase for Spain is estimated up to 1.25 degrees during autumn while the maximum increase for Italy is estimated up to 1.75 degrees during winter. The maximum increase for Greece is estimated up to 0.25 degrees during autumn while the maximum decrease is estimated up to 1 degree during spring. Precipitation change is very location and seasonal dependent. Annual precipitation is estimated to be lower over Spain (up to 40%) except the coastal regions where increases are found (up to 60% south and up to 20% north). Annual precipitation over Italy is estimated to be higher up to 40% except the north region and west Sicily where a decrease up to 20% is found. Annual precipitation change over Greece is estimated in the range of ±20% for most of the country, where decreases are found over the Aegean Sea, the north-eastern continental land and Attica region. During winter precipitation rates are estimated to be lower for the major part of Spain. Over Italy a decrease in precipitation rates is found at the central part of the country. For the rest parts of Italy an increase is found. The general trend over Greece is a decrease in the precipitation rates. During spring reduction in precipitation rates is dominant over Spain. Over Italy an increase is found in the precipitation rates except the northern regions. Over Greece increases in precipitation rates are found for most of the country with an exception at the south Aegean Sea. During summer precipitation rates over Spain are estimated to increase at the south coastal zone, the east border and at

the central of the country. Over Italy increases at the precipitation rates are found over north Italy and decreases are found at the south. Over Greece decreases in the precipitation rates are found for most of the country with an exception of the western Greece, Peloponnesus and south Crete. During autumn decreases in precipitation rates are dominant over Spain and Italy. Over Greece increases at the precipitation rates are found over west and north regions of the country as well as at the central Aegean Sea.

Conclusions: Climatic and meteorological parameters affecting tree crops are assessed in S. Europe for future years under two different RCPs in order the related uncertainties to be assessed. Moreover, simulations produced by the GISS-WRF provide high-resolution results. Comparison between the RCP8.5 and RCP4.5 outputs suggests an increase in the annual temperature all over the domain according to RCP8.5 while the RCP4.5 estimates an increase only in the western part. Both RCPs suggest an increase in the annual temperature over Spain, where RCP8.5 suggest more than 0.5 degrees higher increases compare to RCP4.5. Over Italy RCP8.5 estimates an increase all over the country while RCP4.5 estimates a small decrease at the central and south parts. In general, annual temperature over Italy under RCP8.5 is 1.0 degree higher compared to RCP4.5. Over Greece RCP8.5 estimates an increase in the annual temperature while RCP4.5 estimates a decrease. In general, annual temperature over Greece under RCP8.5 is 0.75 degrees higher compared to RCP4.5. Annual precipitation over Spain is estimated to decrease up to 40% for both of RCPs with an exception of the coastal zone where RCP4.5 suggests an increase up to 80% for the south coast. Over Italy both RCPs agree to the an annual precipitation reduction up to 20-40% over the northern part of the country while it is estimated an increase up to 20-40% at the south. For the central part of the country RCP8.5 suggests a decrease in precipitation up to 40% while RCP4.5 suggests an increase up to 40%. Over Greece precipitation for both RCPs is estimated to change ±20%. The general trend for both RCPs is a precipitation increase over the land and a decrease over the sea. However, deviations from this trend are found, locally. The high-resolution future climatic conditions provided by the project are of particular interest not only to the scientific community but to the policy makers as well, for supporting their decision to adapt to climate change in other sectors (e.g., energy, water, health, tourism). For this reason, the projections of future climatic conditions in S. Europe have been transferred with presentations in "science for policy" conference-oriented climate change sessions.

Action C.3 Interface development of a software application for accounting tree-crop carbon sequestration

Foreseen start date: 01/01/2017 Actual start date: 01/06/2016
Foreseen end date: 31/06/2018 Actual end date: 30/10/2020

The web-based version of the tree crops CO_2 Removal Capacity Calculation Tool (CO_2RCCT) that was developed by TERRA NOVA in Action C.4, developed by a subcontractor of UEHR. This application is available to the end-users through the web-site of the project. The application is self-sufficient containing information about the tool and brief user instructions. The graphical user interface is self-explanatory permitting its use to all the interested parts.
The web application was developed in three main stages.
In the first stage, an initial version of the CO_2RCCT.xlsx was used as a baseline and the web application was designed and developed in order to recreate the produced methodology of the CO_2RCA. The focus on this stage was to discuss with the partners the visual aspects of the application and to finalize the graphical user interface as well as the functionality provided to the users. In the second stage, a released version of the CO_2RCCT was used to capture the

algorithm in the web application and make sure that both tools (CO_2RCCT and web application) are creating the same results. In third and final stage, the application was tested internally by the subcontractor, TERRA NOVA and Panteion University (UEHR) and the findings formed the basis for corrections and advancements of the application. In this stage, as the application was approaching its release version, the documentation was drafted.
The web application can be used from farmers and policy makers in examining current status and creating scenarios in an easily manageable, user friendly way. The data required is minimum, but the user is permitted to insert farm specific values if available.
The sustainability of the web application is ensured twofold. Firstly, a back-end is designed to provide access to an administration user with a capability to insert new datasets and to update already existing data. Secondly, the lifetime of the application is extended by hosting the web application in a UEHR's subdomain and by ensuring the future support of it with UEHR's funds.
To be able to make long term predictions, a dynamic geophysical model for estimating CO_2 balance in tree crops has been developed by UEHR.
In this spatial-temporal model, the biomass growth rate (C1), the present and future climatic conditions (C2) and the soil characteristics (LUCAS dataset) are used to predict in a monthly time step, the CO_2 sequestration at the spatial level of NUTS 1, 2 or 3.
The model has been developed in the open-source programming language R and it is available in GitHub (both the code and the full dataset) as a package and as a web application (dashboard). So, the web application can be used interactively, to examine various cases, and examine the results online or by downloading the row data. The open-source package on the other side, can be used to make more advanced calculations (more options) or/and use it as a framework in order extend the model, since there are no dependencies. Both options make the model accessible to a broader audience.

Action C.4 Carbon input/output calculation for current and future years

Foreseen start date: 01/11/2016 Actual start date: 01/12/2016
Foreseen end date: 30/06/2018 Actual end date: 30/10/2020

In Action C.4 a specialized algorithm (CO_2RCA: CO_2 Removal Capacity Algorithm) was designed and developed to efficiently and accurately calculate the tree crops' capacity to remove CO_2 from atmosphere. CO_2RCA's design principles provide calculation of the tree crop's carbon balance which is strictly related to atmosphere's CO_2 (CO_2 related carbon). More specifically, it calculates the annual balance between the mass of CO_2 which is captured from atmosphere throughout the biological cycle of the tree to produce new wood biomass as well as fruits biomass, and the mass of CO_2 which is emitted to atmosphere by the applied agricultural practices. Moreover, it calculates the annual CO_2 gain which results by the application of "green" agricultural practices. CO_2RCA was designed and developed by TERRA NOVA in close collaboration with AUA's team as well as with UEHR's team regarding the development of the equations supporting the Soil section.
Based on the CO_2RCA, an e-tool (Tree crops' CO_2 Removal Capacity Calculation Tool [CO_2RCCT]) was designed and developed enabling the calculation of tree crops CO_2 removal capacity under different scenarios (e.g., cultivation practices, trees protection, fuels, energy, etc.).
Specifically, regarding the cultivation of the trees, the following alternative "green" practices were also examined and incorporated into the CO_2RCCT:

- 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.

CO_2RCCT was developed at a pilot scale incorporating 5 tree species (Orange, Apple, Peach, Almond, Olive), in 3 countries (Greece, Italy, Spain). It is translated in English, Greek, Italian and Spanish.

CO_2RCCT 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].

The operation of the CO_2RCCT is supported by an extended back-end database, which includes official statistical data, field experiments results, data provided by agencies and authorities, results of a questionnaire survey performed to Greek farmers by AUA, data by international literature.

CO_2RCCT was developed by TERRA NOVA in close collaboration with AUA's team regarding the currently applied cultivation practices for the 5 pilot tree species, as well as regarding best, "green", practices that could be potentially applied, and UEHR regarding the set-up of the Soil section. Concerning the back-end data base, beside TERRA NOVA and AUA, important data were provided by the scientific teams of UNIBAS and CSIC regarding coefficients for the specific tree crops' cultivation in Italy and Spain respectively as well as statistical data at national scale.

First of all, it has to be noted that although the development and primary testing of the CO_2RCCT was concluded by the 30th of September 2019, the 30th of October 2020 is declared as the Actual End Date because until the end of the project the tool was kept on tested and further improved.

The various runs of the CO_2RCCT revealed the significance of tree crops as a climate mitigation measure. Through a series of appropriate indexes, CO_2RCCT produces results that can be used to efficiently compare alternative cultivation scenarios and potentially applied "green" agricultural practices. These results are useful tools for policy makers to evaluate agricultural policies, assess them and improve them or modify them accordingly towards the direction of promoting "green" and environmentally friendly agricultural practices and enhancing the sustainability of the agricultural sector while simultaneously combating climate change.

CO_2RCA, CO_2RCCT and their results were presented (see Action E.3) to policy makers, agricultural stakeholders and to the scientific community. The so far feed-back by the policy makers and the stakeholders is enthusiastic, since they acknowledge the tremendous potentials arose based on the CO_2RCCT's extracted results. In fact, there are already stakeholders who will use CO_2RCCT to extract results that they will support them to promote policy suggestions to the competent policy makers and authorities.

Action C.5. Suggestions of Climate Change Mitigation Policies and Measures

Foreseen start date: 01/06/2017	Actual start date: 01/09/2017
Foreseen end date: 3/09/2018	Actual end date: 30/10/2020

This action was implemented by the Institute of Urban Environment and Human Resources (UEHR), which developed:

(a) An evaluation and ranking of the sustainable management practices that will contribute to increasing carbon sequestration (Deliverable: Report on policy suggestions for climate change mitigation policies – February 2020).
(b) An "economic module" consisting of a user-friendly methodology, aiming to evaluate the economic benefits arising from tree-cultivation practices that lead towards an increase of carbon sequestration (Deliverable: Economic Module – February 2020).

