LIFE Project Number

<LIFE14 CCM/GR/000635**>**

Progress Report

Covering the project activities from 31/03/2017 to 30/06/2018

Reporting Date

<30/06/2018>

LIFE PROJECT NAME or Acronym

<LIFE CLIMATREE>

Data Project

Project location:	
Project start date:	<16/07/2015>
Project end date:	<28/06/2019>
Total budget:	€ **1.931.447**
EU contribution:	€ **1.158.868**
(%) of eligible costs:	60%

Data Beneficiary

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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
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
PAGE: Policy Analysis of the Greenhouse Effect
GHG: Greenhouse Gases
SOC: Soil Organic Carbon
EPs: Emissions Potentials
SPs: Sequestration Potentials

3. Executive summary

This reporting period could be characterised by a significant progress of the core actions of the project. The processes that describe the CO2 balance of the cultivations have been

identified and studied in a systematic way. A set of rigorous simplified equations have been developed to reflect in a quantitative way the physiology of the main CO2 balance processes. Both the absorption and the emission processes have been assigned on an algorithmic structure based on the findings of C.1 Action as well as on the state of the art knowledge. As a result, a comprehensive algorithm that resembles the CO1 balance has been created within C.4 Action. This algorithm fed the development of a simulation model and the web-tool permitting operational estimates of CO2 balance under different conditions and alternative scenarios.
One of the key milestones of this period has been the EU monitoring visit which took place the 19th of March 2018 at the premises of Panteion University in Athens and in which the technical and financial progress of the project have been presented and reviewed. In line with the successive EU letter on the project visit (20/07/2018) where the positive developments of the project are highlighted and following the urge of the project adviser (Mrs. Hana Mandelikova) to consider the need for a project prolongation, an internal decision was taken among the project's beneficiaries for the official request of an one year's prolongation of the project, until 28/06/2019, which shall be prepared in collaboration with the project monitoring officer upon the submission of the current report. The following report aims at presenting the progress of all ongoing Actions and activities, the reasoning behind the need to officially apply for a formal amendment request taking into account the current progress of C Actions and the time needed to successfully complete the project's remaining Actions.

As it has been already mentioned during the Athens visit as well as in monthly progress reports, the implementation period of Action C.1 has been extended until March 2018, a six months' elongation to its initial deadline (09/2017). This elongation has been imposed by unfavorable weather conditions of 2017 spring (rainy and cold weather) that delayed agricultural field works for some period. Indicatively, the harvesting period of orange and apple trees was delayed influencing the 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. Although Action C.4 has concluded to the structure of the Algorithm incorporating its core equations, it requires further work to finalize the development of EP_p and SP_S equations, to complete the collection of data for the supporting back-end database and finally to perform a series of trial operations of the algorithm by AUA, CSIC and UNIBAS. This would require an overall 9 months prolongation of Action C.4. This prolongation although mainly induced by the extension of Action C.1 will serve the objectives of optimization and further improvement of the algorithm. The extension of C.4 will lead to a similar extension of Action C.3. Accordingly, this is expected to affect the implementation of D Actions (Monitoring of the Impact of the Project) in order to facilitate the outcomes of Actions C.3 and C.4. Lastly, although the implementation of Actions E.2, E.3 and F.1, F.2, F.3 are in accordance with the approved timetable of the project, they will be also extended to incorporate the required overall extension of the project's duration.

During this reporting period although all C Actions indicate a remarkable progress according to the official timeline, the major progress has been achieved for Action C.4, one of the core Actions of the project. All D Actions have been initiated without serious deviations from their official start date and are expected to be positively affected by a possible project prolongation. Lastly, Actions E.2, E.3 and F.1, F.2, F.3 , which follow the official duration of the whole project, will be also affected by a possible change in the

official project's duration.

Under these conditions and following an internal beneficiaries' decision it is suggested that an overall extension of the duration of the project for a period of 12 months should be requested. Such an evolution will create sufficient room for fully exploiting the policy potentials of the project by communicating effectively its results (which will be finalized with a delay than originally foreseen) to a number of important stakeholders. It should be noted that a communication has been already established with EU Authorities, National Ministries (Environment and Agriculture), and the project's action plan and expected outputs were already presented to a number of influential actors: DG CLIMA, National Ministries, National Accounting Authorities & LULUCF experts. We consider of key importance to use part of the requested extension in order to systematically organize a synchronized exploitation of the project's findings towards the achievement of climate change mitigation targets described in the 2030 EU's Climate and Energy framework.

Lastly, the replies to technical and financial issues raised in the official EU letter (Ares(2018)3877308 - LIFE14 CCM/GR/000635 - CLIMATREE - Project Visit) can be found as an annex to the current report.

4. Administrative part

During this reporting period the Institute of Urban Environment and Human Resources (UEHR) (Coordinating Beneficiary) has remained in close contact with all beneficiaries for the sound coordination and progress of both the technical, financial and administrative parts. The Four (4) Management Committees (Scientific, Quality Assurance / Quality Control (QA/QC), Financial and Technical) continued to be operative for the successful and effective project management and a group meeting took place the 18th of March prior to the organization of the 3rd Project Visit in Athens. The scientific Committee continued the control of the prepared deliverables, through an internal “reviewing” process, while the Financial Committee was concentrated on the delineation of the financial procedures, the CLIMATREE’s timesheets, accompanied by other relevant financial documents, sent every 3 months following the adoption of the new templates provide in the official LIFE webpage.

As already stated above, during the EU monitoring visit which took place at the 19th of March 2018 at the premises of Panteion University in Athens, both the technical and financial progress were presented and discussed along with the Monitoring Officer and Mrs. Hana Mandelikova, acting as the EASME representative, and the possible need to extend the official duration of the project was informally discussed. Following this event an internal decision was taken among the project's beneficiaries for the official request of an one year's prolongation of the project, until 28/06/2019. This decision was followed by an update of financial information among partners for the investigation of the need for a financial amendment too. Upon the contact of partners it has been decided that no such need would be requested so all beneficiaries focused on the determination of their need for extending the duration of the Actions which they coordinate.

