LIFE Project Number

LIFE14 CCM/IT/000905

Progress Report[1]

Covering the project activities from 30/09/2017[2] to 30/09/2018

Reporting Date[3]

30/09/2018

LIFE PROJECT NAME or Acronym

LIFE FoResMit

Data Project

Project location:	Italy Toscana; Greece: Anatoliki Makedonia, Thraki
Project start date:	01/09/2015
Project end date:	31/08/2019
Total budget:	€ 1,480,568
EU contribution:	€ 879,264
(%) of eligible costs:	60

Data Beneficiary

Name Beneficiary:	Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria
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Project Website:	www.lifeFoResMit.com

[1] Progress Report without any payment request (for Progress Reports with payment request, use the Mid-term Report template)

[2] Project start date in the case of the first Progress Report, otherwise date since the last reporting period

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

1. Table of contents

2. List of key-words and abbreviations

- BD = Bulk Density
- C = carbon
- CEC = cation exchange capacity
- CH_4 = methane
- CO_2 = carbon dioxide
- CRU = Climate Research Unit
- EGM = Environmental Gas Monitoring
- FoResMit = Recovery of degraded coniferous Forests for environmental sustainability Restoration and climate change Mitigation
- GHG = green-house gas
- GWP = Global Warming Potential
- IRGA = Infra-Red Gan Analyzer
- N = nitrogen
- NGO = non-governmental organization
- N_2O = nitrous oxide
- NPP = Net Primary Produtivity
- PCR-DGGE = Polimerase Chain Reaction - Denaturing Gradient Gel Electrophoresis

3. Executive summary

3.1 General progress

This report is an update of the activities carried out under the project LIFE "Recovery of degraded coniferous Forests for environmental sustainability Restoration and climate change Mitigation - FoResMit" (LIFE14 CCM/IT/000905) over the period between 1/10/2017 and 30/09/2018. Overall, the project achieved the objectives foreseen for this period. Monitoring actions are running as expected, following the protocols defined in the initial phase. The five carbon pools (above and below-ground biomass, litter soil and deadwood) (action D1) and the GHG emissions (action D2) are continuously monitored on 18 sub-plots for each site. Action D3 is running to manage the carbon credits generated by the project and key stakeholders' identification were identified in order to involve them in the future activities of the governance of the project.

A large effort has been put on dissemination actions: 17 technical and scientific papers have been published (Action E5), partners participated to 6 events (Actions E6, E8, E10) and

diffusion to institution and policy makers was implemented (Action E9). We also applied to transfer and replicate the project approach in other areas.

3.2 Assessment as to whether the project objectives and work plan are still viable

The project objectives and work plan foreseen are still feasible and their demonstration is in progress. The activities carried out in the first 3 years of the FoResMit project showed that the foreseen objectives are achievable. In particular, implementation Actions were successful and structural and changes in the forest stands are evident. Monitoring Actions are therefore demonstrating the impacts of thinning treatments, with a good assessment of differences between treated and control plots.

3.3 Identified deviations, problems and corrective actions taken in the period

No deviations, problems and corrective actions taken in this project period. We had a delay in Action D2 related to the measurement of gas samples: the gas chromatograph had a problem with valves because of the breaking of a solenoid. New valves have been bought and replaced. This caused overall a 3 months delay in the gas measurements, but we expect to conclude the Action in the foreseen time.

4. Administrative part

4.1 Description of project management

The FoResMit project proceeds smoothly and all actions are completed or in progress as foreseen. At all times, the FoResMit project has benefited from close collaboration between all beneficiaries, who maintained close contact among each other *via* e-mails, telephone and meetings.

The management of the project has been carried out in compliance with what was established in the proposal approved by the EC. All partners have been acting in compliance with the Grant Agreement and the Partnership Agreement.

The FoResMit management process needs daily work to maintain a permanent flow of action with the aim of achieving the objectives set. The specific management activities carried out by the coordinating beneficiary CREA in this period were:

- Organisation of Coordination meetings;
- Organisation of different phone and web meetings between some beneficiaries, to plan and monitor the project technical activities;
- Continuous contact between all project beneficiaries for monitoring project activities;
- Preparation of material for meetings and dissemination events;
- General actions and activities for the coordination of the project;
- Management of the financial aspects of the project;
- Monthly reports to the LIFE external team monitor on the evolution of the project;

During this project period, the associated beneficiaries PROVIFI, DUTH and DAMT participated in project management activities and attended the project management meetings. In addition, specific monitoring tasks have been carried out for each action:

- CREA, as coordinating beneficiary, has had continuous contact with all project beneficiaries for monitoring project activities;
- CREA, as coordinating beneficiary, has prepared and sent a monthly indication of operative activities to be done to all the partners;
- CREA, as coordinating beneficiary, has sent a monthly report to the monitor of LIFE's External Assistance Team on the progress of the project, allowing to follow-up of the FoResMit project.