A set of 13 different management practices were identified, evaluated and demonstrated in order to increase tree productivity per cultivated area and to achieve a better CO_2 balance (i.e. less emissions from cultural management and higher CO_2 sequestration). These practices, which consider the whole life cycle of orchards were evaluated on the basis of a set of relevant indicators/criteria (e.g. CO_2 sequestration, easiness and cost of implementation, impact on farmer's yield/income). The combined used of more than one of these practices was further examined.
Concerning the "economic module", the results of the CO_2 calculation algorithm were initially used (as estimated in the Deliverable of Action C.4) to estimate the crop-specific annual sequestration potential of the selected tree-crops (due to the application of the best farming practices). For this purpose, two scenarios were developed for each tree-crop: (a) a baseline scenario based on current farming practices and (b) an optimal scenario considering the application of a combination of best practices for CO_2 storage.
These values were then converted into monetary ones by using four alternative monetary assessments/valuation methods for (marginal) carbon sequestration values (€/CO_2). Three of these methods, are based on previous (recent) value estimates, which were collected and reviewed to provide up to date knowledge and information about carbon prices. Namely, Emission Trading Schemes (ETS), Voluntary carbon markets (covering a wide variety of global projects, but focusing on the agricultural and forest sectors), as well as various Integrated Assessment Models – IAMs (e.g. DICE, RICE, FUND, etc.) were reviewed to identify the most relevant (to the project's objectives) carbon value estimates. Furthermore, a novel method - developed in this project (Action D.2) - was also incorporated in the economic module in order to specifically address the characteristics of the agricultural sector (i.e. the supply and demand perspective of farmers and consumers, respectively).
By combining the carbon values/prices results with the agriculture-based carbon sequestration (CO_2 algorithm) a set of carbon prices was defined for evaluating various mitigation scenarios. The main outcome of C.5 Action was the estimation of monetary values of CO_2 sequestration in a per-hectare basis for each tree crop, linking thus the cultivation area, the product and the farming practices to the value of the ecosystem service of CO_2 sequestration. Following this analysis, it became evident that the value-added of the best practices is not very diverse among the selected crops, enabling thus the implementation of a common financial instrument for all crops adopting best practices for CO_2 storage. Another important outcome of C.5 Action was the integration of the per-hectare value estimates into a GIS-environment to estimate the aggregate regional and national values under the aforementioned (baseline/optimal) scenarios. Substantial, actual and potential, benefits (by adopting the best practices) from tree-crop cultivations have been demonstrated in all three countries, while the regional differentiation of these benefits was also highlighted.
Finally, a framework with financial instruments, which could be used to support the exploitation of mitigation potential of tree cultivations, was traced. In this context a wide range of economic incentives (direct payments or indirect payments) was delineated. The findings of this action are taken into consideration in Action D.2, when investigating the farmers' potential benefits of CO_2 sequestration (i.e. the overall benefits of the agricultural sector).

The C.5 outcomes can play an important role: (a) in supporting the development of international standards for a relevant to tree-crops sequestration voluntary market, (b) in defining the principles that underline an ecosystem payment vehicle for tree-crops cultivations, (c) in tracing how to incorporate these tools within the framework of the forthcoming CAP, and consequently, in (d) boosting the contribution of the tree-crops sector in reaching the key mitigation goal of the EU for a 30% emissions' reduction by 2030 in the Effort Sharing Regulation

Action D.1. Evaluation of the effectiveness of the proposed policies and measures

Foreseen start date: 01/10/2017Actual start date: 1/10/2017
Foreseen end date: 30/4/2019 Actual end date: 30/10/2020

D1 action was implemented by Università degli Studi della Basilicata (Unibas) and evaluated the effectiveness of the proposed best practices to contribute towards climate change mitigations targets. This have been done controlling the effectiveness of the "best cultivation practices" (BCP) to help climate change mitigation considering also the strategies descripted in the C1 Action deliverable "Best Available Practices Guide for Tree-Crops Carbon Sequestration." The evaluation was based on the following indicators:

- Impact of reduction of Greenhouse Gas (GHG) emissions related to orchard management;
- Improve the potential of agricultural tree crops land use as carbon sink area.

Moreover, the approach foreseen a comparative analysis of CO2 fluxes between "conventional" and "LIFE CLIMATREE BCP" showing potential practices that will be encouraged/discourage through appropriate policies as developed in C5 Action.
The main outcomes of D1 action reported the amount of total GHG emissions avoided an the SOC stock due to BAP application with the aim of helping the orchard management choice of farmers that can be oriented towards the adoption of a sustainable set of practices that includes practices capable of favoring the storage of carbon in the soil.
The D1 action outcomes could have the role of strengthen the significance of measuring C fluxes in fruit tree ecosystems to support the implementation of environmentally friendly policy within the tree crops category and help the conservation or even the improvement of the soil natural capital.
Deliverables: within the D1 Action Unibas produced a deliverable titled "Evaluation of the effectiveness of the proposed policies and measures"(Annexed in this report).
Publications: The significance of the increasing carbon storage into soil (and tree permanent biomass) was discussed and reviewed within an international context through the following publication: Montanaro G., Xiloyannis C., Nuzzo V., Dichio B., 2017. Orchard management, soil organic carbon and ecosystem services in Mediterranean fruit tree crops. Scientia Horticulturae, 217: 92-101, DOI: 10.1016/j.scienta.2017.01.012
Comparing to the foreseen time schedule, the implementation period of D1 Action was extended in 2018 (see LIFE CLIMATREE Amendment Request Letter of December 2018) due to the elongation period of C1 Action that affected the implementation of C5 action as well as all the D actions (Monitoring of the Impact of the Project) Actions. A second extension was request in 2020 due to the coronavirus (COVID-19) outbreak constraints and restrictions (see LIFE CLIMATREE 2nd Amendment Request Letter of March 2020). In details, quality assessment of primary data was carried out by 31 October 2019, the effectiveness indicators of proposed policies were implemented by 01 April 2020 and the report on the evaluation of policy suggestions for climate change mitigation policies was refined and delivered by the 31 October 2020.

No problems were encountered.

Action D.2. Assessment of the socioeconomic impact of the project's output

Foreseen start date: 01/10/2017Actual start date: 01/04/2018
Foreseen end date: 30/04/2019 Actual end date: 30/10/2020

This action was implemented by the Institute of Urban Environment and Human Resources (UEHR), which developed and applied a novel assessment method for estimating the monetary value of the ecosystem service of carbon sequestration, as provided by the tree cultivations. For this purpose, a survey was designed and conducted aiming at identifying the individuals' preferences against CO2 sequestration by agricultural (tree-cultivation) activities. More specifically, consumers' behavior towards a potential ecolabel certification mechanism (for tree cultivations' commodities produced by techniques that maximize CO2 sequestration) was investigated.
The survey questionnaire was designed following extensive meetings among the responsible beneficiary's team design. The selected methodology (evaluation of households' preferences based on actual family's shopping decisions) combined elements of both stated and revealed preference methods aiming at exploring the participants' willingness to pay for eco-certified olive oil. A web-based technology for survey building and collection was used to emulate a paper survey (suitable for face-to-face interviews) in an online environment (i.e. for mobile devices such as tablets and smartphones), by using an open source survey software tool (LimeSurvey).
The survey was conducted during the period November 2018-May 2019. A total of 529 completed interviews were collected. The interviews took place in the two biggest metropolitan areas of Greece (Athens, Thessaloniki), using the supermarket stores as collection points. In particular, 58 stores from 9 different supermarket chains were visited in 15 different areas/neighborhoods in Athens and 7 different areas/neighborhoods in Thessaloniki. The findings of this survey were aggregated at the national level and were also used in a benefit transfer setting in order to estimate the value of carbon sequestration in Italy and Spain (its replication in those two countries was also examined as a possible activity after the end of the Project, aiming at validating the benefit transfer results). After the completion of the survey implementation and the statistical processing and data analysis, the action's report (Deliverable: "Assessment of the socioeconomic impact of the project's outputs", October 2020) was prepared, including the survey results and the analysis of the socio-economic evaluation of the project.
Based on this analysis, Greek consumers are willing to pay an extra premium (of 1.59€/lit) for the certified olive oil, which (on average) corresponds to a price that is 30% higher than the current market price of this product. This higher premium was then used to calculate: (a)the economic value of CO_2 sequestration being a regulating Ecosystem Service (ES). This ES stands to have a value equal to 1270€/hectare/year of olive groves adapting rich mitigation practices. Remarkably this finding is the first contribution in the relevant literature concerning the valuation of CO_2 sequestration in terms of land allocated to the provision of this ES. Such an estimate relates the ES with its actual provider, land-use. Hence permit the delineation of meaningful policy instruments. On the other hand, the value of the ES can be translated to Euros per tons of CO_2 sequestered. The marginal value of carbon sequestration comes up to 256,9€ per ton of CO_2 sequester; based on the algorithm of C4 Action. Remarkably this value is close to the value costs, incurred by CO_2 emissions, as estimated by Stern report. LIFE CLIMATREE. Similar estimates were obtained (by using the benefit transfer method) for the other two countries (Italy, Spain). So, an important outcome of D.2 is that society attributes

a significant value to nature-based mitigation actions arising from tree cultivation, which is also much higher than the current carbon markets' prices (i.e. carbon offsets traded in compliance or voluntary markets). These benefits can be transferred to the rural areas through properly designed financial instruments, providing economic incentives to farmers in order to internalize this positive externality. Therefore, D.2 outcomes can play an important role on providing recommendations to national governments and/or EU institutions (policymakers) on how to design and adopt the most efficient incentives (economic instruments) for carbon sequestration of tree crops, promoting thus the transition to a sustainable low carbon agriculture. Estimates, concerning monetary valuation of CO2 sequestration by tree cultivations, will be published in the Journal of Sustainable Production and Consumption in a forthcoming (2021) paper entitled "Managing tree-crops for climate mitigation. An economic evaluation trading-off carbon with marketed goods".
It should be also noticed that the questionnaire survey has also an important contribution as an awareness raising activity/tool for the general public on the potential contribution (benefits) of tree-crop cultivations to climate mitigation.

Action D.3 Assessment of the impact of the proposed methodology in supporting the ecosystem function restoration

Foreseen start date: 1/10/2017 Actual start date: 1/10/2017
Foreseen end date: 30/04/2019 Actual end date: 30/10/2020

Tree crops supporting ecosystem services
Woody perennial crops have the potential to provide several ecosystem services in addition to the fruit production. Because of their perennial nature, in contrast with herbaceous crops, trees can accumulate and store CO_2 in their woody structure. However, in fruit tree crops, it is not possible to seasonally decide where to plant the crop or not depending on the availability of resources. This is important under scarce water conditions, such as in the Mediterranean area. Because of this, in order to properly assess the impact of restoring ecosystems with tree crop plantations is necessary to carry out a concomitant analysis of carbon fixation and water use. The impact assessment of woody perennial crops for the ecosystem function (i.e. carbon accumulation) has been obtained under two scenarios: 1) under no limitations of water restrictions and for a citrus orchard eastern Spain, and 2) by assessing responses to different water availability regimes in almond trees. These scenarios were selected because they are considered fully representative of the main tree cultivation options. In fact, Citrus trees are planted in 395,000 ha in the EU, of which 60% are located in Spain. They are an evergreen crop with high potential for CO2 fixation in their permanent structure and citrus trees are sensitive to water stress and their performance and survival relies on the application of external water resources by irrigation. On the other hand, almond is the most important fruit crops in extension with 743,000 ha of which 82% are located in Spain. In addition, the area covered with Almond is expanding because the high commercial value. It is a resilient crop, that can be managed under different watering regime.