Throughout the whole reporting period a constant communication was kept among the Coordinating Beneficiary and all Associated Beneficiaries through emails, telephone

contacts, Skype meetings, working groups and regular team meetings on a regular basis. (A full list of all the meeting and events that took place within this reporting period can be found in the Annex F.1.1). This communication ensures the proper development of the project's progress and the production of the project's deliverables in line with the approved time schedule. All beneficiaries continued to submit on a monthly basis their progress in line with the Actions under implementation and an aggregated report of all activities for each month has been submitted to the External Monitoring Team of the Project.

5. Technical part

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 C.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 being 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 C.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.

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 nationwide 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. The proposed methodology is of immense significance for the policy makers, since it constitutes of a fundamental tool for the inclusive accounting of Orchards Carbon Sink potentials. In specific, through the proposed methodology it becomes possible to estimate in Regional and National Level the annual atmospheric carbon removal. Moreover, this estimate is established on readily available (through national statistics) data.

Dissemination of the proposed methodology to the relevant stakeholders has already begun. Farmers are reached through the on-going training programs of the Hellenic Agricultural Organization DEMETER, since these programs were one of the focal points

for the conduction of the farmers' survey. It must be noted here that even though the participants were of limited number the total audience of these programs exceeds annually the 3000 farmers. In addition to farmers the outreach activities target also to experts and policy makers, who will be informed through a scheduled publication of the proposed methodology in well respected international peer-reviewed scientific journal.

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 C.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 C.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 considering also 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 and most of results have been published in an international journal (Fiore A., Lardo E., Montanaro G., Laterza D., Loiudice C., Berloco T., Dichio B., Xiloyannis C., 2018. Mitigation of global warming impact of fresh fruit production through climate smart management. J. 3634-3643 doi:10.1016/j.jclepro.2017.08.062)

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 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 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 C 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. More over 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 in its present form by the 30th of March 2018. In this period the final draft of the deliverable was communicated to all beneficiaries in order to be subjected to internal review. The comments received after this short consultation period were incorporated in the final C.1 deliverable (Annex C.1), which was finalized by March 30, 2018. Lastly, the communication process facilitated the operational representation of the CO_2 balance in the algorithm developed in C.4 Action.

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 started and was completed on time. No problems have been encountered in regards to this Action. The Deliverable of the Action C2: "Future climatic and meteorological conditions affecting tree crops in S. Europe" has been completed and is attached with the current progress report (Annex C.2).

The main findings and results suggest that temperature changes using 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. 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%. Temperature change using 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.

The databases containing the climatic and meteorological parameters have been completed. The results of this Action are already used as input to the software that is developed for accounting future tree-crop carbon sequestration (Action C3) as well as for the carbon input / output calculation for future years (Action C4). In addition, since the assessment of the impact of the proposed methodologies in supporting ecosystem functions restoration depends on climatic conditions, the estimated changes in the future climate that affects tree crops cultivations are needed for analyzing different climatic scenarios (Action D3).

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 Anticipated end date: 28/06/2019

Action C.3 started earlier than originally defined, 01/01/2017, in order to investigate the capabilities, characteristics and data requirements of the available models, tools and methodologies concerning the CO_2 balance of crop cultivations.

Based on the literature review as well as on the knowledge provided by Actions A.1, A.2, C.1, C.2 and C.4 two objectives are being carried out.

The first is the development of a web-based CO_2 balance estimation tool. Once the processes defining the CO_2 balance have been quantified an electronic tool will be created to permit operational estimates by different users. In fact a user interface, reflecting the methodology developed by C.3 and C.4 Actions, will be created. This web-based tool which is currently under development, will incorporate the CO_2 Removal Potential Algorithm(CO_2 RPA) which is developed in Action C.4 and incorporate CO_2 calculation equations as well as the supporting Back-end Database.

The web-based tool will require by the users to login by using username and password the web-based tool will include a number of specific tabs into which the user will input data that are required for the calculation of the CO_2 Removal Potential of a specific tree crop farm or a broader area:

- ✓ type of cultivated tree
- ✓ surface of the cultivated land
- ✓ geographical location of the cultivated land
- ✓ yield of the tree crop farm
- ✓ planting density of the tree crop farm
- ✓ percentage of trees in juvenile phase
- ✓ annual quantity of prunings and type of applied management
- ✓ type of applied fertilizers and pesticides and annual quantities consumed
- ✓ annual consumption of fossil fuels and electricity

The user of the web-based tool will be able to examine tree crops scenarios during the same running of the tool and thus to acquire the CO_2 Removal Potential of the overall tree crops farms or broader areas as well as to obtain a comparative view of the extracted results.

The tool will have a “save” option so as the user:

- ✓ to be able in a future login to continue the input of data from the point that he had stopped
- ✓ to retrieve the extracted inputs and results at a future use of the tool.

The CO_2 Removal Potential estimates will be presented appropriately (sub and total values, graphical display in charts [bar charts, pie charts, doughnut charts]).

The data inputs alongside with the extracted CO_2 Removal Potential results will be exported in printable pdf format.

The second objective will be development of the web-based model to reflect the dynamics of the processes involved in CO_2 balance incorporating a spatial dimension. The model will be available in a web-based form as well. Specifically, a spatio-temporal model incorporating three pools (biomass, debris and soil) is designed to cover all different tree crops. The tree crops CO_2 sequestration will be calculated yearly for regions (NUTS 1,2,3) in the countries of CLIMATREE. The biomass will include the tree above ground (trunk, branches,) as well as the roots. Debris will consist of fallen fruits and prunings residues.

Finally, the calculation of the carbon related to atmosphere CO_2, which is stored into the soil will be performed by utilizing the RothC model. (Coleman, K., Jenkinson, D.S., 1995. RothC-26.3 A Model for the Turnover of Carbon in Soil. Model description and user guide). The meteorological and soil characteristics data required for the model is similar to the ones required by the "tool" and the relevant processing is under development in Action C.4.