Project beneficiaries have carried out different meetings in order to organize, coordinate and develop the project. The coordination meetings, held from 30/09/2017 to 30/09/2018, were:

- Progress and Coordination meetings:
  - Progress meeting on 8-9th May 2018, at the coordinator partner CREA premises and demonstration site in Florence, Italy;
- Monitoring meetings with LIFE's External Assistance Team:
  - Monitoring meeting during the progress meeting on 8-9th May 2018 at the demonstration site and coordinator partner CREA premises in Florence, Italy: Mr. Alberto Cozzi.

In addition, many phone and web meetings between some partners were organised, to plan and monitor the project technical activities.

4.2 Organization of the project team and the project management structure

The project management structure is very simple as only 4 beneficiaries, plus the EC and the LIFE external team. The following diagram provides information about the general management structure (**Figure 4.2.1**):

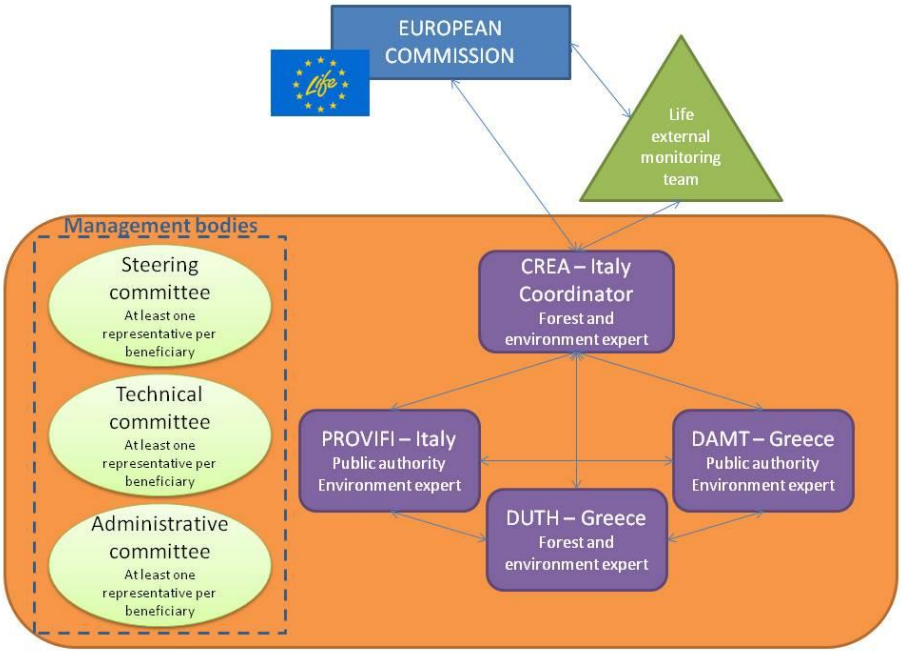

Figure 4.2.1 FoResMit management structure.

In particular the FoResMit beneficiaries defined the following three management structures:

- **Steering Committee:**
  - CREA: Alessandra Lagomarsino, Ugo Chiavetta e Alessandro Paletto
  - PROVIFI: Alessandro Varallo
  - DUTH: Kalliopi Radoglou
  - DAMT: Panagiotis Mouchtaridis
- **Technical Committee:**
  - CREA: Alessandra Lagomarsino e Isabella De Meo
  - PROVIFI: Luciana Gheri
  - DUTH: Elias Milios
  - DAMT: Maria Triadafillidou
- **Administrative Committee:**
  - CREA: Massimo Aglietti
  - PROVIFI: Simonetta Pappalardo

- DUTH: Kyriaki Kitikidou
- DAMT: Foteini Doukalianou

5. Technical part

5.1 Progress per action

Action A1 Climatic characterization and vegetation survey

Foreseen start date: 01/09/2015 Actual start date:01/09/2015
Foreseen end date: 31/12/2015 Actual end date:30/06/2016

Action Completed in June 2016. For details see MTR.

Action A2 Pedological survey

Foreseen start date:	01/09/2015	Actual start date:01/09/2015
Foreseen end date:	31/03/2016	Actual end date:30/06/2016

Action Completed in June 2016. For details see MTR.

Action C1 Realization of thinning intervention in Italy

Foreseen start date:	01/01/2016	Actual start date:01/11/2015
Foreseen end date:	31/12/2016	Actual end date:31/12/2016

Action Completed in December 2016. For details see MTR.

Action C2 Realization of thinning intervention in Greece

Foreseen start date:	01/01/2016	Actual start date:01/01/2016
Foreseen end date:	31/12/2016	Actual end date:31/12/2016

Action Completed in December 2016. For details see MTR.

Action D1 Monitoring and quantification of C pools in vegetation and soil

Foreseen start date:	01/01/2016	Actual start date:01/10/2015
Foreseen end date:	30/06/2019	Actual end date: 30/06/2019

Aboveground biomass

The activities related to the aboveground biomass monitoring for Monte Morello and Xanthi sites from the last report were oriented to three aspects:

1. Checking and further restoring of the field monitoring plot materialization and identification element (plot stakes, tree markings and plot delimitation).
2. Monitoring single tree growth after the thinning: stem cores were extracted, prepared, and read. Data coming from the tree rings were elaborated to assess the single tree growth.
3. Preparing relations between growth and climate for the different species present in the plots in order to understand the effect and the mitigation potential of each of them after the thinning.