1. Scenario 1. Increase the plantation under no restrictions of irrigation

In the Mediterranean countries' coastal areas, the initial suggestion is to plant evergreen trees because of their high potential for carbon fixation in their structure. However, in order to proceed with his suggested ecosystem restoration action, it is required to properly identify the potential gain in CO_2 fixation and the associated water consumption costs. In this sense, the objective of the activities carried out within the LIFE CLIMATREE project was to quantify

and assessing carbon fixations and water consumption in a citrus trees orchard.
Data were obtained during three growing season at a 400-ha commercial farm planted with Hernandina mandarin (Citrus x clementina, hort. ex Tan) grafted onto Carrizo Citrange (Citrus x sinensis, Osb. 3 Poncirustrifoliata, Raf.). The orchard was located in eastern Spain (39°27'15" N, 0° 33'32" W), at 105 m above sea level. The area is characterized by a Mediterranean climate with warm, dry summers and mild winter conditions with an average annual reference evapotranspiration (ETo) and rainfall of 1.100 and 500 mm, respectively.
The commercial plot was flat and drip-irrigated during the growing season, with 6 self-flushing pressure compensating on-line emitters set to irrigate at a rate of 4 l h-1 per tree, arranged in two lines. The trees were mature, with an average height of 2.80 m and the area shaded by the canopy was 66% of the allotted spacing. Soil was sandy loam in texture. Irrigation was applied daily to fulfil crop evapotranspiration (ETc). Sensible heat (H), latent heat (·E) and carbon (Fc) fluxes were measured by EC equipment installed at a height of 6.5 m on a scaffold, placed in the center of the plot.
Net ecosystem carbon fluxes (FNEE) was then computed from the 30-minute Fc fluxes (after performing gap filling) by calculating the average daily and monthly fluxes.
The measured evapotranspiration (ETc, water consumption rates) ranged from 0.03 to 4.27 mm/day. Mean annual ETc values were 1.88±0.79, 1.53±0.62 and 1.81±0.84 mm/day in three experimental seasons under evaluation. The daily F_{NEE} ranged between -11.8 and 13.5 g CO_2/m^2/day, -15.5 and 18.9 g CO_2/m^2/day and -16.7 and 22.3 g CO_2/m^2/day in each of three experimental seasons, respectively (data not shown). Based on a complete analysis of one year of data the citrus orchard fixed 3.855 kg CO_2/ha/year, demonstrating its ability to fix carbon. The orchard reduced its net assimilation and *WUE*, acting as a carbon source during the rainiest period of the season. It was concluded that the seasonal carbon fixation by a citrus orchard was found to be around 3.855 kg CO_2/ha/year at a cost of evapotranspiring (consuming water) of 6970 m^3/ha.

2. Scenario 2. Increase the plantation under low availability of water resources

The trial was carried out in an almond plot (*Prunus dulcis* var. "Belona") located on the "Las Dehesillas" farm, belonging to the municipality of Hellín (Albacete) (38º 22 '58.18' 'N, 1º 30 '32.72' 'Or, 500 masl). With an annual precipitation in the last five years of only 268 mm. The duration of the trial covers the period between 2018 and 2020. In the trial, several deficit irrigation treatments were applied in order to obtain the water productivity as total biomass yield versus water application. A total of 10 treatments were applied a summarized in Table 1 combining: i) different irrigation regimes (100, 60 and 30% of the estimated crop evapotranspiration (ETc) and a regulated deficit irrigation (RDI) where stress was only imposed during the kernel filling ii) one or two drip lines installed and iii) a soil management consisting of having a bare soil or a cover crop installed in the inter-row orchard. The cover crop consisted of a mixture of plant leguminous and grass species

Treatment	**Irrigation Regime**	**Number of drip lines**	**Soil management**
T0	100% ETc	2	Bare soil
T1	60% ETv	2	Bare soil
T2	60% ETc	2	Cover crop
T3	60% ETc	1	Bare soil
T4	30% ETc	2	Bare soil
T5	30% ETc	2	Cover crop
T6	30% ETc	1	Bare soil

T7	RDI	2	Bare soil
T8	RDI	2	Bare soil
T9	RDI	2 -1	Bare soil

Table 1. Summary of the different management options employed in the almond trail.

The effects of the management options carried out during the three seasons was quantified at the end of the project activities during August 2020 taking advantage of the project extension granted. All deficit irrigation treatments applied reduced yield with respect to the control (Table 2). However, the deficit irrigation regime applied were able to improve water productivity (Table 2). Therefore, biomass production by each unit of water can be improved when deficit irrigation is applied.

Treatment	**Irrigation applied (mm)**	**Yield (kg/tree)**	**Water productivity (kg/m3)**
T0	400	11,1a	0,79
T1	237	9,9ab	1,19 (+50%)
T2	213	7,9bc	1,06 (+33%)
T3	204	10,6ab	1,48 (+87%)
T4	104	8,0b	2,20 (+177%)
T5	114	6,5c	1,63 (+105%)
T6	124	7,2bc	1,66 (109%)
T7	140	8,5b	1,73 (+218%)
T8	142	9,1b	1,83 (231%))
T9	172	9,0b	1,50 (188%)

Table 2 Summary of the effects different management options employed. Different letters indicate statistically significant differences at $P<0.05$.

Particularly the RDI strategy investigated was particularly effective in increasing water productivity and therefore can be proposed as an ecosystem function restoration practice to ensure fixing atmospheric CO_2 with limited water resources. This is because the RDI is an irrigation strategy where the water restrictions are imposed only in those phenological periods less sensitive to water restrictions. On the other hand, the use of cover crops cannot be suggested as an ecosystem function restoration in semi-arid climates because it reduced the allocation of yield biomass in comparisons with bare soil conditions (Table 2). The use of a single drip line in comparisons with the standard approach of having two drip lines per tree row, yielded not conclusive results because while under 60% ETc regime it allowed increasing water productivity but the opposite was found under 30% ETc

For a more in-depth analysis of the effects of the different practices on the ecosystem function, in Table 3 it is reported the vegetative growth and indexes for allocation efficiency. It is important to note how the all the deficit irrigation strategies reduced canopy diameter but clearly increased the reproduction efficiency evaluated using the yield by trunk cross sectional area index.

Treatment	**Tree canopy diameter (m)**	**Relative trunk growth (%)**	**Yield/TCSA (Kg/cm2)**
T0	4,07a	85,1a	2,23a
T1	3,52b	70,7b	2,50ab
T2	3,32c	78,2b	3,14bc
T3	3,42b	59,0c	2,34ab

T4	3,42b	77,8b	3,10b
T5	3,28c	84,4a	3,81c
T6	3,38bc	77,0b	3,44bc
T7	3,62b	83,5a	2,92b
T8	3,67b	62,9c	2,72b
T9	3,36bc	76,3bc	2,75b

Table 3. Summary of the different management options employed in the almond demo trail on tree vegetative biomass growth and the ecosystem functioning partitioning function Yield by Trunk Cross Sectional Area (TCSA).

Under conditions of water scarcity, the use of a regulated deficit irrigation strategy was the most convenient for increasing water productivity. This allows increasing the efficiency of carbon fixation under conditions of limited availability of water resources. In inland areas and under conditions of limited water resources, as an ecosystem function restoration strategy, it is therefore suggested to crop almond trees under regulated deficit irrigation resulting in very significant water savings.

Action E.1 Creation of project's logo

Foreseen start date: 16/07/2015 Actual start date: 01/09/2015
Foreseen end date: 30/09/2015 Actual end date: 16/10/2015

No major problems have been encountered for this Action. The design of the official LIFE LIFE CLIMATREE logo was successfully completed and was used in all project's deliverables, reports and dissemination material.

Action E.2 Development, launching and maintenance of project's website

Foreseen start date: 16/07/2015 Actual start date: 01/10/2015
Foreseen end date: 28/06/2019 Anticipated end date: 30/10/2020

The design of the website and the development of its content started in October 2015. Once completed, the LIFE CLIMATREE website offers information about the project and its actions, the beneficiaries and the activities during the implementation of the project. In addition, it contains useful links and links to the official Facebook page and Twitter account of the project.
Within the website a dedicated blog has been developed where questions or subjects related to the project will be uploaded in order to initiate a dialogue with interested parties.
The statistics regarding the use of the Project website (visits, page views, etc.) are provided by Jimdo (platform which was used for the development of the Project website). From the 25th of May 2016 Google Analytics are also used for the counting of the website's activity. Thus, the statistics regarding the LIFE CLIMATREE Website are provided by Jimdo platform for the time period until May 2016 and from that date on they are provided by Google Analytics.
Until the end of the project, 4,404 visitors of the LIFE CLIMATREE website had been recorded with 11,667page views (average of 2.65page views/ visit). Home page was the most visited (2,773 times by 2189 visitors) followed by "The project" section (1,168 times by 364 visitors).
The website features the budget, EC contribution and an explicit acknowledgement to the support of the LIFE financial instrument of EU.
LIFE CLIMATREEs' website was designed, developed and launched at the following web

address: www.lifeclimatree.eu. The website is maintained by TN with the contribution of all beneficiaries and will continue to operate for at least 5 years after the end of the project.

Action E.3 Dissemination of project's progress and results

Foreseen start date: 16/07/2015	Actual start date: 16/07/2015
Foreseen end date: 28/06/2019	Actual end date: 30/10/2020

The Dissemination strategy (Annex F.3.1 of the Mid Term Reports) focused on two groups of relevant stakeholders: a) decision and policy makers at the European and National levels in relation to climate and agricultural policies, b) Farmers and stakeholders from the sectors of agriculture and crop cultivations. From the first months of the project the coordinating team met with DG CLIMA in order to investigate priorities concerning the inclusion of the LULUCF sector. Immediately after that the national authorities and related stakeholders were contacted in all, three, countries. Mrs. Vitullo Marina in Italy, Mr. Iordanis Tzamtzis in Greece and Mr. Juan José Rincón Cristobal in Spain were contacted in order to systematically address the needs of NIR's by the LIFE CLIMATREE actions. While all these actions concerned the climate aspects of LIFE CLIMATREE, the agricultural aspects seek their dissemination with contact with high level stakeholders. The National Institute of Agriculture (Hellenic Agricultural Organization - HAO) as well as the Ministry of Agriculture were contacted. Specifically, Prof. Serkos Haroutounian, Mr. Ioannis Spanos and Prof. Kostas Bithas presented LIFE CLIMATREE as well as the CO_2 Removal Capacity Algorithm, its results and its potential applications to the Minister of Agriculture Mr. Arahovitis in 2018. Furthermore, the above were presented by Prof. Haroutounian twice (the second one was in the context of the Thessaloniki International Fair 2019) to the former Minister of Agriculture, Mr. Voridis. Additionally, an operational working meeting was organized with the director in charge for the design of the forthcoming CAP in 2020 organized by EASME with the participation of stakeholders and decision makers. In this meeting Prof. Kostas Bithas and Prof. Petros Roussos presented the findings of LIFE CLIMATREE. Next, the General Secretary of the Ministry of Agriculture, Dr. K. Baginetas, participated in the final conference of LIFE CLIMATREE in order to get familiar with the policy implications of LIFE CLIMATREE. Currently, the beneficiaries of LIFE CLIMATREE support with expertise the "design" of the new CAP. In this context, a workshop is currently planned with the participation of Dr. K. Baginetas and the Unit of Environment, Planning and Climate Change. This workshop will streamline the findings of LIFE CLIMATREE to feed the design of carbon farming schemes in Greece. As a result, a strategic collaboration with the Ministry of Agriculture, Greece, has been established focusing on the design of coupled agricultural-climate policies under the inspirations of the new CAP and the Green Deal. Towards the same direction a strategic collaboration was established with the Bank of Greece, Unit of Climate Change. This Unit has developed a high number of climate relevant activities and participate as a key beneficiary in the LIFE IP Climate Adapt. The Bank of Greece (BOG) participated with a presentation in the final conference of LIFE CLIMATREE. The strategic collaboration with the Bank of Greece will be fully explored for the implementation of the After- LIFE Plan since BOG is high influential actor. The After -LIFE Plan will be supported by the strategic collaboration with HAO. This national organization will incorporate the findings of LIFE CLIMATREE in its standard education program targeting farmers and agriculture consultants. Several meetings have been organized with experts of HAO and especially with the unit of Education and the Institute of Soil. Furthermore, in collaboration with the Institute of Soil two projects proposals have been developed to address the still remaining gaps in the exploitation of mitigation potentials.