During this reporting period the site-map of the web-tool has been created and the next step includes its development. This process is expected to last longer than it has been initially scheduled (31/06/2018) due to a series of delays occurred in Action C.1 which affected the implementation of Actions C.4 and C.3 accordingly. This extra period will also contribute significantly towards the maximization of the policy impact of the specific tool through a testing and updating with the involvement relevant stakeholders. The implementation of the web-based model is expected to require an extension of C.3 for at least 9 months beyond the initial schedule.

The required extension for the implementation of the two core Actions (C3 and C.4) are expected to affect the overall duration of the project and therefore a need for a one year prolongation (28/06/2020) beyond the initial end date (28/06/2019) is essential in order to optimize the results of the project and maximize its potential policy impact. It has to be pointed out that the CO_2 Removal Potential Algorithm as well as the respective web-based tool is expected to reveal the importance of the European orchards towards Climate Change mitigation as CO_2 removal basins. The results of these 2 Actions will supply Action C.5 with the required data that will support the designed policy proposals. Lastly, The web tool will also provide the policy makers with the opportunity to examine different scenarios, to quantify the current CO2 absorption and to predict future impact of the current status and the farmers with an idea of how their current practices affect the environment".

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

Foreseen start date: 1/11/2016	Actual start date: 1/12/2016
Foreseen end date: 30/06/2018	Anticipated end date: 31/3/2019

The design of the structure of the algorithm (CO_2 RPA: CO_2 Removal Potential Algorithm) that calculates the CO_2 Removal Potential of tree crops as well as the formulation of the relevant equations has been finalized by TERRA NOVA (except of the ones for SP_S and EP_p which are under progress).

The core equation reflecting the RPA algorithm is the following:

$$\mathbf{TRP = RP_{BF} + RP_{BW} + SP_S + EP_f + EP_{ff\&e} + EP_p}$$

where

TRP	CO_2 Total Removal Potential of a specific tree crop farm or a broader area where tree crops are cultivated
$\mathbf{RP_{BF}}$	CO_2 Removal Potential due to the production of fruit biomass
$\mathbf{RP_{BW}}$	CO_2 Removal Potential regarding the production of annually new trunk, branches and roots biomass
$\mathbf{SP_S}$	CO_2 Storage Potential of soil regarding the carbon of the fallen biomass
$\mathbf{EP_f}$	CO_2 Emissions Potential due to the use of fertilizers
$\mathbf{EP_{ff\&e}}$	CO_2 Emissions Potential due to the use of fossil fuels & electricity

EP_p CO_2 Emissions Potential due to the use of pesticides

TRP is the sum of the mass of CO_2 which is captured from the atmosphere during the annual biological cycle of the tree minus the mass of CO_2 which is emitted to the atmosphere by the applied agricultural practices (the Emissions Potential values have a negative sign in the above equation).

All values are expressed in *tn CO_2 per year*.

CO_2 RPA takes into account:
- ✓ the biological cycle of the tree, and
- ✓ the practices applied for its cultivation, maintenance, protection and harvesting.

When referring to a "tree crop", it is meant the tree itself and its surroundings as a biological unit, as well as the anthropogenic interventions in the context of its cultivation.
It has to be underlined that CO_2 RPA calculates carbon which is strictly related to atmosphere's CO_2 (CO_2 related carbon) in terms of capture or emissions.

CO_2 RPA boundaries are:
In terms of subject: the tree itself and subsequently the tree crop land either of a specific farm or of a broader area which is exclusively used for the cultivation of tree crops.
In terms of time: 1 entire calendar year taking into account that within a year a full productive cycle of the tree crop will be performed, while all types of the relevant agricultural works will be implemented, and thus a full cultivation cycle can be considered as a completed one.

CO_2 RPA is structured in such a way to operate in 2 alternative sections:
- ➢ the Specific Farm, mainly having as users the farmers, agriculturalists and professionals or researchers in general whose interest is on the local scale
- ➢ the Broader Area (e.g. an entire Region), mainly having as users the decision makers.

CO_2 RPA operation, and thus its design, is based on 2 types of users:
→ The one that knows the data required to be imported in algorithm's interface (usually these are the farmers). Even in this case the user may not have knowledge of the entire required data.
→ The one that does not know the entire required data or he has a general view of the subject like the type of cultivated tree and the geographical area (these are usually the Decision/ Policy makers).
In order to enable the operation of the algorithm in the cases that the user does not have access or knowledge to all the required data, an extended Back-end Database has been developed by TERRA NOVA to support algorithm with all information necessary for the corresponding equations. This information was retrieved by:
- The results of CLIMATREE Actions A.1, A.3 and C.1
- AUA's previous research results on tree crops cultivation
- National statistical data regarding the agricultural sector
- International scientific references
- Data officially published by national and international organisations.

CO_2 RPA's Back-end Database includes information about the 5 selected tree species: (Olive, Apple, Orange, Peach, Almond).

CO_2 RPA was developed in excel (.xlsx) format. Its 9th version is provided in Annex C.4. Each one of the nine versions represent successive development stages based on the progress in structuring the algorithm and creation of the database as well as on the improvements which were performed according to the trial operations results.

Further works that are required to be completed (they have been already initiated and currently are in progress) are:

☑ the collection of missing data to complete the supporting back-end database

☑ the development of the pesticides section to calculate EP_p (CO_2 Emissions Potential due to the use of pesticides)

☑ the development of the soil section to calculate SP_S(CO_2 Storage Potential of soil regarding the carbon of the fallen biomass). UEHR has selected for this purpose to analyze the RothC model due to its simplicity and the availability of data (at regional and national level in Greece, Italy and Spain) to run the model. To this end, data input from Actions C.2 (climatological variables), C.1 (biomass litter) and soil characteristics are available and preprocessed.

☑ the trial operation of CO_2 RPA by AUA, CSIC and UNIBAS in order to identify possible points that need to be improved.