Belowground biomass

Since the belowground biomass is derived from aboveground biomass, its progress is perfectly parallel to the progress of the latter for Monte Morello and Xanthi sites.

Litter

Litterfall has been collected from the 72 litter traps installed in Monte Morello and Xanthi sites in January and July 2018 and, according to the previous planning, it has been separated into coniferous and broadleaves and further into leaves, reproductive structures, twigs and branches < 4cm, bark. The results from the sampling of 2017 showed a very similar species composition of the plots with data derived from the aboveground biomass measurements.
Compared to unthinned plots, under selective thinning coniferous litterfall fraction decreased of about 30% while deciduous litterfall fraction increased of about 12.5 %, in line with the project objective to favor broadleaves native species. On the other hand, under traditional thinning both coniferous and deciduous litterfall fractions decreased of about 20 % and 7%, respectively.
The results of the new sampling (2018 - the second year after thinning intervention), can be obtained at the end of the current growing season to complete the physiological processes related to all litter fractions to be collected and measured.

Forest floor

Litter has been collected in November 2017 in each sub-plot, for a total of 72 sampling points in Monte Morello and Xanthi sites, as foreseen in the protocol. Collected samples were fractionated in the fractions L, F and H and the following analyses have been performed on each fraction:

- C and N percentage content and stock (g m^{-2}) for both sites.
- Enzyme activities related to the cycling of C, N, P and S, at Monte Morello site: N-acetyl-β-glucosaminidase (NAG), β-glucosidase (βG), butyrate esterase (BUT), acid phosphatase (AP), arylsulphatase (ARYL), β-xylosidase (XYL), cellulose (CELL) and acetate esterase (AC).
- The composition and structure of the bacterial and fungal communities, at Monte Morello site.

These last two measurements were not foreseen in the initial project but gave important indications on the short-term impact of thinning on litter characteristics, decomposition rates and therefore C input and losses. Decomposition process was characterized by changes in chemical and microbial comunities composition, driving differences in enzymatic pattern and functional diversity among litter fractions. Thinning operations basically increased litter biomass in all fractions, and the highest increase was observed in F fraction with traditional thinning (thinning from below). C and N content of litter fractions was not affected by treatments, confirming similar characteristics in the three theses. The increase of biomass did not correspond to an increase of litter activity. Enzyme activities showed the lowest values in the selective thinning in all fraction, showing a clear trend towards lower decomposition, mainly for cellulose and hemicellulose degrading enzymes.

Deadwood

In the period from October 2017 to September 2018, the amount of CO_2 saved by the deadwood volume employed for energy generation (woodchips, process residues, end-of-life products) at Monte Morello site was estimated in accordance with the principles of circular bioeconomy. During the silvicultural treatments, lying deadwood and standing dead trees volume belonging to 1st and 2nd decay class with diameter above 30 cm was collected in the selective thinning. In the forest area managed with traditional thinning only standing dead trees are harvested, while lying deadwood was not removed. Consequently, a deadwood

volume of 9.5 m^3 ha^{-1} was removed in the area managed with traditional thinning (5.35 ha) and 18.2 m^3 ha^{-1} in the area managed with selective thinning (4.73 ha). Therefore, in the Monte Morello forest more than 30% of the deadwood stock (equal to 8 tCO_{2eq} ha^{-1} in parcels managed with traditional thinning and 16 tCO_{2eq} ha^{-1} in parcels managed with selective thinning) has been withdrawn and used for energy purposes. Consequently, the total deadwood C-stock has decreased of 117.8 tCO_{2eq} in 10.08 ha (74.1 tCO_{2eq} in parcels managed with selective thinning and 43.8 tCO_{2eq} in parcels managed with traditional thinning).
Conversely, the CO_2eq emissions saved were estimated in 627 $kgCO_2eq$ m^{-3} of deadwood removed during the silvicultural treatments for a total of 85.8 tCO_{2eq} in 10.08 ha.
We investigated the correlation between the decay of logs, the decomposer microorganisms and their activities, in terms of GHG production and enzymes. The decomposition of deadwood was visually assessed using a five decay-class system and for each decay class four wood samples were collected. CO_2, CH_4 and N_2O potential production from each decay class was measured in closed systems by means of gas-chromatography. Enzyme activities related to carbon, nitrogen, sulphur and phosphorus cycling were measured fluorometrically. The composition of decomposer microbial communities (fungi, bacteria and actinobacteria) was assessed by using PCR-DGGE fingerprinting. CO_2 production and enzyme activities were significantly higher in the last decay classes of deadwood. The molecular approach highlighted differences in microbial community structure both at species and abundance level, depending on the rate of decay.