Moreover, the CO_2RCA, the CO_2RCCT (.xlsx) and the Deliverable of Action C.4 were communicated to:

- the Climate Change departments of the Hellenic Ministries of Environment and Agriculture, as well as to the Secretary Generals of the two Ministries
- Mr. Janusz Wojciechowski, Commissioner of EU Directorate General AGRI (Agriculture and Rural Development)
- Mr. Frans Timmermans, Executive Vice-President of EU Directorate General CLIMA (Climate Action)
- Mr. Virginijus Sinkevicius, Commissioner of EU Directorate General ENV (Environment).

Finally, the Deliverable of Action C.4 and the CO_2RCCT were presented and sent to the Hellenic Association of Young Farmers, which expressed increased interest to use it for extracting measurable data and consequently arguments to promote "green" agricultural practices to its members.

Two significant milestones for the Dissemination Activities were the LIFE CLIMATREE meetings of Matera and Madrid. A number of national and local stakeholders were informed. Especially the Madrid meeting resulted in significant dissemination impacts as the results of the project were relatively more mature (Ministries Agricultural Ranks, Unions of Farmers etc.).

CO_2RCA) has been presented by Mr. I. Spanos/TERRA NOVA at the following Conferences:

- CLIMATICO 2019 International Conference, 12.4.2019, Limassol, Cyprus
- EFITA-HAICTA-WCCA International Congress, 29.6.2019, Rhodes, Greece

The CO_2RCA and the final/current version of the CO_2RCCT, its extracted results as well as its application potentials will be presented by Mr. I. Spanos at the EFITA 2021 International web-Conference.

The last period of the project, the period of 2020, focused on an intensive dissemination with stakeholders seeking the incorporation of LIFE CLIMATREE findings in the forthcoming CAP as well as the inspiration of voluntary initiatives such as voluntary CO_2 markets and ecolabeling schemes. In this context, LIFE CLIMATREE was presented in the webinar series: Climate neutral food and wood. Soon after that the final e-conference of LIFE CLIMATREE took place on 22 October 2020. The meeting met considerable success and induced a series of dissemination activities. Ten editions of the YPAITHROS XORA newspaper had released concerning the findings of LIFE CLIMATREE. One edition of NEA newspaper presented LIFE CLIMATREE. These actions induced a broad communication to farmers and stakeholders in rural areas. These activities, among other impacts, have supported the preparatory actions towards the development of a voluntary CO2 market, in Greece.

Overall, the dissemination Activities reached a high peak in the last year of LIFE CLIMATREE exploiting its extension until the 30th of October 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 been participating in the dissemination pool. This pool will continue to be influenced by the after-LIFE activities.

It is worth mentioned that due to the extension of the project, the intensive of the dissemination activities and the implication of the Covid-19 on the necessity of the electronic equipment, the budget of this Actions has been overcome the originally foreseen one.

Action E.4. Development of project's notice boards

Foreseen start date; 1st Set: 30/06/2016; 2nd Set: 28/04/2017
Actual start date; 1st Set: 30/06/2016; 2nd Set: 28/10/2017

Foreseen end date; 1st Set: 30/06/2016; 2nd Set: 28/04/2017

Actual end date; 1st Set: 30/06/2016; 2nd Set: 28/10/2017

The design and installation of the 1st set of Notice Boards took place in the 12th month
The 2nd set took place in the 10th of 2017 and this small delay was taking place in order to incorporate some basic results from the implementation of C Actions.
No other major problems have been encountered for this Action.

Action E.5 Development of Layman's Report

Foreseen start date: 01/02/2019 Actual start date: 01/06/2019
Foreseen end date: 30/06/2019 Actual end date: 30/10/2020

The Layman's report has been drafted at the last months of LIFE CLIMATREE in order to incorporate the very updated findings as well as to raise the policy implications arising from the recent development in the forthcoming CAP. The Layman's report mainly targets agricultural stakeholders and seeks the exploitation of the mitigation potentials of tree cultivations. Farmers, Unions, agronomists and consultants as well as regional and national authorities are communicated the findings of the project in an operational way. The mitigation rich cultivation methods are demonstrated. The use of the tool established by LIFE CLIMATREE is presented and its potential as a standard method for assessing CO_2 sequestration is presented. LIFE CLIMATREE seeks the broader possible distribution of the Layman's Report under the constrains impact by Covid-19. As a result, the Layman's Report (LR) will be distributed as hard copy with the YPAITHROS HORA newspaper, in Greece. This ensures the broad distribution of LR on farmers and stakeholders. HAO, the state institute of Agriculture, in Greece, will upload the Layman's Report in its educational site; all beneficiaries will upload the report in their websites. LR will be available online through the project's website.

Action F.1 Project management by UEHR

Foreseen start date: 16/07/2015 Actual start date: 16/07/2015
Foreseen end date: 28/06/2019 Actual end date: 30/10/2020

The Kickoff meeting of the Project took place on the 7th and 8th of October 2015 following the signature of the Partnership Agreements in September 2015. Apart from the short delay in the installment of the 1st prefinancing caused by the Greek banks' dysfunction of the 2015 summer, no serious problems have emerged for the initiation of the project.
The Project Management team established a constant communication with all the participating Beneficiaries through emails, telephone contacts, skype meetings, working groups and regular team meetings in order to certify the successful implementation of necessary managerial, administrative and financial documentation, the proper development of the project's progress and the production of the project's deliverables in line with the approved time schedule. As a result, all partners submitted on a monthly basis their progress in line with the Actions which are under implementation. An aggregate report of all LIFE CLIMATREE's works for each month was then submitted to the LIFE External Monitor.
Two interim progress reports have been submitted and useful comments from the supervising authorities have been received. The actual workload of the project required the extension at a period of one year, until June 2020. In addition, the implication of Covid-19 resulted in an additional need of a further extension until 30/10/2020. All these adjustments imposed an additional burden in the project management by UEHR. The coordinating beneficiary

successfully managed the project in the extended periods following cost-effective management methods result in only marginal additional, other than those foreseen, costs.

Action F.2 Monitoring of project progress

Foreseen start date: 16/07/2015	Actual start date: 16/07/2015
Foreseen end date: 28/06/2019	Actual end date: 30/10/2020

A Quality Assurance/Quality Control System was developed in order to monitor the progress of the implementation of the LIFE CLIMATREE project. A QA/QC Committee was established at the kickoff meeting, the QA/QC manual was formulated by the Committee and submitted with the 1st Mid-term report. The Committee consisted of one representative of each project beneficiary. Its role was to assist the task of project monitoring by completing and evaluating the corresponding report.
We have not encountered any remarkable problems for this specific Action.
4 QA/QC reports have been submitted including the one (Final) submitted with the final report. Furthermore, the Deliverables of actions, A, C and D were reviewed by the coordinating beneficiary accompanied by relevant members of the scientific committee. This review process established a quality control focusing on the interconnections and interdependencies of A, C and D Actions.

Action F.3 Networking activities with other relevant EU projects

Foreseen start date: 16/07/2015	Actual start date: 16/07/2015
Foreseen end date: 28/06/2019	Actual end date: 30/10/2020

Since the initiation of the Project, LIFE CLIMATREE's team has applied a structured networking strategy with other relevant projects and key stakeholders. The objective is to maximize the Operational Application of the project in the EU level by exchanging information and outcomes with other relevant projects and key actors. Main networking activities so far include the establishment of contacts with the following LIFE Projects: LIFE Olive Clima, LIFE Organiko, LIFE ECOCITRIC, LIFE IPNOA, ADAPT2CLIMA etc. An important networking action is the establishment of operational contact with the European Agroforestry Federation (http://www.agroforestry.eu) who were also invited and actively participated in the MATERA meeting (8-11/3/17). In addition, LIFE LIFE CLIMATREE participated in LIFE IPNOA's (LIFE11 ENV/IT/000302) final workshop in Pisa, Italy. UEHR and CSIC also participated in the closing workshop of LIFE ECOCITRIC Project (LIFE13 ENV/ES/000889) in Spain. UEHR organized of two working meetings in Rome (7/3/2016) with: LIFE OLIVE4CLIMATE, LULUCF Italy (Ispra Ambiente Institute) and LIFE MEDINET.
During 2017 LIFE CLIMATREE networked with LIFE DAIRY CLIM and LIFE IRRIMAN+ while during 2018 with LIFE FOREST CO2 participating in its addressing meeting in Murcia, Spain (February 2018).
The collaboration with MEDINET and OLIVE4CLIMA took substantial forms with systematic exchange of data, methods, models and most important ideas. This is reflected partially in the submission of LIFE CLIMATREE participated in the meetings of MEDINET in Lisbon and in Viterbo, with operational presentations. Finally, LIFE CLIMATREE were presented as a key-project at the final conference of LIFE OLIVE4CLIMA took place in Perugia on 3 December 2019.

Action F.4 Development of project's After- LIFE Plan

Foreseen start date: 01/02/2019	Actual start date: 01/06/2019
Foreseen end date: 30/06/2019	Actual end date: 30/10/2020

The after-LIFE Plan aims at the following objectives:

- Enhance and enrich the novel methodology permitting estimates of CO_2 balance
- Disseminating further the findings of LIFE CLIMATREE
- Inducing behavioral changes of farmers; adapting mitigation rich practices.
- Supporting the incorporation of the findings within the forthcoming CAP
- Inspiring mitigation incentives outside CAP, through ecolabeling schemes and CO_2 voluntary markets

The coordinating beneficiary in collaboration with the Agriculture University of Athens are designing field experiments in order to create additional data concerning CO_2 sequestration from soil and biomass. These data will be used to enrich the model developed in C3 Action and the algorithm developed in C4 Action. Different cultivation methods are tested in the Olympia, Western Greece, with the collaboration of volunteer farmers, and premises belonging to the coordinator of LIFE CLIMATREE. As a result, standardized experiments will contribute to the robustness of the CO_2 balance methodology. HAO and Prof. Petros Roussos of Agriculture University, are essential supporters of these experiments. HAO will contribute to the development of education programs for farmers and agricultural consultants. Education activities have been planned in Spain and Greece, and this experience will be exploited to design education actions in Italy. In Greece, specifically, the collaboration with HAO makes room for the development of a standard education program for farmers and consultants. CSIC is designing a similar plan for the region of Murcia. Next, the findings of the project will be disseminating with coordinated actions in conferences, scientific and policy relevant journals, to enrich the knowledge of the scientific community. A major objective of the After-LIFE Plan is the influence of new CAP to meet climate targets. Novel instruments, such as carbon farming and ecolabeling schemes can facilitate climate targets. LIFE CLIMATREE findings will support the realization of carbon farming schemes by offering CO_2 balance evaluation and CO_2 sequestration certification methods. Close consultation with the Agricultural Authorities, especially in Greece, make possible the realization of carbon farming schemes for tree cultivations. Furthermore, the After-LIFE Plan envisages also private, close to market, initiatives. The realization of a CO_2 voluntary market for the mitigation potentials of best cultivation practices is under consideration in Greece. The partnership includes private banks and private companies with expertise in agriculture, farmer unions, consultants and research centers.[2] Although the impacts of the pandemic have caused significant delays, we expect that within 2022 a voluntary CO_2 market will be initiated to support the exploitation of mitigation potentials. In this context, gaps in certification standards and process are addressed. Towards this objective in close collaboration with the University of Perugia, the coordinator of OLIVE4CLIMA, we delineate the development of a Mediterranean initiative. Among others this initiative incorporates the submission of two proposals (CARECROPS, GEOCARBON) in the LIFE 2020 calls. these projects seek the geographical expansion of the CO_2 voluntary market, beyond Greece, by incorporating stakeholders from Italy, Spain and Portugal.