For this purpose, as well as due to the 6 months extension of the implementation of Action C.1, a 9 months prolongation of Action C.4 is needed (the actual work load for this Action was originally underestimated during the preparation of the project Proposal). This prolongation is considered substantial in order to deliver an algorithm of optimum performance regarding the calculation of the CO_2Removal Potential.

Action C.5 Suggestions and Evaluation of Climate Change Mitigation policies and measures

Foreseen start date: 1/06/2017	Actual start date: 1/09/2017
Foreseen end date: 30/09/2018	Actual (or anticipated) end date: 28/6/2019

Action C5 started with a 3 months delay following the delays in the implementation of Actions C.1, C.3, C.4., as the Action's main purpose is to develop a set of suggestions for mitigation policies using data from the relevant previous Actions.

The first step within Action C5 is to assign monetary values in the CO_2 sequestration induced by crop cultivations. CO_2 sequestration is an externality with positive, but yet ignored in economic terms, impacts on society. C5 attempts to attribute a monetary value to this externality. Such values could enrich agriculture and climate policies as well as relevant decision making processes. The monetary valuation of CO_2 sequestration will be incorporated in the web based tool (Action C3) through an "economic module" which calculates the monetary benefit in the specific characteristics of such case study.

Within this reporting period, a variety of carbon prices were collected and reviewed. The values from Emission Trading Schemes and carbon taxes models were collected from global databases. At a next step, the carbon prices obtained by the voluntary carbon markets covering a wide variety of global projects, and the compliance schemes were reviewed. Furthermore, a review was conducted in order to identify carbon values derived through various Integrated Assessment Models (IAMs). IAMs attribute values on CO_2 emissions valuing the negative externality of emitting CO_2 in the atmosphere, known as the "Social Cost of Carbon" or SCC. At the margin the monetary value of CO_2 emission

equates the value of CO_2 sequestration. Therefore SCC prices could be used as a proxy for the CO_2 sequestration, taking also into account limitations. SCC values were estimated under different Integrated Assessment Models, like DICE, RICE, FUND, PAGE etc and a detailed report containing information on these models, their analytical use was attempted. Beyond the above mentioned values of CO_2, C5 investigated also agriculture-relevant CO_2 values and prices. Recent EU reports suggest a price of around €20/ton of CO_2 in the agriculture sector which belongs to the "non-ETS" sectors (EU, 2016). As a next step, a combination of all the evidence on carbon pricing will be attempted in order to propose a set of appropriate carbon prices in the calculations of the economic module for evaluating different mitigation scenarios.

The beneficiary in charge has also started to investigate the implications for the EU's revised Common Agricultural Policy (CAP).The rationale behind the policy proposal under development is to enhance the European tree crop cultivation sector with climate objectives by developing appropriate incentives to motivate the farmers to apply "carbon" friendly practices. As CO_2 sequestration is a positive externality which reflects the status of an important ecosystem service, a payment vehicle may enrich its potential. CLIMATREE seeks to define the principles that underline such an ecosystem payment vehicle and traces how to incorporate it within the framework of the revised CAP.

The final report on policy suggestions for climate change mitigation is expected by June 2019.

Based on the appropriate carbon values, the economic benefits of the proposed policies and measures will be evaluated by Action D.1 (Evaluation of the Effectiveness of the proposed policies and measures). In this respect benefits from using new cultivation practices in tree crops will be evaluated. The findings of C.5 Action will be incorporated in the investigation of the overall socioeconomic benefits of GHG reduction in agriculture foreseen in Action D.2.

The main concept of the policy proposal under development is to enhance the European tree crop cultivation sector and to motivate "carbon" friendly practices through the introduction of these cultivations into an Emissions Trading system.

Reference: EU 2016, Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry into the 2030 climate and energy framework, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2016:0479:FIN

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

Foreseen start date: 1/10/2017	Actual start date: 1/10/2017
Foreseen end date: 30/04/2019	Actual (or anticipated) end date: 28/06/2019

Action D.1 regularly started in October 2017. Due to the required extension of Actions C.1, C.3 & C.4, the anticipated end date would be optimally extended beyond the official end date of the project (28/06/2019).

Based on a literature survey that has taken place, Action D1 has already started to identify some key criteria in order to evaluate the best cultivation practices proposed in Action C1

including:

- Reduction of GHGs emissions
- Impact on regulating/supporting ecosystem services
- Impact on increasing SOC

The overall objective of the D1 Action is to provide the basis to expand awareness of agricultural land (namely tree crops) as carbon sink.
In combination with the literature survey, key documents, outputs and knowledge provided by the Action C.2 (Projections of future climatic conditions for tree crop categories in S. Europe), Action C.3 (Interface development of software application) and Action C.5 are under assessment. Hence the evaluation of the effectiveness of the proposed policies and measures is ongoing and will be enriched by the outputs of the aforementioned Actions.

Moreover, the results will be compared with measurements exported through the operation of the interface (Action C.3) and will also be examined in a holistic approach regarding their effectiveness to promote innovative policy suggestions (Action C.5) based on the performance indicators. This last step is expected to last until the rest of the remaining time for this action. The delay of this action is foreseen to follow the overall delay in C and D Actions already explained above, affecting also the expected deliverable on “The evaluation of policy suggestions for climate change mitigation policies".

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

Foreseen start date: 1/10/2017	Actual start date: 1/4/2018
Foreseen end date: 30/04/2019	Actual (or anticipated) end date: 28/06/2019

Action D.2 started on April 2018 following a required extension of the implementation of Actions C.1, C.3, C4 and C.5. Similarly to Action D.1 the anticipated end date would be optimally extended beyond the official end date of the project (28/06/2019).