Soil
Soil samples were collected in Monte Morello and Xanthi sites in November 2017 at depth of 0-10 and 10-30 cm within each plot, for a total of 72 samples and 216 measures carried out and elaborated. Total organic C (TOC) and total N (TN) contents in the bulk soil were measured by dry combustion on a Thermo Flash 2000 CN soil analyser. Further, undisturbed soil samples were collected for soil bulk density (BD) measurement, to calculate soil organic C stock for each depth.
The effect of thinning appeared clearer under selective treatment, inducing a general increase of C and N stock (Kg m^{-2}) in the deeper layer at both sites, although C stock was greater in Xanthi and N in Monte Morello. The selective thinning increased soil C and N stock also in comparison with the traditional one, although at the Monte Morello site was not significant. On the other hand, at the Xanthi site thinning produced a significant increase of C stock in the upper soil layer both under selective and traditional treatments and in the deeper layer under the selective one.

Action D2: Monitoring and quantification of GHG emissions and Global Warming Potential

Foreseen start date:	01/01/2016	Actual start date:01/01/2016
Foreseen end date:	30/06/2019	Actual end date: 30/06/2019

The Action is divided into three sections, related to: i) GHG (CO_2, N_2O and CH_4) from soil with field sampling and gas chromatographic determination; ii) CO_2 field measurement with and without litter, iii) GHG (CO_2, N_2O and CH_4) fluxes from deadwood with field sampling and gas chromatographic determination

GHG emissions from soil – gas chromatographic determination
From October 2017 to September 2018, 40 sampling events has been performed in Monte Morello and Xanthi sites, with a total of 5000 vials collected. 75 % of samples were analysed by

gas chromatography and 75% of GHG fluxes have been calculated between October 2017 and September 2018 for both sites.
Soil temperature resulted the main driving variables for CO_2 efflux and CH_4 uptake. Soil moisture content and organic matter pools featured distinct CO_2 emission patterns between the two sites. N_2O fluxes showed a positive correlation with soil moisture under wetter climatic conditions only (Monte Morello). GHG fluxes showed significant correlations with C and N content of both forest floor and mineral soil, especially in the deepest layers, suggesting that it should be considered, together with environmental variables for accounting GHG fluxes in degraded forests.
Short-term effects of thinning on CO_2 emissions were dependent on the timing of logging operations and organic matter inputs. After thinning CH_4 uptake increased significantly under selective treatment, independently from specific site-induced effects. N_2O fluxes were characterized by low emissions in both sites and were not affected by treatments. Soil CO_2 efflux was the largest component of global warming potential (GWP) from both sites (11553 Kg ha^{-1} y^{-1} on average). Although its large global warming potential, N_2O contribution to GWP was about 131 Kg CO_2eq ha^{-1} y^{-1}. However, in the short-term both thinning approaches produced a weak effect on total GWP.
The increase of CO_2 emissions during thinning operations and in the short-term after thinning operations was expected. We observed a stabilization of fluxes 6 months after thinning around values of Control plots for CO_2 and N_2O. The contribution of CH_4-CO_2 equivalent to total GWP showed a clear and significant CH_4 sink behaviour under selective treatment (36 Kg ha^{-1} y^{-1} on average).

CO_2 emissions – Field measurement
CO_2 emissions were measured in Monte Morello site by a portable instrument considering soil with and without litter, for a total of 36 points. Two semi-permanent plastic collars were installed onto the soil surface in each sub-plot. In one of them all litter was removed, and it was covered with a plastic net to prevent further litter accumulation (no-litter, NL). The other was left with litter inside (L). Measurements of NL and L collars were made manually with infrared gas analyzers (IRGA) operating in closed-path mode. The environmental gas monitor (EGM-4, PP systems, UK) was equipped with the SRC-1 SR cuvette placed on top of soil collars.
The three components of soil respiration were analysed: soil respiration without litter - SR_{NL}, soil respiration with litter - SR_T and the difference between the two, which gives litter respiration - SR_L
Litter contribution to CO_2 emissions was highly variable (between 2 and 72 %), with the highest yearly contribution of about 32 % in Control plots. Both thinning treatments reduced significantly SR_L percentage by almost half throughout the year, except for summer when the reduction of CO_2 emissions was not significant. This reduction was possibly related to a mechanical consequence of the enrichment of low decomposed organic matter (L and F litter fractions) lowering gas diffusion.

GHG emissions from deadwood
A field demonstration trial with 18 mesocosms have been installed and GHG emissions are monitored once a month in plot 1 (Control) of Monte Morello site. This activity will determine the contribution of deadwood to GWP, thus calculating the reduction of GHG emissions in Selective thinning, where deadwood of classes 1 and 2 is removed. In the first 18 months of the deadwood-derived CO_2 was higher in the first decomposition classes (up to two-times than soil respiration). Deadwood was a net source of N_2O and CH_4, too.