Furthermore, the after-LIFE Plan incorporates standard activities such as:

- The maintenance of the LIFE CLIMATREE site for at least 5 years after the end of the project.
- The availability of the e-tool and C3 model, with free access, through the website of LIFE

[2] Agreement for confidentiality prevents the inclusion of identities within the Final Report.

CLIMATREE and the website of the coordinating beneficiary for, at least, 5 years and 10 years, respectively.

- The distribution of the Layman's report in conferences, workshops and other events.

All the activities have been adjusted to facilitate the new conditions imposed by the constrains induced by the pandemic of Covid-19.

6.2 Main deviations, problems and corrective actions implemented

LIFE CLIMATREE has been an extremely demanding project whose implementation required well-coordinated actions. The ambitious objectives required an effective implementation plan including feedback mechanisms and, accordingly, re-scheduling processes. The ultimate target was the achievement of the basic objective: the evaluation and demonstration of the mitigation potentials of tree cultivations. During the implementation of the project several modifications and deviations were undertaken in order to effectively achieve its objectives. Major deviations were requested and approved. Minor deviations were decided by the coordinator Prof. K. Bithas following requests and proposals of the beneficiaries. Minor deviations mainly concerned: rescheduling the duration of the Actions in order to facilitate better interconnections under unexpected constrains and delays, rescheduling the workload of the Actions in order to have an effective allocation of the available resources. Minor deviations were the outcome of the major deviation and the long period of the project implementation. Minor deviations were necessary to create a hospitalized setting for all beneficiaries, a setting permitting concentration on the actual progress of the project and achievement of objectives. It is worth mentioned that the larger period of the project together with certain unexpected constraints induced, in some cases, cost higher than those defined in the budget approved. These costs, when feasible, were undertaken by the beneficiaries. The major deviations induced by two unexpected events; first, the weather conditions at spring 2017, and second the constraints imposed by the pandemic COVID-19.
The spring of 2017 had high precipitation, both in intensity and duration, as well as it was relatively cold with remarkably lower temperatures than those prevailing this time of the year. These conditions were present in the areas where measurements and interviews with farmers had been planned. Indicatively, the harvesting period of orange and apple orchards had been delayed influencing data collection and analysis.

This induced a further delay on the gathering of the supplementary data for the agricultural activities through the survey research with farmers. The elongation affected the implementation of Actions C.3 and C.4 that aim to develop the software application (Action C.3) reflecting in an operational way the CO_2 Removal Potential Algorithm (Action C.4) respectively. The implementation of D Actions were also affected.
In this context, after the monitoring visit period in Athens at 20/07/2018 and in co-ordination with the Project Adviser Mrs. Hanna Mandelikova we lounged an official request for a prolongation by one additional year. This request was approved and the project extended until 28/06/2019.
As we were stepping at the final period of the year the impacts of the COVID-19 pandemic hit the activities of LIFE CLIMATREE and especially those concerning the dissemination including the organization of the final conference. The new reality was obvious during the monitoring visit on 11 March 2020, taking place in Athens. Under the impacts of COVID-19 in Italy and Spain and the foreseen problems in Greece the managing committee decided to ask for an extension until 30/10/2020. The objective of this extension was to re-design the

dissemination activities under the impacts of the pandemic and to seek new ways to disseminate the project results. The organization of the final meeting was among the major challenges under the new constraints. The request approved and the project exploited this period both on finding effective ways to disseminate findings as well as to edit and finalize all major Deliverables included the algorithm and the e-tool. The achievement of this last period justifies this extension as the dissemination activities mounted during this very last period. The perfect timing, induced by the needs of the new CAP to develop carbon farming and ecolabeling schemes, permitted essential dissemination activities to take place. .

It has to be underlined that the design, development, testing and optimization of the CO_2RCA and the CO_2RCCT proved to be substantially time demanding and labour intense in terms of scientific personnel engagement, a fact that actually was not foreseen at the proposal stage of the project. Nevertheless, the final result compensated the efforts allocated to this purpose. It is worthy to mention that 51 draft versions of CO_2RCCT were developed prior to its launching on the project's website. Even then, CO_2RCCT was kept on being optimized based on remarks and comments of the project's scientific team as well as by stakeholders and other scientists. Today the 14th released version of CO_2RCCT (.xlsx) is uploaded to the project's website and is freely available to any interested scientist, stakeholder or policy maker.

Compared to the foreseen time schedule, the implementation period of C.5 action was extended in 2018 (see 1st LIFE CLIMATREE Amendment Request Letter – December 2018) due to the elongation/prolongation period of C.1 Action that affected the implementation of C.4 Action (CO2 calculation algorithm), which was also essential for the current action (C.5). A second extension was given in 2020 due to the coronavirus (COVID-19) outbreak constraints and restrictions (see LIFE CLIMATREE 2nd Amendment Request Letter – March 2018). Based on these extensions, the two action's reports were refined and delivered by the 29th of February 2020.

It should be noticed that one of the original aims of the economic module (developed in action C.5) was to evaluate the effectiveness of the proposed policies and measures in action D1. However, during the implementation stage of C.5 it was concluded that: (a) mitigation practices in different tree cultivations have quite similar economic benefits (added value), (b) future policy implementation requires that the marginal benefits from climate change mitigation should be linked to the cultivated area (hectares) and should avoid the rigid of over-specialization. As a consequence, the proposed policies/measures in D1 were decided to be evaluated based on the "environmental" indicator of CO_2 sequestration, and additionally, to suggest in action C.5 various economic incentives (direct payments or indirect payments) that can be used alternatively or conjunctively to achieve certain cultivation scenarios that have been evaluated and prioritized in action C.5 (see deliverable: Report on policy suggestions for climate change mitigation policies).

Action D.2 started on April 2018, following a required extension of the implementation of actions C.1, C.3, C.4 and C.5 (see 1st LIFE CLIMATREE Amendment Request Letter – December 2018). A second extension was given in 2020 due to the coronavirus (COVID-19) outbreak constraints and restrictions (see LIFE CLIMATREE 2nd Amendment Request Letter – March 2018). Based on these extensions, the action's report was refined and delivered by the 30th of October 2020. It should be also noticed that according to the initial plan, the questionnaire survey after the pilot implementation in Greece (i.e. upon its completion and its statistical processing and data analysis) would be replicated in Italy and Spain. However, as the survey results were generated in late January 2020, this activity was actually cancelled a few weeks later, due to the COVID-19 pandemic (since in-person interviews were not possible due to restrictions on movement and social distancing). A benefit transfer method

was followed to overcome this problem, while a replication process is planned in those two countries after the end of the Project, as a validation of our benefit transfer method.

6.3 Evaluation of Project Implementation

Action	Foreseen in the revised proposal	Achieved	Evaluation
Action A.1. Selection and analysis of tree-crop categories in S. Europe	Objectives: To identify the prominent tree-crops of S. Europe with regard to their characteristics defining their carbon sink potentials as well as their GHG emissions. Expected Results: The formation of clusters of individual tree-crops with regard to their biological, cultivation, and climatic zone characteristics.	1.A comprehensive framework for the assessment of Tree Crops Ecosystem Services (ES), complemented by a set of potential indicators for the enumeration of ES 2. A methodology for the clustering of Tree Crops, that concluded to 4 major clusters	Though this action exhibited a significant prolongation, fully met its objectives within the prescribed budget limitations. Moreover, this prolongation presented crucial benefits enabling the partially overlap with C.1 Action, thus ensuring coherency between the results and the prerequisites for LIFE CLIMATREE's objective materialization.
Action A.2. Adjustment of the "Land use, land-use change and forestry (LULUCF) Methodology" to the environmental problem targeted	Objectives: To offer improved estimates of CO_2 balance in permanent tree crops taking into account the high inherent uncertainty of current LULUCF accounting system To determine CO_2 balance in permanent tree crops was a gap for accounting emissions and removals in the current LULUCF framework. Expected Results: More accurate estimation of CO_2 balance in tree-ecosystems.	- Identification of potential contributions to the LULUCF methodology -Important processes defining the CO_2 balance have been traced. Soil functioning was one of the key processes which was almost "ignored" in LULUCF based accounts. We made a first attempt to study in Italy the CO_2 carbon balance. -Carbon balance based on the Net Ecosystem Carbon Balance which includes CO_2 soil emissions and carbon inputs to ecosystem. The relevant findings published as LIFE CLIMATREE outcome (https://doi.org/10.1016/j.agee.2016.05.031)	The Action A.2 started on time (October 2015) and it was being implemented without problems or delays. The main objectives (deliverable and milestone) of the Action have been reached.
Action A.3. Analysis of climatic, environmental and socioeconomic parameters of tree-crop categories in	Objectives: To examine the current status of tree crop categories in S. Europe assessing the parameters interconnected with them	-Collection of environmental/ climatic and socioeconomic data for Greece, Italy and Spain -Database with the parameters influencing tree crop in these countries	The Action was successfully initiated following the selection of the main tree crop categories defined in Action A.1. The extension of Action A.1 suggested a two-month extension of Action A.3 in order to incorporate A.1 inputs in environmental parameters

S. Europe	Expected Results: Detailed description for the environmental, climatic and socioeconomic parameters influencing the selected tree crop categories in S. Europe. The findings defined the "current state conditions".	-Report on the climatic, environmental and socioeconomic parameters relevant to tree crops	affecting tree crop cultivations. The final report of Action A.3 was completed in May 2015 with, a minor, 2-month delay.
Action C.1. Life Cycle Assessment of carbon cycle in tree-crop categories	Objectives: Action C.1 was one of the core actions of LIFE CLIMATREE and aimed at the development of a novel methodology for the estimation of CO_2 balance of tree cultivations. The methodology based on data and information readily available at the national level in order to have a direct operational appeal. The methodology took into account, but it was not constrained, the IPCC methods for CO_2 accounting Expected Results: An operational methodology for estimating CO_2 balance was delineated. The methodology reflects not only the relevant biological process but the manmade inputs such as cultivation methods and technical factors. As a result, the methodology attempted a kind of Life Cycle assessment for tree-crops taking into account the framework of the CO_2 estimations and paying particular attention to avoid double counting of CO_2 emissions and removals. Based on the methodology the Best Available Practices was defined.	This Action has been produced: -A complete list of the variables affecting carbon sequestration, their definition and the methodology to assess their effects -A literature review report on those variables -An experimental calculation of those variables numeric value -A report on the significance of each variable against the MESA most important functions	Weather conditions at spring 2017 delayed data collection and analysis. This induced an extension of C.1 Action whose major deliverables made public in March 2018.