Action D.2 investigates the potential impacts of the CLIMATREE findings on society. As CLIMATREE investigates a fundamental Ecosystemic Service (ES) of crop cultivations, their capacity to sequester CO_2, Action D.2 will attempt to elucidate the preferences of individuals in the study areas for this ES. By applying novel and standard methodologies from environmental economics one could define economic benefits arising from CO_2 sequestration. Action D.2 applies a survey process to identify individual preferences against CO_2 sequestration by agricultural activities. Following extensive meetings among the responsible beneficiary's team, the design of 1st draft questionnaire was initialised (Annex D.2). The questionnaire will be based on a novel/prototype valuation methodology which focuses on the evaluation of households' preferences under different consumption scenarios based on the actual family's shopping basket/portfolio. As a result, the methodology combines elements of both stated and revealed preferences methods and so it eliminates those constraints arising from sole stated preferences. The findings of the Action will be compared to relevant findings from other LIFE project such as Carbon Credits (e.g. OLIVE4CLIMATE). Carbon credit is the title of an economic incentive defined for olive-oil products by OLIVE4CLIMATE project. This is based on an indirect evaluation of the CO_2 mitigation potential which could arise out of the proper management of the production process of olive oil. Once properly managed, olive oil production may lead to positive climate effects whose economic value could be used as an incentive for farmers and other stakeholders. CLIMATREE will take into consideration those findings

and compare them with the monetization results produced though the analysis of the surveying process.
In the forthcoming period a pilot test of the designed questionnaire will take place in Athens and the survey will be implemented in Greece and Spain, with potential extension in Italy.

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 (or anticipated) end date: 28/06/2019

During the progress for this action the consortium has defined the following aspects to be studied during the last year of the project execution.

1. Definition of the measures to be suggested

- Implementing woody perennial crops with high resiliency to climatic changes and extreme events. This implies the possibility of selecting woody perennial crops with increased drought resistance such as olive, pomegranate and almond. The current makets yield value for these crops can also result in important economic benefits for farmers
    - Implementing agro-forestry practices. Agroforestry is a land use management system in which trees or shrubs are grown around or among crops or pastureland. This can be promoted in more humid areas under a precipitation regime of more than 600 mm/year. Cereal crops and pastureland can be then re-converted to increase the CO_2 absorption capacity in the soil as well as in the woody perennial structures.
- Implementing greening practices (soil conservation). This includes the selection and implementation of appropriate cover crops mixtures depending on the soil and environmental conditions within the area. The mixture should always include both grass and leguminous species in order to increase soil water retention capacity and the nitrogen levels

2. Methods to quantify the impact

- CO_2 sink capacity through both modelling and experimental data collection.
- Economic returns for end-users
- Carbon and water footprints and the possible implementation of eco-innovation label to recognize in the local and international markets the efforts carried out to reduce carbon and water footprints.

3. Agro-ecosystems to focus

- Arid and semi-arid conditions, where water stored in the soil is the main limiting factor for implementing the ecosystem function restoration activities
- Extensive woody perennial area, where tree productivity and therefore the CO_2 source capacity is limited by the cultivation methods and the low inputs used.
- Intensive current open-field vegetable crops to be planted with intensive woody crops. This considers the possibility of replacing current vegetable crops land with woody crops able to capture and store CO_2 in their woody permanent structure. The socio-economic consequences around this possible cropping patterns changes will be evaluated considering the entire value chain.

So far the consortium has been working on reviewing the CO_2 absorption potential for the most common woody perennial crops in the Mediterranean Sea basin (link with previous actions) and analysis of water footprint when replacing horticulture cropping areas with woody perennial crops. For instance, data obtained in a citrus orchard have shown that the citrus orchard are able to fix up to 3,855 kg CO_2/ha/year, demonstrating its ability to fix carbon.

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: 28/06/2019

The design of the website and the development of its content started in October 2015. The 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. The website is being maintained and will continue to be maintained and updated until the end 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 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 30.9.2018, 2,660 visitors of CLIMATREE website have been recorded. Approximately 9,424 page views were reached with an average of 3.54 page views/ visitor.

The website features the budget, EC contribution and an explicit acknowledgement to the support of the LIFE financial instrument of EU.

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.

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 Anticipated end date: 28/06/2019

The Dissemination strategy (Annex F.3.1 of the Mid Term Report) 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. Within this reporting period the dissemination strategy continued mainly with the establishment of contacts with relevant LULUCF experts in the 3 countries, and an exchange of expertise over the content of the web based tool to incorporate the challenges and limitations of this specific sector. In this respect, a

group meeting took place in the premises of UEHR (7/2018) among UEHR's group and Mr. Iordanis Tzamtzis (Greece's LULUCF corresponding officer) and Mrs Juan Jose Rincon Cristobal (Spain's ex-LULUCF corresponding officer) in order to further discuss the prospect of incorporating CLIMATREE's results onto forthcoming policy proposals. Beyond its genuine merit the web tool is expected to support project's key actions (C& D sets of Actions), which are expected to drive the dissemination of CLIMATREE in farmer and agricultural stakeholders, starting from the next meeting designed to take place in Spain during March 2019.

Indeed, the next steps of the dissemination strategy will be targeted to key stakeholders of the agricultural sector who shall test the efficacy of the web based tool to contribute into designing effective mitigation policies in the tree crops sector. Particularly a thematic workshop is foreseen to take place along within the organization of the next project meeting in Murcia (03/2019). This event is foreseen to be followed by a visit to relevant ministries and authorities in Madrid for presenting the potential of CLIMATREE to contribute in national mitigation policies. In fact this meeting will initiate a phase of extensive dissemination activities including: a) relevant stakeholders of the agricultural sector in the 3 countries, b) relevant ministries in the 3 countries and c) the relevant EU authorities.

A series of important activities took place during this reporting period serving the overall dissemination and networking strategy of the project already presented and submitted in Annex E.3 & F.3. Lastly, an update of Noticeboards has taken place in Spain and relevant photos can be found in the same Annex (E.3 & F.3).