Action D3 Governance of the project results in the carbon voluntary market

Foreseen start date:	01/01/2018	Actual start date:01/01/2016
Foreseen end date:	30/08/2019	Actual end date: 30/08/2019

The forest management practices (selective and traditional thinning) were analysed to investigate their contribution in terms of provisioning (timber and bioenergy production), cultural (recreational benefits) and regulating (climate change mitigation) ES. For each forest management option was performed: (1) a biophysical assessment of selected ES by using primary data and calculating indicators for wood production with special regard to biomass for energy use (living trees and deadwood volume harvested), recreational benefits (tourists' preferences for each forest management practice), climate change mitigation (carbon sequestration in above-ground and below-ground biomass), and (2) an economic valuation of wood production, recreational benefits and climate change mitigation ES using direct and indirect methods (environmental evaluation techniques).
The results show that the effects of the selective thinning on ES are higher that the effects of the traditional thinning. The economic value of the three ES provided by traditional and selective thinning are respectively: bioenergy production 154.2 € ha^{-1} yr^{-1} and 223.3 € ha^{-1} yr^{-1}; recreational benefits 193.2 € ha^{-1} yr^{-1} and 231.9 € ha^{-1} yr^{-1}; carbon sequestration 29.0 € ha^{-1} yr^{-1} and 36.2 € ha^{-1} yr^{-1}. The integrated (biophysical and economic) assessment of ES in addition to the trade-off analysis can provide multi-perspective insights for forest policy makers and can be included as a part of the local forest management plans.
The forest-wood chain at local level following the circular bioeconomy approach was performed in the Monte Morello site. The study was divided in two steps: 1) in the first step materials flow (timber and biomass for energy use) and carbon dioxide (CO_2) emissions of productive process were analyzed; 2) in the second step a set of indicators – specific for the forest sector – to quantify the 4R (Reduce, Reuse, Recycle, Recover) of circular bioeconomy was identified and tested (Table 1). In this study the following aspects were considered: improvement of production process efficiency in term of economic value (economic sustainability) and of reduction of CO_2 emission (environmental sustainability); reuse and lifetime of wood products; optimization of potential wood assortments; and energy recover from the wood products. The results showed that forest-wood chain by thinning in Monte Morello forest has not optimized the commercial wood assortments because all wood volume was allocated for bioenergy production. This aspect has generated a negative economic impact and reduced the life-span of wood products. Conversely, the results showed a positive balance regard to the CO_2 emissions and for the energy enhancement of deadwood stock of the Monte Morello forest.

Table 1. 4R framework of the circular bioeconomy and indicators defined for the forest sector (FoResMit project).

4R	Definition	Indicator defined for the forest sector
Reduce	Improving of the process efficiency reducing the utilization of natural resource	I_1 - ratio (on annual basis) between the economic value of the wood harvested and the wood volume harvested [€ m^{-3}] I_2 - CO_2 emissions of the steps of forest-wood chain (from the felling to the transport) for unit volume [tCO_2 m^{-3}]
Reuse	Life span of products/Products re-utilization before its disposal of .	I_3 - product life span before to be send to landfill or to be used for energy generation [years]
Recycle	Level of recyclability of the	I_4 - ratio between the potential economic value of

	products for other purpose/objects (paper, animal bedding, chipboard panels)	the wood assortment and the real value earned. [€ $€^{-1}$]
Recover	Energy production from the "end-of-life products"	I_5 - ratio between CO_2 emissions saved by the timber sold for energy production (respect to the diesel oil) and the total cubic meter collected [$kgCO_2$ m^{-3}] I_6 - ratio between deadwood used for energy purpose and deadwood available in forest [m^3 m^{-3}]

Action E.1 Project website

Foreseen start date: 01/09/2015 Actual start date: 01/09/2015
Foreseen end date: 31/12/2015 Actual end date: 31/08/2019

During this project period CREA periodically updated the web site www.lifeFoResMit.com and the project Facebook page. In September 2018 the website visitors are 505,408 and the Facebook friends are 222.

Action E.4 Diffusion material preparation

Foreseen start date: 01/09/2015 Actual start date: 01/09/2015
Foreseen end date: 31/08/2019 Actual end date:31/08/2019

During this period, all partners prepared various dissemination materials to be used in fairs, conferences, newsletters, etc, in particular:

- 3,000 leaflets/brochures/factsheets in English and Italian
- 200 pens, 200 pencils as FoResMit gadget.