Action C.2. Projections of future climatic conditions for tree crop categories in S. Europe	Objectives: Objectives: Climatic and meteorological parameters affecting tree crops in S. Europe for future years. Expected Results: i) Climatic parameters relevant to trees cultivations for Europe for the period 2000 – 2060. ii) Monthly average changes in the meteorological parameters affecting trees cultivations in S. Europe between current (i.e., 2008 – 2012) and future years (i.e., 2048-2052).	The Action C2 has been successfully implemented according to the initial time schedule, providing future climatic and meteorological parameters affecting tree crops in S. Europe.	The estimated future climatic and meteorological parameters affecting tree crops in S. Europe have been used by the Actions C3 and Action D3.
Action C.3. Interface development of a software application for accounting tree-crop carbon sequestration	Objectives: The design of a web-based application for accounting tree crop carbon sequestration for the Mediterranean region under different geographical, climatic and ecosystemic conditions. Expected Results: - A model reflecting the properties of LIFE CLIMATREE-based methodology for estimating CO2 sequestration -A software application of the model.	The objective of the Action was accomplished in two different time scales. In the first time scale, a web based application for the Tree crops' CO2 Removal Capacity Calculation Tool (CO2RCCT) was developed to capture yearly changes. In the second time scale, a geophysical model for estimating CO2 balance in tree crops has been created and based on that, a web application (dashboard) was designed to capture long term changes. In both cases, the core algorithms applied were based on LIFE 's dataset, incorporating different geographic and climatic conditions.	The methodology developed in C4 and C3, alongside the web-applications and the relevant documentation, with minimum input, can serve as a basis for extending the calculations in different regions and apply it in the years to come.

Action C.4. Carbon input / output calculation for current and future years	Objectives: The development of a methodology that will calculate the carbon balance of tree crops Expected results: Determination of CO_2 balance in tree crop ecosystems. Obtain a relationship among the carbon balance of tree-ecosystem and the specific climatic condition. Modelling of Carbon balance of tree-ecosystem for the future years	A specialized Algorithm (CO_2 Removal Capacity Algorithm – CO_2RCA) was designed and developed to calculate the carbon balance, in terms of atmosphere related CO_2, of tree crops. Based on CO_2RCA a specialized e-tool (CO_2 Removal Capacity Calculation Tool [CO_2RCCT]) was designed and developed enabling the effective and accurate calculation of tree crops CO_2 removal capacity under different scenarios (eg. cultivation practices, trees protection, fuels, energy, etc.). Both, the CO_2RCA and the CO_2RCCT, were tested and optimised regarding their operation and the coherence and rationality of the extracted results.	Although the implementation of Action C.4 proved to be significantly more demanding and time consuming than what was originally foreseen in the approved Proposal, Action C.4 delivered: (a) a detailed Algorithm (CO_2RCA) which is suitable for the accurate calculation of the CO_2 Removal Capacity of tree crops (b) a specialized e-tool (CO_2RCCT) which, based on the CO_2RCA, incorporates all parameters related to the biological cycle of the tree to produce new wood and fruits biomass and the applied agricultural practices enabling the user to also assess "green" agricultural practices. The analysis of the results extracted by runs of CO_2RCCT for a series of alternative scenarios, revealed tremendous potentials in the fields of climate change mitigation, sustainable agriculture enhancement and business development. The enthusiastic feedback by various stakeholders to whom it was presented, prove its capability to be used as an important decision-making support tool that will provide to policy makers the necessary data to plan efficient climate change mitigation strategies, enhancing simultaneously the agricultural sector by promoting "greener" cultivation practices.
Action C.5 Suggestions of Climate Change Mitigation Policies and Measures	Objectives: Develop a set of suggestions for the formulation of climate change mitigation policies and measures. Expected Results: -Development of a guide for the suggestion of climate change mitigation policies and their incorporation into CAP -Development of a user friendly "economic module", based on a methodology that will consider the specific characteristics of each case study.	-13 different management practices were identified and proposed in order to increase tree productivity per cultivated area and to achieve a better CO2 balance. -Four (qualitative) evaluation criteria were used to prioritize these practices (CO2 sequestration, implementation easiness, application cost, impact on yield/farmer's income) -Examination of 4 different economic valuation methods/practices for CO2 sequestration -Assessment of economic values for 2 different scenarios and 5 different tree-crops under 4 alternative marginal values of CO2	This action is considered to be implemented successfully. Achieved results were in line with the expected ones, as they were used to develop: (a) the Guide for "climate change mitigation policies", (b) an "economic module" that could be applied in each case study and (c) an analytical evaluation of the economic benefits arising from tree crop sequestration. All methodologies involved are concerned of high scientific level, guaranteeing the validity of the delivered results. The success of this action was to develop an easy to apply method for assessing the benefits of tree crop sequestration, as well as an easy-to-use tool (guide) for selecting the most appropriate/sustainable (for farmers

	-Evaluation of the economic benefits arising from tree crops sequestration.	-GIS-based estimation of economic benefits for tree crops sequestration (at NUTS-3 level). -Development of three alternative economic instruments, based on three distinct cultivation scenarios in order to provide incentives to farmers to adopt mitigation practices.	and/or decision makers) agricultural practices.
Action D.1 Evaluation of the effectiveness of the proposed policies and measures	Objectives: Evaluate the policies for the "best cultivation practices" (BCP) to help climate change mitigation Expected Results: Tree crops estimation of the amount of total GHG emissions avoided and the SOC stock change due to BAP application.	Evaluation of the performance of suggested policies and the effectiveness of the BAP. In details the following points have been achieved: • Indicators for the impact of reduction of Greenhouse Gas (GHG) emissions related to orchard management were considered; • Indicators for the improve the potential of agricultural tree crops land use as carbon sink area (Increase C sink capacity of tree crops) were considered; • Qualitative evaluation of the proposed BAP and policies considering •Quantitative evaluation of the Carbon absorptions from the atmosphere and the CO2 emission reduction.	Results were in line with expected results foreseen in the proposal. The D1 Action provided indicators for the control and the evaluation of the effectiveness of the BAP, at tree crop cultivation field scale, with the aim to promote and assess the role of BAP application in terms of CO_2 balance necessary to achieve climate change mitigation targets in southern Europe areas.
Action D.2 Assessment of the socioeconomic impact of the project's output	Objectives: Present the benefits of tree crop cultivations and describe the overall economic contribution of tree crops' CO2 abatement. Expected Results: A report on the socioeconomic impact of the project An integrated evaluation framework relating to selected tree crop plantations	-Design of a novel methodology/survey for assessing the benefits of tree crop cultivations related to CO2 sequestration. Contrary to previous research/literature this method was based on a voluntary payment method (eco-label program). -Participation of 529 people in this survey. -Completion of the economic analysis and creation of an integrated report regarding the "Assessment of the socioeconomic impact of the project's outputs". -The survey results have led to a quantitative evaluation of the Project's impact (benefits): (a) at the farm level (producers/supply perspective),	This action is considered to be implemented successfully. Achieved results were in line with the expected ones, as they were used to develop: (a) a report on the socioeconomic impact of the project, (b) an evaluation framework related to olive tree plantation, which can be generalized for all orchards/tree cultivations (based on the results of Action C.5 the added value of mitigation best practices is comparable among all tree crops). The evaluation framework (methodology) was a novel one, aiming at: (a) taking into consideration the main characteristics of the agricultural sector (i.e. the supply-demand perspectives of both farmers and consumers), (b) avoiding the double counting of certain environmental benefits (e.g. co-

		(b) at the societal level (consumers/ demand perspective), (c) at the national level (aggregate benefits). -Possible (future) replication of the survey in other countries.	benefits of tree cultivations) The success of this action was: (a) to identify the underlying preferences of society towards sustainable agricultural management practices (applied in tree crops), which will contribute to climate change mitigation, (b) to provide insight into the social benefits of carbon sequestration of tree crops.
Action D.3. Assessment of the impact of the proposed methodology in supporting the ecosystem function restoration	Objectives: To present quantitative information on different scenarios for ecosystem function restorations based on the environmental costs (at water consumption level) for fixing CO_2 Expected Results: A report analyzing different scenarios with varying climatic, resource availability and crop conditions where the impact of the proposed measures on the ecosystem restoration can be estimated.	-Determine water consumption patterns for evergreen crops in relation to the carbon fixation capacity -Determine different ecosystem function restoration scenarios based on the availability of water resources for irrigation Testing 10 scenarios for water availability to determine the productivity potential for ecosystem function restoration	This action is considered to be implemented successfully even if it was more oriented to obtain technical agronomical information to support the ecosystem function restoration. Achieved results were useful to quantify the water consumption rates and to determine the water requirements to fully support an ecosystem restoration function based on the use of woody perennial crops. In addition, strategies for optimizing carbon fixation under limited water availabilities were designed. The different scenarios designed were all validated in field studies under different environmental conditions
Action E.1. Creation of project's logo	Objectives: Production of the Project's logo	The project's logo was successfully produced	No problems have been encountered for this Action.
Action E.2. Development, launching and maintenance of project's website	Objectives: Development, launching and maintenance of project's website Expected Results: - At least 50 visitors/ month - At least 500 likes at the project's facebook page - At least 100 followers on Twitter	The design of the website and the development of its content started in October 2015. The LIFE CLIMATREE website has been recorded 4,404 visitors The LIFE CLIMATREE website had approximately ~65 visitors/ month. The project's facebook page has received 311 likes and the project's twitter account has 291 followers	Action E.2 have been implemented without problems.

Action E.3. Dissemination of project's progress and results	Objective of this Action is the communication of the knowledge that will be extracted from the implementation of the project's Actions to the relevant stakeholders, the farmers and their associations, the scientific community and the public in general, aiming at: - Assisting & Informing stakeholders to understand the linkage between climate change and tree cultivations - Demonstrating to farmers and associations their key role towards climate change mitigation. - Operational demonstration of mitigation rich cultivation practices (C5 Deliverable) - Demonstration of financial incentives facilitated by the forthcoming CAP and promotion of mitigation rich practices - Demonstration of the potentials of ecolabeling schemes and CO_2 voluntary markets to exploit tree crops mitigation potentials. - Meetings with the Ministry of Agriculture in Greece.	• Creation of Informative Leaflets: 7/16 • Creation of Informative Posters: 7/16 • Participation in webinar series: Climate neutral food and wood of DG CLIMA and EASME. •The final e-conference •Four editions of Greek newspapers. •Interview with Prof. Kostas Bithas by SKAI radio.	Extremely successful dissemination which provoked at the right rime around the end of the project. The influence seems great. Constraints induced by Covid-19 pandemic were overcome with a marginal extension and re-designing dissemination activities
Action E.4. Development of project's notice boards	Production of Project's Noticeboards	1st and 2nd set of Project's Noticeboards have been already produced.	No problems have been faced.
Action E.5. Development of Layman's Report	Objectives: To communicate the findings of the project targeting a wide audience of stakeholders and the public. To inspire initiatives exploiting the mitigation potentials of tree cultivations.	•Distribution in hard copy with newspapers in Greece • Uploaded in relevant key sites (CSIC, HAO etc.)	Broad dissemination of the project findings to non-technical audience inspiring the exploitation of mitigation potentials of croplands.