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	Anticipated end date: 28/06/2019

On March 2017 the Mid Term Report of the project was submitted to the EU and the 2nd Financial Installment was transferred to CLIMATREE's coordinating beneficiary on 2/9/2017. The transfer of payment to all beneficiaries according to the project's approved budget was followed. Another important milestone has been the organization of the 3rd Project's Visit in collaboration with the project's monitoring officer accompanied by Mrs. Hana Mandelikova officially representing the EU and particularly the EASME Unit. The visit was held in the premises of Panteion University in Athens (19/3/2018). During the visit CLIMATREE's Actions' progress was presented and discussed and a financial check took place on the basis of each beneficiary. The event was briefly covered by a short press release of the Greek TV channel Skai (http://www.skai.gr/player/TV/?mmid=303460). During the visit the official timeline of the project was discussed particularly regarding the adequate development of the running project's Actions. Following the project's visit, a couple of internal meetings, as well as the official EU letter (20/07/2018), it has been decided that the project will officially ask for a one year prolongation (28/06/2020) in order to meet the expectations in terms of policy impact and replicability of the project's results in Greece and other EU Member States within and after the duration of this project. Following, this internal decision a round of communications was held among beneficiaries in order to identify whether a financial amendment would be also needed. After an updating on the beneficiaries financial data and forecasting it was decided that there would be no need for requesting a financial amendment.

Overall, all partners continued to submit on a monthly basis their progress in line with the Actions which are under implementation and a constant communication was held with all Beneficiaries through emails, telephone contacts, skype meetings, working groups and regular team meetings to ensure the proper administrative, financial and technical progress according to the approved time schedule. In regards to future group meetings an initial plan has been made for the organization of the next project's event accompanied by a project monitoring visit in Murcia on March 2019.

A full list of all the meetings and events that took place within this reporting period is presented in the Annex of Action F.1.1. Lastly, it should be noted that might the foreseen end date of the project be extended the works of this specific Actions will follow the new agreed deadline.

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	Anticipated end date: 28/06/2019

The 2nd QA/QC report was completed on December 2017 prior to the submission of the Mid Term Report, covering the activities of the project until 31/12/2017 and can be found as an Annex F.2. In this same report a table listing the deliverables and milestones foreseen for the reporting period can be found, indicating the actual date of completion/ accomplishment and the date foreseen in the revised period.

During this reporting period all beneficiaries continued to submit to the coordinating beneficiary their financial progress and documentation every 3 months. As also mentioned in Action F.1 an extensive exchange of the beneficiaries financial documentation took place in order to identify the need for requesting a budget amendment.

The 3rd QA/QC report is expected to be delivered according to the project's schedule by December 2018.

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 (or anticipated) end date: 28/06/2019

CLIMATREE's structured networking strategy continued mainly with collaboration and communication with other relevant projects and key stakeholders. Specifically, during this reporting a close collaboration was kept with projects LIFEOLIVE4CLIMATE (LIFE15CCM/IT/000141) and LIFE MEDINET (LIFE15 PRE/IT/000001),as well as with the European Agroforestry Federation (http://www.agroforestry.eu). The collaboration with Olive4climate focuses on the exchange of information on the issue of carbon values also examined under Action D.2 and with Medinet on the exchange of data in specific categories of LULUCF. Indicatively, during this reporting period CLIMATREE participated in: LIFE Platform meeting on Ecosystem Services, Tallinn, Estonia (10-12 May, 2017), (CSIC) assisted to a networking event organized by the LIFE IRRIMAN+ project where potential connections between IRRIMAN and CLIMATREE projects were discussed, "Workshop of LIFE MediNet 4-5 December, 2017 Lisbon- Portugal, International Agricultural Exhibition of Agrotica (Thessaloniki, 2/2018), Medinet's workshop on "gain and losses in soil organic carbon" , 14th-16th of June, in Viterbo Italy.

A full list of all dissemination and networking activities in presented in Annex E.3 & F.3.

No remarkable problems have been encountered for this specific Action so far.

Action F.6 Indicator Tables of Project's Progress

Foreseen start date: 31/03/2017	Actual start date: 31/03/2017
Foreseen end date: 28/06/2019	Actual (or anticipated) end date: 28/06/2019

More specific and updated estimates concerning the CO_2 balance of tree crops will be extracted upon the completion of Actions C.3 and C.4. These estimates will be compared to the national GHG inventories and will contribute to more precise estimates concerning croplands at the aggregate national level.

CLIMATREE estimates could be used as a verification variable which could have further effect:

- To reduce the inherent uncertainty of GHG inventory
- To support the incorporation of clima objectives within agricultural and land use policies
- To indentify the ecosystemic contribution of tree cultivations.

6. Envisaged progress until next report

Regarding Action C.4, a number of further works (collection of data for the back-end database, development of EP_p and SP_S equations, trial operation of CO_2 RPA by AUA, CSIC and UNIBAS) are required to be completed (they have been already initiated and currently are in progress). For this purpose, a 9 months prolongation of Action C.4 is needed (the actual work load for this Action was originally underestimated during the preparation of the project Proposal). This is considered substantial in order to deliver an algorithm of optimum performance regarding the calculation of the CO_2 Emissions Potential. In addition, the progress of C.4 has provided C.3 with the substantial input for the development of the "tool" permitting operational applications of CO_2 balance. In addition, a public tender for the development of the "Web Tool" will be launched by UEHR (C.3 Action). As described in the respective section the tool has been delineated and in the immediate next period it will be made fully operative once the subcontracting process will be completed. In addition, the main deliverables of Action C.5 are expected to be completed by 28/06/2019. In addition, Actions D.1, D.2 and D.3 will proceed according to the progress achieved mainly in Actions C.3, C.4 and C.5 and the dissemination strategy is expected to be more actively orientated to the relevant stakeholder described earlier in this report. Lastly, the next project meeting is expected to take place on March 2019 in Murcia along with a dissemination event directed to Spanish farmers and stakeholders on the use of the web-based tool.

A detailed Gantt chart can be found as Annex F.1.3.