Action E.5 Press and media release

Foreseen start date: 01/09/2015 Actual start date: 01/09/2015
Foreseen end date: 31/08/2019 Actual end date:31/08/2019

During this period, CREA produced the following technical 17 articles:

- University thesis: Rillo Migliorini Giovannini Matteo. Filiera bosco-legno-energia: valorizzazione dei prodotti legnosi derivati da due tipologie di diradamento nella pineta di Monte Morello (FI). Università degli Studi di Firenze.
- University thesis: Magazzini Matteo. Analisi dell'attività e della struttura delle comunità microbiche della necromassa di Pino nero. Università degli Studi di Firenze.
- University thesis: Silvia Guerrini. Innovazione e sostenibilità: Progetto FoResMit. Indagine percettiva dei boschi di Monte Morello. Università la Sapienza di Roma.
- University thesis: Roberto Vecchio. Ciclo del carbonio ed emissioni di gas serra dal suolo di una pineta degradata sottoposta a differenti tipi di diradamento. Università degli Studi di Firenze.
- University thesis: Walter Vieri. Studio dendrocronologico e analisi delle relazioni clima-accrescimento nella foresta periurbana di Monte Morello (FI). Università degli Studi di Firenze.
- Paletto, A., De Meo, I., Grilli, G., & Nikodinoska, N. (2017). Effects of different thinning systems on the economic value of ecosystem services: A case-study in a black pine peri-urban forest in Central Italy Annals of Forest Research, 60, 313-326. DOI: 10.15287/afr.2017.799
- Torresan, C., Chiavetta, U., Hackenberg, J. (2018). Applying quantitative structure models to plot-based terrestrial laser data to assess dendrometric parameters in dense

mixed forests. Forest Systems, Volume 27, Issue 1, e004. https://doi.org/10.5424/fs/2018271-12658.

- 1 abstract in conference book of EGU, SISEF, Foresta and Quovaditis events
- Paletto A, Guerrini S, De Meo I (2017). Exploring visitors' perceptions of silvicultural treatments to increase the destination attractiveness of peri-urban forests: A case study in Tuscany Region (Italy). Urban Forestry & Urban Greening 27: 314-323. http://dx.doi.org/10.1016/j.ufug.2017.06.020.
- Pastorelli, R., Agnelli, A.E., Meo, I.D., (...), Paletto, A., Lagomarsino, A., 2017. Analysis of microbial diversity and greenhouse gas production of decaying pine logs. Forests, 8 (7), 224.
- De Meo, I., Agnelli, A.E., Graziani, A., Kitikidou K., Lagomarsino A., Milios E., Radoglou, K., Paletto, A., 2017. Deadwood volume assessment in Calabrian pine (*Pinus brutia* Ten.) peri-urban forests: Comparison between two sampling methods. Journal of Sustainable Forestry, 36 (7), 666-686.
- 1 article in Annuals of Silvicultural research: Single-entry volume table for Pinus brutia in a planted peri-urban forest
- 1 abstract in Geophysical Research Abstracts: Annual GHG emissions from forest soil of peri-urban conifer forests under different canopy densities in Greece
- 1 article in Forest@: Percezione sociale delle gestione forestale: il caso della foresta periurbana di Monte Morello in provincia di Firenze, 2018, vol. 15, pp. 29-39. doi: 10.3832/efor2769-015
- Isabella De Meo, Alessandra Lagomarsino, Alessandro Elio Agnelli, Alessandro Paletto. Direct and indirect assessment of carbon stock in deadwood: comparison in Calabrian pine (Pinus brutia Ten. subsp. brutia) forests in Italy. Forest Science, in press.
- Gianluigi Mazza, Alessandro E. Agnelli, Paolo Cantiani, Ugo Chiavetta, Foteini Doukalianou, Kyriaki Kitikidou, Elias Milios, Michail Orfanoudakis, Kalliopi Radoglou, Alessandra Lagomarsino. Short-term effects of forest thinning on soil CO_2, N_2O and CH_4 fluxes in Mediterranean peri-urban ecosystems. Science of the total environment. In press.
- Foteini Doukalianou, Alessandra Lagomarsino, Kalliopi Radoglou, Alessandro Elio Agnelli, Kyriaki Kitikidou, Elias Milios, Michail Orfanoudakis. Annual GHG emissions from forest soil of a peri-urban conifer forest in Greece under different thinning intensities and their climate change mitigation potential. Forest Science, submitted.
- Paletto A., De Meo I., Cantiani P., Chiavetta U., Fagarazzi C., Mazza G., Pieratti E., Rillo Migliorini Giovannini M., Lagomarsino A. Analisi della filiera foresta-legno in un prospettiva di (bio)economia circolare: il caso studio delle foresta di monte morello. Italia Forestale e Montana, in press.
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Action E.6 Networking

Foreseen start date: 01/09/2015 Actual start date: 01/09/2015
Foreseen end date: 31/08/2019 Actual end date:31/08/2019

During this period, all the beneficiaries activated networking activities, participating at common workshops and meetings, stimulating an international exchange of ideas with the following projects:

- SelPiBioLife (LIFE13 BIO/IT/282)
- HESOFF LIFE (LIFE11 ENV/PL/459)
- LIFE CarbOnFarm (LIFE12 ENV/IT/719)

- LIFE Future For Coppices (LIFE14 ENV/IT/514)
- LIFE Clima Tree (LIFE14 ENV/GR/635)
- LIFE VITISOM (LIFE15 ENV/IT/392)
- LIFE AForClimate (Life15CCA/IT/000089)
- Life AgroClimaWater (Life14CCA/GR/000389).
- Life ADAPT2CLIMA (LIFE14CCA/GR/000928).