Action F.1. Project Management	Objectives: •The scientific management of the various Actions •The financial management concerning project's expenditures •The monitoring and control of the various activities within the different Actions •The design and organization of the activities required for the dissemination of the project results	•Kick Off Meeting: 10/15 •Compilation of Inception Report: 7/16 •Compilation of Mid-term Report: 5/17	No problems have been faced so far. The Project Management is monitored by the 3 Management Committees of the Project: •The Scientific Committee: decides the details for the implementation of each project's Action •The Financial Committee: monitors the economic figures of project's implementation •The Dissemination Committee: designs and organizes all the activities required for the successful dissemination and diffusion of project's results
Action F.2. Monitoring of Project Progress	Objectives: •Quality Assurance / Quality Control (QA/QC) system will be developed in order to monitor the progress of the implementation of the LIFE CLIMATREE project •QA/QC Committee: will monitor the performance of the project's implementation	•QA/QC Manual: 30/09/2015 •QA/QC 1st Report: 31/3/2017	So far, the Monitoring of the project is successfully achieved through: •The management part: - project milestones - deliverables completion - consistency with the project timetable - performed expenditures and consistency with the proposed cost breakdown •The technical part: - will examine the performance of the project's implementation according to its targets
Action F.3. Networking activities with other relevant EU projects	Objectives: •Identify projects relevant to LIFE CLIMATREE's objectives, aims and actions •Establish communication with the beneficiaries of the most relevant projects •Exchange information about the scientific approach, the targets and the deliverables of each one of these projects •Finally, designing mutual exploitation of the findings, merging efforts and increasing influence.	Established networking activities so far: •DG CLIMA •National LULUCF Accounting Authorities •Greek Ministry of the Environment & Min. of Agriculture •Spanish Ministry of the Environment •Hellenic Agricultural Organization "DIMITRA" •ASSOFRUIT–ITALIA •AGREENMENT srl ALSIA–Regione Basilicata • Participation of LIFE CLIMATREE in LIFE IPNOA's (LIFE11 ENV/IT/000302) final	High influence, by merging findings to the agricultural national authorities in order to incorporate climate objectives in the forthcoming CAP; supporting the design of coupled climate-agricultural policies

		workshop in Pisa, Italy Participation of UEHR and CSIC in the closing workshop of LIFE ECOCITRIC Project (LIFE13 ENV/ES/000889) in Spain •Establishment of Networking with the European Agroforestry Federation (http://www.agroforestry.eu) •Participation as a key presenter at the final conference of OLIVE4CLIMA in Perugia • Participation in the webinar series: Climate neutral food and wood of DG CLIMA and EASME • Participation in the final conference of MEDINET	
Action F.4. Development of project's After-LIFE Plan	Objectives: •To validate and calibrate the novel methodology with date produced with new field measurements. • To inspire initiatives exploiting the mitigation potentials of croplands	• Experimental cultivations permitting structure measurements •Participation in conferences and workshops •Promotion of voluntary initiatives such as ecolabeling and CO_2 voluntary markets •Collaboration with MEDINET and OLIVE4CLIMA co-ordinates in the submission of two new LIFE 2020 proposals •Permanent uploading of e-tool and model on the website of the coordinates as well as the maintenance of the website of CLIMATREE for at least 5 years	The gap in the existing knowledge concerning the link between croplands and CO2 will be addressed with new initiatives; among them we seek new LIFE projects. The existing knowhow will be disseminated further with market-oriented initiatives such as ecolabeling schemes and voluntary markets. The new CAP will be feed with knowhow concerning the operational application of eco schemes and carbon farming.

6.4 Analysis of benefits

The knowhow for exploiting the mitigation potentials of tree cultivation is the major "benefit" created by LIFE CLIMATREE. This knowhow consists of three dimensions. First, a robust accounting of the CO_2 balance of tree cultivations has been established. Second, farming practices, across different climatic and management conditions in Southern Europe, have been evaluated, ranked and demonstrated, on the basis of their CO_2 balance. Third, economic values have been assigned to the ecosystem service of CO_2 sequestration; these values can underline the development of incentives to explore mitigation potentials.

According to IPCC (2006, 2019), the soil and the biomass carbon (C) pools of perennial crops need to be monitored within GHG National Inventory Reports (NIRs). Specifically, for perennial crops the EU member states should report the emissions and removal of GHGs for the historical and projected periods, as well as information on the mitigation policies and measures and on low-carbon development strategies. Requirements are set in:

- The Regulation (EU) No 525/2013 on a mechanism for monitoring and reporting (MMR Regulation),
- Implementing Regulation (EU) No 749/2014 of 30-6-2014 on structure, format, submission processes and review of information reported by Member States,
- Decision No 529/2013/EU on accounting rules on GHG emissions and removals resulting from activities relating to LULUCF and on information concerning actions relating to those activities,
- Regulation (EU) 2018/841 on the inclusion of GHG emissions and removals from LULUCF in the 2030 climate and energy framework
- amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU.

To be compliant with the requirements of the MMR Regulation, the Member States shall report emissions and removals regarding changes in the cropland areas. Additionally, the MMR Implementing Regulation requires that EU Member States, that have not elected cropland management activity in the 1st and 2nd commitment period, to provide annually, preliminary, non-binding estimates of emissions/removals from cropland management for the period prior to 1-1-2022. However, the information currently available in the countries do not allow the proper application of the IPCC Guidelines, that are the basis of the GHG emissions and removal estimations, due to the lack of a comprehensive set of measurements and the lack of information on the effect of the soil management practices. LIFE CLIMATREE enables, countries to correct this weakness. This is a significant contribution as land uses defined as tree cultivations, which occupies a significant land use share in Greece, Spain and Italy.
Data, methods and models developed within LIFE CLIMATREE can substantially contribute to the development of country- based coefficients to support the upgrading of NIRs, especially when combined with those of other relevant projects such as MEDINET and ClimaMed.
Robust accounting and reporting are a necessity before exploiting the mitigation potentials of perennial crops. However, even if a robust LULUCF accounting is achieved this is not enough for evaluating different practices of managing tree cultivations and ranking them based on their mitigation potentials. The inventory, IPCC-based, methodology does not take into account the impacts of human intervention on the farm.
As a result, the CO_2 emissions, induced by cultivation methods, cannot be evaluated as a part of the farming process since they are accounted by the Energy sectors. In this context, in order to evaluate the actual CO_2 balance within the orchard's limits, CLIMATREE merged functionally the IPCC-based methodology and the LCA concept. LIFE CLIMATREE methodology takes into account the biological cycle of the tree and its surroundings as well as the applied cultivation practices This integrated approach permitted the actual assessment and evaluation of the tree crops' mitigation potentials.

Indicative results by the CO_2RCCT are presented in the following Table 1:

Table 1

	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 CO_2 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.

Specifically concerning Greece, the 5 examined tree crops are illustrated, based on the results of the CO_2RCCT, by the following figures (Table 2) regarding the CO_2 Annual Removal Capacity (ARC) and its constituting parameters:

Table 2

Greece			**orange**	**apple**	**peach**	**almond**	**olive**
ARC	CO_2 Annual Removal Capacity	tn CO_2/year	218,437	9,768	280,022	70,437	3,047,921
AR_{BW}	CO_2 Annual Removal due to the production of wood biomass	tn CO_2/year	300,878	58,443	403,408	101,011	4,549,120
AS_S	CO_2 Annual Storage in soil as carbon of the fallen biomass	tn CO_2/year	7,224	2,069	2,719	2,305	54,879
AE_f	CO_2 Annual Emissions due to the use of fertilizers	tn CO_2/year	37,063	15,213	32,746	9,047	635,916
AE_p	CO_2 Annual Emissions due to the use of pesticides	tn CO_2/year	25,353	5,981	32,739	11,609	492,126
$AE_{ff\&e}$	CO_2 Annual Emissions due to the use of fossil fuels & electricity	tn CO_2/year	27,248	29,550	60,620	12,223	428,037
ARC_{area}	CO_2 Annual Removal Capacity per unit of cultivated area	tn CO_2/hectare/year	6.44625	0.87465	7.12835	5.29610	3.73945
$ARC_{product}$	CO_2 Annual Removal Capacity per unit of harvested fruits	tn CO_2/tn of yield/year	0.27844	0.03866	0.45389	2.29570	0.89183
ARC_{tree}	CO_2 Annual Removal Capacity per tree unit	tn CO_2/tree/year	0.01446	0.00118	0.01623	0.01899	0.02157
TAE/TAR	CO_2 Total Annual Emissions / CO_2 Total Annual Removals		0.29102	0.83857	0.31051	0.31824	0.33798

Moreover, it was concluded that by applying a combination of "green" alternative agricultural practices a total reduction of approximately 80% is estimated that can be achieved regarding the current CO_2 emissions, leading by this way to an estimated total CO_2 Annual Removal Capacity of approximately 24,500,000 tn for the 5 tree species, in Greece, Italy and Spain.
Furthermore, the capability to accurately calculate the CO_2 removal from the atmosphere to produce fruits biomass, revealed the potential of tree crops to serve as a Climate Regulator considering the specific CO_2 mass as a "short-term climate loan".
The overall analysis of the CO_2RCCT results proved that tree crops are of significant importance for the regulation of the climate, acting as a Climate Change mitigation measure.
Furthermore, the dynamic potentials of the three major carbon pools (biomass, dead organic matter and soil) are projected for the next 50 years and the relevant estimates are presented by Figure 1 taking into account the existing land uses. These estimates do not take into account the emissions induced by human activities, management practices; as impacts of management practices are considered only those influencing the three carbon pools. The impacts of indicative management practices as well as those of an increasing temperature are presented. The estimates of Figure 1 adopt a rationale compatible with that of National GHGs Inventories. Remarkably, the estimates of Figure 1 are indicated approximations under certain assumptions and therefore they can be interpreted as trends and potentials.

Figure 1. Aggregate Carbon sequestration in 50 years

Total Carbon (in Mt)

	Greece	Spain	Italy
olive	27,67	220,71	36,49
orange	1,96	11,55	3,35
apple	1,35	2,95	12,71
almond	0,43	14,64	1,54
peach	1,34	1,68	2,82

Total Carbon for olives (in Mt)

	+ 0.0 C	+2.0 C	+5.0 C
Greece	31,69	26,20	23,31
Spain	227,65	210,84	187,58
Italy	37,52	34,78	30,94

	field vegetated	not vegetated
Greece	27,67	16,21
Spain	220,71	124,16
Italy	36,49	21,43

	keep pruning	remove pruning
Greece	27,67	25,05
Spain	220,71	196,50
Italy	36,49	32,80

Having identified the mitigation potentials, it is a great challenge to assign a monetary value on them and to trace the development of a comprehensive incentive mechanism for exploiting these potentials. All them define the economic and social benefits identified and induced by LIFE CLIMATREE.

An initial monetary valuation of the mitigation potentials can be performed on the basis of the CO_2 market values as defined at the ETS system. This will offer an indication with "close to the market" approach. With the value of CO_2 around 30 €/ton, the CO_2 absorption induced by current land uses under the prevailing cultivation methods result in an aggregate value of 1,469.14 million € for the 5 orchards under consideration in the three countries of LIFE CLIMATREE. Similarly, the additional CO_2 absorption induced by the best management practices result in an aggregate value of 2.176 million €, respectively.

A novel approach of monetary valuation has been developed within LIFE CLIMATREE for the additional CO_2 absorption induced by best cultivation practices. This is based on citizens preferences for olive oil certified to be produced by the best management practices maximizing the absorption of CO_2. This method estimates the value on the basis of land use allocated to the mitigation rich cultivated orchards. A value around 1200 €/hectare for olive cultivation has been defined. Adopting this value as proxy for all orchards, we estimate the economic benefits of the additional CO_2 absorption that covered by induced by best management practices if applied; the estimates are presented in Figure 2.