7. Impact

Climate Action:

The project aims to contribute towards the promotion of climate change mitigation actions in two directions. On the one hand, it contributes to improving estimation on the carbon sequestration potential of tree crops and accordingly to support European Clima Policies by influencing the relevant official documents and legislative framework. The implementation of the relevant LULUCF framework and the inclusion of the agricultural sector on the framework of the Decision 529/2013 (EC, 2013), which targeted reduction of GHG emissions (i.e. 20% below the 1990 emissions by 2020), will be enhanced through the implementation of the project's key actions. Towards this objective we have established systematic networking with LULUCF reporters in the three countries. Through this networking we try to address their concerns, existing limitations and to reduce the uncertainty in the relevant estimates. We are also collaborating with other relevant LIFE Clima projects, such as LIFE Medinet, seeking towards a coordinated set of actions towards National and European authorities.

On the other hand, the identification of the socioeconomic benefits of the best tree-crop practices are expected to contribute towards a better understanding of the farmer's role. According to these outputs a set of relevant policy proposals, promoting the economic and social benefits of climate change mitigation actions, will be developed targeted at national and EU level. The project aims to contribute towards the promotion of novel approaches in regards to the role of tree crop farmers as "carbon sequesters" from a socioeconomic perspective and link them to specific EU and national policies.

In this respect, the methodology which is in progress through CLIMATREE's action plan:
a) contributes towards a better estimation of the CO_2 emissions and removals resulting from cropland management (i.e., permanent tree-crops);
b) facilitates the monitoring and accounting of carbon stock and fluxes for land use planning
c) informs decision makers towards the formulation of agricultural strategies taking into account the active role of farmers as "carbon sequesters", being an important ecosystem service.

CLIMATREE through the development of the "Web based tool" (Actions C.3 & C.4) and the formulation of policy proposal (Actions C.5 & D.1) supports the implementation of the EU's climate policy and prepares the EU for climate actions challenges in the coming decades, contributing to climate change mitigation through an improved Greenhouse gas accounting of land use.

CLIMATREE's Action plan will further highlight the role of tree crops to contribute to atmospheric CO_2 removal/sequestration, hence national/regional policies might support/promote new tree plantations as a climate oriented strategy.

Key Project-level Indicators (KPIs):

As already highlighted in the previous progress reports, most of the project's indicators are connected with the outcome of Action C.4, the atmospheric CO_2 Removal Potential Algorithm. The update of specific indicators will be possible upon the completion of the specific Action (expected by 03/2019). The key indicator is the CO_2 Removal Potential that will be calculated for Greece, Italy and Spain for the 5 species (orange, olive, apple, almond, peach) of tree crops that are studied within the project. The sub-sections of the CO_2 Removal Potential will be analyzed regarding their significance. Moreover, they will be analyzed in comparison to alternative cultivation practices that could be applied towards a "greener" agriculture.

Other indicators to be included in the analysis:

Soil carbon sequestration

According to IPCC, soil is among the main carbon pools that ought to be monitored in the agricultural sector in order to determine the impact of management practices on GHG emissions/removals. Several models predict the variation of SOC stock (due to the management options adopted) and environmental weather conditions.

CLIMATREE will attempt to evaluate the soil-based CO_2 pool under different management practices. As a result, soil sequestration potentials will be identified and ranked. This is a rather ambitious attempt when compared to the current estimations of soil CO_2 sequestration potentials whose annual changes are reported as zero in the far majority of the cropland area in the three countries.

Based on this findings we will attempt to trace the effects of SOC stock in soil on major soil-based ecosystem services, such as water retention.

Policy implications:

The development of the Project's overall networking and dissemination strategy (as already delivered in Annex F.3.1 of the Mid Term Report) is to ensure the information and involvement of key actors at four levels: a) Global level, b) EU level (EC, Directorate General for Agricultural and Rural Development, Directorate General for Climate Action), c) Member States level (Ministries of Agriculture and Environment), d) Regional level (Regional/ provincial authorities, prefectures).

The outcomes of the project are expected to contribute towards EU policy recommendations by providing an integrated approach regarding the CO_2 Removal Potential that can be achieved by the tree crops cultivations. Towards this objective CLIMATREE has contacted European and National Authorities related to the LULUCF relevant policies in the 3 countries. The final outputs provided through the implementation of C Actions will be communicated to relevant EU authorities (DG CLIMA, DG AGRI, etc) as well as to National Policy makers (Relevant Ministries, and LULUCF officers). CLIMATREE project has been officially presented to delegates of the Climate Change Units and LULUCF experts of the 3 countries. Communications with the aforementioned stakeholders will be further intensified within the next months upon the completion of the CO_2 Removal Potential Algorithm as well as the functional operation of the respective web-based tool.

Furthermore, the alignment of CLIMATREE with the 'Greenhouse gas Monitoring Mechanism Regulation (MMR)'' and other relevant policy proposals issued from the DG Clima is of key importance for the preparation of policy proposals that will be designed for future use by the National Authorities of Greece, Italy and Spain. Specifically, in Spain a link has been established with the "Oficina Española del Cambio Climático" and the methodology used for accounting CO_2 sequestration by different pools has been shared. A further contact is expected to take place in the frames of the next group meeting in Murcia foreseen for the March 2019.

The very same meeting will initiate an effective communication of the project outcomes to farmers as potential users. Indeed the project will seek potential implication in the practices of farmers. Although it is not within the major objectives of the project, an effective dissemination of the potential of certain cultivation practices to sequester CO_2 will be communicated to farmers with the meeting in Murcia to be the first relevant event.

8. Replies to Technical issues of Ares(2018)3877308 - LIFE14 CCM/GR/000635 - CLIMATREE - Project Visit

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

1. Please clarify the actual number of different farmers that participated in the survey and provide scientific evidence showing that the size of the sample is representative and leads to statistically significant outcomes.

In 2016 the year that the survey was performed, the total number of farms in Greece was 562.965, from which 27% regarded tree crops, indicating thus 152.000, as the total number of Tree-Crop farms [1]. Considering that this number corresponds to farmers (N=152.000), which grow exclusively Tree-Crops (P=1), and desired Coefficient of Variation 5% (CV=0,05), we utilized the USDA guidelines on Survey Design and Estimations for Agricultural Surveys [2]. The formula indicated in page 72, was used with the above given figures and the sample size was defined as **67 farmers**.