FoResMit project has been presented at AForClimate opening meeting, held on 31 March 2017 at Arezzo by Dr. Isabella De Meo.

Regarding joint dissemination activities:

- Participation at the LIFE conference Capacity Building for Croatia's National Contact point for the LIFE Programme LIFE14 CAP/HR/000014. Croatian Chamber of Trades and Crafts Ilica 49, Zagreb 2nd of February 2018.
- A common session with SelPiBioLife project will be held at the 4th International Congress on Planted Forests in Beijing, China, 23-27 October, 2018: Management of degraded coniferous planted forests to increase the provision of ecosystem services.-
- Joint participation with SelPiBioLife at the seminar "La gestione della foresta mediterranea secondo i principi della selvicoltura naturalistica e della partecipazione". Oral presentation for FoResmit: De Meo I., Lagomarsino A., Paletto A. (2017). L'erogazione dei servizi ecosistemici in boschi periurbani. L'esperienza del progetto Life Foresmit. Mottola (TA), 25-28 maggio 2017

The networking was useful to implement several field activities comparable in different project's areas, producing the following outputs:

- De Meo I., Cantiani P., Fagarazzi C., Lorenzini L., Lagomarsino A., Paletto A. Forest visitors' preferences for alternative management scenarios: the example of the restoration of degraded forests in Italy (article in press).
- Paesaggio forestale e strategie di gestione forestale sostenibile: l'opinione dei visitatori. PALETTO A., CANTIANI P., DE MEO I., FAGARAZZI C., LORENZINI L. Presentazione orale al Congresso nazionale di Selvicoltura. Novembre 2018.
- E. Bianchetto, P. Cantiani, U Chiavetta, I De Meo, A Lagomarsino, A Paletto, S Mocali, S Landi, E Salerni.(2017) The role of forest management practices to increase the provision of forest ecosystem services: the experiences of two LIFE projects in Central Italy. SUSTAINABLE RESTORATION OF MEDITERRANEAN FORESTS. International Congress, Palermo 19-21 April 2017.
- P Cantiani, I De Meo, A Lagomarsino, M Marchi, Al Paletto (2017). Analysis of the influence of the silvicultural treatments on ecosystem services in black pine (Pinus nigra J.F.Arnold) stands in Central Italy. SUSTAINABLE RESTORATION OF MEDITERRANEAN FORESTS. International Congress, Palermo 19-21 April 2017.
- Graziani A., I De Meo, A Paletto, A Lagomarsino P Agnelli A.E., Cantiani P., Pastorelli R. (2016). Forest management practices to increase multiple ecosystem services in Italian coniferous forests: SelPiBioLife and LIFEFoResMit Projects. Poster presented at Workshop on "Mediterranean forest management and Natura 2000". Parc naturel régional du Luberon (France), 9th – 11thMay 2016.
- Giuntini F., De Meo I., Graziani A., Cantiani P., Paletto A. (2017). Stima del volume di legno morto in rimboschimenti di pino nero (Pinus nigra J.F.Arnold) in Toscana: confronto tra casi studio Dendronatura 2 (1): 19-29.

Action E.8 Demonstration workshop, seminars, conferences and other events

Foreseen start date: 01/09/2015 Actual start date: 01/09/2015
Foreseen end date: 31/08/2019 Actual end date:31/08/2019

Workshop: Quale futuro per il pino nero? 06 aprile 2018, Firenze. Organized in collaboration with SelPiBioLife project.

Action E.9 Dissemination to Institutions and policy makers

Foreseen start date: 01/09/2015 Actual start date: 01/09/2015
Foreseen end date: 31/08/2019 Actual end date:31/08/2019

After disseminating the project result we were contacted by the UNCEM (Unione Nazionale Comuni Comunità Enti Montani – National Union of Mountain Municipalities, Communities and other entities) and from Marche Region to use FoResMit results to estimate the carbon sequestration potential from thinning in Regione Marche forests. In fact, FoResMit results allowed to quantify the forest area to be thinned necessary to compensate 9,000 t of CO_2 emitted during the realization of the third lane of the Regione Marche freeway.
During this activity we participated to 2 technical meeting in Ancona aiming at the agreement on the procedure to apply, at exchanging data e showing the results of replication activity. Additionally, Regione Marche and UNCEM invited FoResMit project to show results of these activities during a technical workshop in Ancona. In the Annex Dissemination Report related to Action E.9 we include the letter of invitation and the Ancona workshop presentation.
All these activities represent also a networking activity since the replication was jointly realized with the SelPiBioLife project in order to amplify the results of both projects.