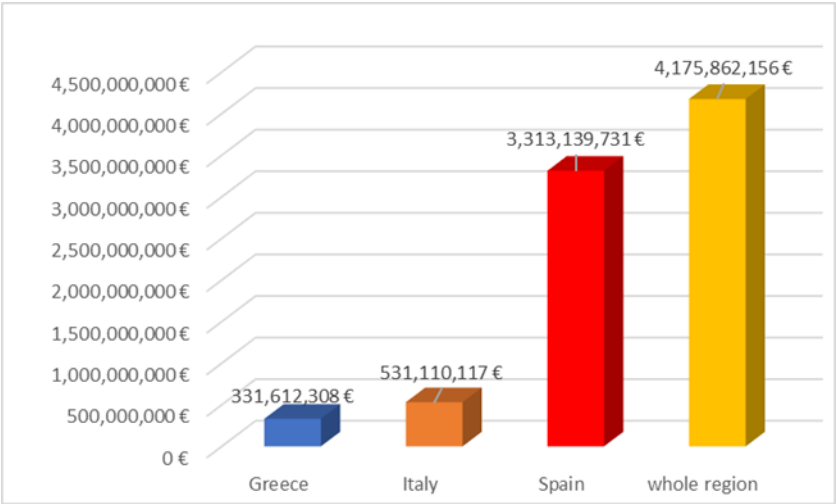

Figure 2. Annual Aggregate Economic values of additional CO_2 absorption induced when by mitigation rich practices in the 30% of existing cultivation.

All these economic benefits demonstrate the monetary value of the CO_2 absorptions, being a regulatory ecosystem service created by farmers. Farmers, especially when adopting mitigation rich cultivation methods, induce an ecosystem service amounted to significant monetary benefits. The "internalization" of this externality would create a practical incentive for securing and further extending the ecosystem service at hand. The realization of CO_2 absorption depends on farmers practices and can be influences by a suitably designed system of incentives. Such a system of incentives has been traced and promoted by LIFE CLIMATREE's deliverables. A system of incentives can be facilitated within the forthcoming CAP under "Ecoschemes" and especially "carbon farming" schemes. The novel methodology, concerning the balance of CO_2, can be used as a verification and certification system for developing carbon farming schemes. On the other hand, ecolabeling schemes for agricultural products being the yield of mitigation rich methods, can be developed. Pioneering initiative have been traced by OLIVE4CLIMA LIFE and the methods of LIFE CLIMATREE can directly support the broader certification concerning almost all taken cultivations. Furthermore, the robust assessment of CO_2 balance permits the development of voluntary market projects.
All these initiatives concern all farmers working in cropland areas, being estimated around 660,000 farmers. These stakeholders are the major actors in rural areas. Any contribution to their welfare will be a significant contribution to the economic sustainability of rural areas. The rural sustainability can strengthen by enhancing employment and income for farmers and their family.
At the same time, the adoption of mitigation rich, best management practices, result in significant environmental co-benefit. As demonstrated by C1 and D3 Actions, mitigation rich cultivation methods support soil formation, water infiltration, biodiversity enhancement and desertification avoidance. The D1 action results may strengthen the significance of increasing Soil Organic Carbon (SOC) management practices for fruit tree crops. These significant contributions are linked to the environmental sustainability of rural areas.

Finally, it must be underlined that a series of rising potentials for using the CO_2RCA and the CO_2RCCT 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' CO_2 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 CO_2 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 CO_2 credits of their own tree crop farms.

The above potential uses of the CO_2RCA and the CO_2RCCT 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 CO_2 emissions and consequently to increased CO_2 Annual Removal Capacity of their orchards.
- ☑ Avoidance of currency export to third, non-EU countries for purchasing CO_2 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 CO_2 Annual Removal Capacity of the orchards
  - ✓ certification of the calculated CO_2 credits
  - ✓ brokering of the certified CO_2 credits.

Closing, it has to be noted that the replicability/transferability potentials of the CO_2RCA and the CO_2RCCT are significant towards 2 directions:

- the expansion of CO_2RCCT to other types of tree crops
- the application of CO_2RCA to other countries that already cultivate, or they are interested to develop, tree crop farms.

7. Key Project-level Indicators

Key indicators/Objective	Decriptors	Units	At the beginning	At the end	5 Years beyond	Choose the Type of project action(s) targeting the main project outcome(s) within the project area	Comments
Coverage/Range of the environmental/climate change impact	Total area affected by the project	hectares	0	10,943,034	11.490.185	*Total area of permanent tree crop cultivations (in ha) in all three countries.* The mitigation potential of those areas, which was unclear at the beginning of the project, was estimated at the end of the project. After the project, it will be still possible to estimate the mitigation benefits of those areas (based on current trends as well as on the possible financing/subsidization of this ecosystem service, a 5% increase of the permanent tree crops area is considered as a realistic estimate 5 years after the end of the project). The main project outcomes within the project area are: (a) Capacity building and (b)closing knowledge gaps (including monitoring)	LULUCF methodology includes rough estimates of CO2 emissions and removal from permanent tree crop cultivations. The project aimed to provide a tool for a more accurate estimation reducing existing uncertainties.
Coverage/Range of the environmental/climate change impact	Total human population affected by the project	# of people	0	660.000	693.000	*Number of farmers cultivating permanent tree crops in Greece, Spain and Italy.* The project highlighted the role of this population in mitigating climate change.	Concerning the 5-year impact, we used the same assumption as with the case of the total area (5% increase in the number of tree-crop farmers)
Mitigation	Tree crop cultivation area following good mitigation practices	hectares	0	0	3.282.910	*Tree crop cultivation areas where good practices are adopted.* This indicator highlights a rational and "achievable" target for climate change mitigation best practices: 30% of the total tree-crop area	This target is set based on the socio-economic analysis (actions D.2 and C.5), which among others explored the maximum environmental benefits that can be achieved through market incentives and traced the potential future financial instruments (or farm support options) for farmers adopting good mitigation practices
Mitigation	Reduction of carbon emissions	tn (CO_2) / year	N/A	0	3.01*10^6 t CO3	*Reduction of carbon emissions from tree crop agriculture due to the implementation of good mitigation practices.* Five year after the project a 30% of this area is projected to adopt these practices. Emissions reductions are an important that should be estimated separately from total carbon removals because some agri-environmental policies may rely on these estimates.	At the beginning of the program, the (initial) value of this indicator was not a reliable estimate (i.e. it was not possible to attach a precise value on tree cultivations' annual CO2 removal capacity). Therefore, LIFE CLIMATREE contribution lies in identifying precise values of CO2 emission reductions, as well as in estimating the achievable targets for future climate goals/policies of EU agri-environmental policy
Mitigation	Total Carbon removal	tn (CO_2) / year	N/A	49.3 *10^6 t CO_2	54.4 *10^6 t CO_3	*Achievable Carbon removal of tree cultivations in all three countries (total annual removal capacity of CO_2)* The difference between the two time periods reflects the additional carbon removal that can be achieved if the target for indicator 3 (tree crop cultivation area following good mitigation practices) is met. In that case, mitigation practices can contribute to about **5.1 million tons per year.**	At the beginning of the program, the (initial) value of this indicator was not a reliable estimate (i.e. it was not possible to attach a precise value on tree cultivations' annual CO2 removal capacity). Therefore, LIFE CLIMATREE contribution lies in identifying precise values of CO2 sequestration, as well as in estimating the achievable targets for future climate goals/policies of EU agri-environmental policy
Mitigation	Total benefits of carbon sequestration by tree cultivations	€/year	N/A	1,469.14 Million €	2,176.10 Million €	*Achievable monetary benefits of Carbon sequestration by tree cultivations in all three countries* ***end of project**: TEV $_{seq}$= actual carbon sequestration [see Indicator 6] x current price of EU ETS* ***5-years beyond**: TEVseq= predicted carbon sequestration [see Indicator 6] x forecasted price of EU ETS* The current EU ETS price (29.9€/t) is used for the end of the project estimate A conservative 2025 forecast of the EU ETS price (40€/t) is used for the "5-year beyond" value	At the beginning of the program, the (initial) value of this indicator was not a reliable estimate (i.e. it was not possible to attach a precise economic value on the benefits of CO2 sequestration by tree cultivations). Therefore, LIFE CLIMATREE contribution lies in identifying precise economic estimates of this ecosystem service (CO2 sequestration), as well as in estimating the achievable total benefits from this particular sector. It should be noted that a conventional and modest marginal carbon sequestration value (i.e. EU ETS price) is used for this indicator due to the fact that significant part of the total benefits from tree crops are already provided (without adopting best practices)
Mitigation	Economic value of good mitigation practices	€/year	N/A	0	4,157 Million €	*Total value that society attributes to tree crop agriculture following good mitigation practices* *= [target value of indicator 3(i.e. tree cultivations following good mitigation practices)]x [per hectare ecosystemic value of CO2 sequestration]* Based on D.2 action deliverable: the most reliable value for this ecosystemic service was the 1272€/hectare	This indicator estimates the additional social value of adopting good mitigation practices. It is not a paradox that this value is higher than the total value of carbon sequestration, as it reflects the necessity/importance/costs required for climate mitigation action related to tree crop cultivations (which is not the case for the current tree crop cultivation practices). This estimate also highlights the financial incentives that can be given to farmers through various policy tools.
Governance	Involvement of non-governmental organisations (NGOs) in project activities	# of NGOs	0	8	10	8 stakeholders from the Agriculture, Forestry and Fishing sector (and particularly from sector 1.2: Growing of perennial crops) were involved in project activities during the program and other two are expected to be involved during the following 5-year period	Interventions of those NGOs were targeting EU environmental or climate action policies, at regional, national and EU level
Information and Awareness	Website and social media	# of website visitors # of page views (and average page views per visit) # of projects' results documents to download # of people who follow the facebook page # of unique users of the facebook page # of users sawing a project's tweet on Twitter (tweet impressions)	0 visitors 0 page views 0 documents 0 followers of FB page 0 users of FB page 0 tweet impressions	4,404 visitors 11, 667 page views (2.65 page views/visit) 16 documents 311 followers of Facebook page 116,649 uniques users of Facebook page 37,894 tweet impressions	7,500 visitors 20,000 page views 20 documents 500 followers of Facebook page 180,000 unique users of Facebook page 60,000 tweet impressions	Indicators related to the website and social media activity: Reaching and/or awareness raising of the general public through the project website and the project's social media (Facebook, Twitter)	
Information and Awareness	Other tools for reaching/raising awareness of the general public	# of publications in journals/conferences # of participations (of the beneficiaries) in events/workshops # of posters and information boards # of publications # of print media # of other media/broadcasts # of people participated in the final event # of individuals whose awareness was raised through the project activities	0 publications in journals/conferences 0 participations (of the beneficiaries) in events/workshops 0 posters and information boards 0 print media (newspapers) 0 other media/broadcasts awareness raised to 0 individuals	17 publications in journals/conferences 12 participations (of the beneficiaries) in events/workshops 10 posters and information boards 5 articles in newspapers (about 20,000 copies of newspapers distributed) 2 other media/broadcasts 150 people participating in the final conference awareness raised to 50,000 individuals	25 publications in journals/conferences 18 participations (of the beneficiaries) in events/workshops 10 posters and information boards 8 articles in newspapers (about 40,000 copies of newspapers) 5 other media/broadcasts awareness raised to 100,000 individuals		
Information and Awareness	Participants in surveys	# of participants in surveys	0 participants	529 participants	1500 participants	*Number of participants in the survey of action D.2*	This survey served also as an information/awareness raising activity for Greek citizens, which is planned to be replicated in Italy and Spain at the 5-year after the project period.
Networking	Networking with other LIFE projects	# of projects	2 projects	8 projects	10 projects		
Networking	Members of interest groups	# of individuals	0 individuals	150 individuals	200 individuals	*Networking, Workshops and other stakeholder events*	