Even though this was an adequately documented sample size we decided to set a higher **target of 250 farmers**, aiming to provide more accurate and credible estimations, but also defining a minimum **threshold of 125 farmers**, which was almost double to the scientifically defined sample size.

The total number of participants in the study was **155 farmers**, which translate to the 0,1% of the total Greek Tree-Crop Farms. This sample size is considered adequate for the extraction scientifically sound conclusions, and exceeds by almost 24% the initial threshold and by 131% the scientifically defined threshold. In specific the number of farmers participated in the survey are indicated by the number of questionnaires, which are given in follow for each Tree-Crop:

- Olive: 41 Questionnaires
- Orange: 48 Questionnaires
- Peach: 34 Questionnaires
- Apple: 29 Questionnaires

- Almond: 03 Questionnaires
- **Total: 155 Questionnaires**

It must be noted that in the case of Qualitative studies reviewed by Burton and Wilson in 2006 [3], it has been indicated that a bigger sample size is required. Even though in our case the survey was targeting quantitative – numeric – data, we cross-checked our initial design against two international case studies.

The first regarding the study of the agri-environmental schemes environmental effects in Western Europe [4] was based on 789 farmers from 10 different countries suggesting an average sample size of almost 80 farmers per country. This figure was well in our limits and was surpassed by almost 94% by our results.

The second study regarded 12 sites across 9 countries: Ethiopia and Kenya in East- ern Africa; Malawi, Mozambique and Zimbabwe in Southern Africa; Niger and Nigeria in Western Africa; and Bangladesh and India in South Asia. In each site, one or two main regional markets were selected, around which a set of 4–8 villages was randomly selected stratifying by distance to the selected markets and major roads. The village surveys were carried out during 2010 and early 2011 with groups of 10–30 farmers of different age, gender, land and livestock ownership to capture the diversity of farming practices, including main crop residue uses and general information about each local context. These figures translate to a range of 480 - 2.880 participating farmers from 9 countries, indicating an average of 53 - 320 farmers per country. Also in this case our results stand almost in the middle of the suggested sample size indicating the validity of our results.

[1] Seraskeris N and Dionysopoulou L. Research on the Articulation of Greek Agricultural and Livestock Farms of 2016. Hellenic Statistical Authority. Athens. p. 36.
[2] Vogel FA. Survey Design and Estimations for Agricultural Surveys. (1986). U.S. Department of Agriculture, Statistical Reporting Service. Washington DC. p. 74.
[3] R.J.F. Burton, G.A. Wilson. Injecting social psychology theory into conceptualisations of agricultural agency: Towards a post-productivist farmer self-identity Journal of Rural Studies 22 (2006) 95–115. https://doi.org/10.1016/j.jrurstud.2005.07.004
[4] J. Primdahl B. Peco, J. Schramek, E. Andersen, J.J. Onate. Environmental effects of agri-environmental schemes in Western Europe. Journal of Environmental Management 67 (2003) 129–138. doi:10.1016/S0301-4797(02)00192-5
[5] D. Valbuena et al. / Field Crops Research 132 (2012) 175–184. doi:10.1016/j.fcr.2012.02.022

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

2. Please discuss the reasons for dropping the use of the initially foreseen CESAR model and the use of the RothC model. Refer to the analysis and credibility of each model's results.

The CESAR model (Vleeshouwers and Verhagen, 2002) is an integrated approach capturing the effects of crop, climate and soil on the carbon budget. It is detailed and as a result requires a number of parameters not readily available for the tree crops in the Mediterranean region. For that reason our approach, as far as the tree is concerned, is based on the data collected in C1 and for the soil in model RothC (Coleman and Jenkinson, 1996; Coleman et al., 1997). RothC , which has many common ideas with other models like

CENTURY, needs few inputs that are easily obtainable. It is based on first order kinetics and so an analytic solution can be acquired and adopted for the web based application providing us with instantaneous results. As far as accuracy and credibility is concerned, RothC has been tested and updated for Spain (Farina et al., 2013) and Italy (Farina et al., 2013) and has been compared with the major soil models (CENTURY, CANDY among others) using datasets from long-term experiments, a study which is available in a special issue of Geoderma (1997).

Coleman K., Jenkinson D.S. (1996) RothC-26.3 - A Model for the turnover of carbon in soil. In: Powlson D.S., Smith P., Smith J.U. (eds) Evaluation of Soil Organic Matter Models. NATO ASI Series (Series I: Global Environmental Change), vol 38. Springer, Berlin, Heidelberg.

Coleman K., Jenkinson D.S., Crocker G.J., Grace P.R., Klir J., Korschens M., Poulton P.R. and Richter D.D. (1997). Simulating trends in soil organic carbon in long-term experiments using RothC-26.3, *Geoderma* 81, 29-44.

Farina R., Coleman K., Whitemore AP., (2013). Modification of the RothC model for simulations of soil organic C dynamics in dryland regions, *Geoderma* 200, 18-30

Farina R., Marchetti A., Francaviglia R., Napoli R. and Di Bene C. (2017). Modeling regional soil C stocks and CO_2 emissions under Mediterranean cropping systems and soil types. *Agriculture, Ecosystems and Environment* 238, 128-141.

Vleeshouwers L.M., Verhagen A., (2002). Carbon emission and sequestration by agricultural land use: a model study for Europe, *Global Change Biology* 8(6), 519-530.

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

3. Thank you for presenting the algorithm during the visit. Please discuss whether you intend to publish the new accounting methodology in peer reviewed journals and present it in relevant conferences. In addition, discuss other plans you have that will be used to verify its scientific coherence and added value for the policy makers and stakeholders. In the action's foreseen report, please remember to identify all sources used for the design of the algorithm and refer to any limitations in their use.

Indeed, we are planning to publish an article in peer reviewed journal regarding the CO_2 Removal Potential Algorithm (RPA) that is under development in Action C.4, which will present its concept, its structure and of course its equations. The publication of further articles to present results and conclusions extracted by the use of the CO_2 RPA upon its completion is also under consideration.