Action E.10 International fairs and other events

Foreseen start date: 01/09/2015 Actual start date: 01/09/2015
Foreseen end date: 31/08/2019 Actual end date:31/08/2019

The FoResMit beneficiaries have disseminated the project activities objectives and preliminary results participating at the following fairs:

- 42°Congresso SISS, Società italiana di Scienze del Suolo, 5-7 December 2017.
- Presentation of the results in the international conference Quo vanditis, agriculture forestry and society under Global Change, 2nd - 4th October 2017, Velké Karlovice (Czech Republic),
- 27th International Fair for Agricultural Machinery, Equipment & Supplies 'Agrotica' that took place on 1-4/02/2018 in the International Exhibition & Congress Center of Thessaloniki in Greece.
- From Octrober 2017 until April 2018 DAMT has organized and performed several "one day" environmental actions (about 11) in collaboration with the elementary schools in the area of Xanthi Region. At that events DAMT work group informed the students and teachers about the services and the benefits of the forests and especially about the Life ForesMit program and its activities and objectives. Also at the end of day the students planted fir trees (Abies borisii-regis) with their names in the forest.

In the Annex Dissemination Report related to Action E.10 we show the evidences of the participation at the indicated events.

Action E.11 Digital supports for international diffusion

Foreseen start date: 01/09/2015 Actual start date: 01/09/2015
Foreseen end date: 31/08/2019 Actual end date:31/08/2019

During this period, the beneficiaries used the preliminary project video prepared by CREA in the previous period in some project events.

5.2 Envisaged progress until next report

Number/name of action	2015		2016				2017				2018				2019		
	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III
Action A.1 Climatic characterization and vegetation survey																	
	/	/	/	/													
Action A.2 Pedological survey																	
	/	/	/	/													
Action C.1 Realization of thinning intervention in Italy																	
		/	/	/	/	/											
Action C.2 Realization of thinning intervention in Greece																	
			/	/	/	/											
Action D.1. Monitoring and quantification of C pools in vegetation and soil																	
		/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	
Action D.2. Monitoring and quantification of GHG emissions and Global Warming Potential																	
			/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	
Action D.3. Governance of the project results in the carbon voluntary market																	
											/	/	/				
														X	X	X	
Action D.4. Monitoring of technical-socio-economic assessment of the LIFE FoResMit project																	
															X	X	X
Action E.1. Project website																	
	/	/															
Action E.2. LIFE+ information boards																	
	/	/															
Action E.3. Layman's report																	
																X	X
Action E.4. Diffusion material preparation																	
	/	/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	X
Action E.5. Press and media releases																	
	/	/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	X
Action E.6. Networking																	
	/	/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	X
Action E.7. LIFE FoResMit manual																	
															X	X	X

Action E.8. Demonstration workshop, seminars, conferences and other events	/	/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	X
Action E.9. Dissemination to Institutions and policy makers	/	/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	X
Action E.10. International fairs and other events	/	/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	X
Action E.11. Digital supports for international diffusion	/	/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	X
Action E.12. After-LIFE Communication Plan																	
																	X
Action F.1. Project management	/	/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	X
Action F.2. Monitoring	/	/	/	/	/	/	/	/	/	/	/	/	/				
														X	X	X	X
Action F.3. Audit																	
																	X

Key ■ Task foreseen in the proposal / Actual task duration X Next actions to Progress Report 30/11/2019

In particular, the following activities of the following Actions will be carried out during the next months until the project Final Report foreseen for the 30st of November 2019.

Action D.1. Monitoring and quantification of C pools in vegetation and soil
Within December 2018 the final sampling of biomass, litter, forest floor and soil will be performed. In the following three months, soil and forest floor samples will be analysed for their C and N content, stocks will be calculated, and final impact of thinning treatments will be assessed. Measurements of aboveground and belowground increments will be performed and net primary productivity (NPP) will be calculated..

Action D.2. Monitoring and quantification of GHG emissions and Global Warming Potential
Simultaneously to the last sampling of soil, gas collection for GHG determination will lasted. In the following three months all gas chromatographic measurements will be completed, and data analysed to calculate cumulative fluxes of CO_2, CH_4 and N_2O and GWP

Action D.3. Governance of the project results in the carbon voluntary market
Results from Actions D1 and D2 will be used in Action D3 to calculate the C credits generated by the thinning treatments considering the overall impact on: C increase in biomass, C increase in soil and forest floor, C losses as CO_2 equivalents (sum of CO_2, CH_4 and N_2O).

Action E.3 Layman's report

CREA, with the support of all the project beneficiaries, will prepare the FoResMit Layman's report to be attached to the Final Report as Deliverable and to be distributed at the project final workshops and events.

Action E.4 Diffusion material preparation
All the FoResMit beneficiaries will produce more FoResMit dissemination material in relation with the organisation and participation at project events and activities.

Action E.5 Press and media releases
All the FoResMit beneficiaries will produce more articles in relation with the progress of the project activities.

Action E.6 Networking
All the FoResMit beneficiaries will be responsible for the organisation of networking activities in relation with the progress of the project activities.

Action E.7 LIFE FoResMit manual
CREA and DUTH, with the support of all the project beneficiaries, will prepare the FoResMit manual to be attached to the Final Report as Deliverable and to be distributed at the project final workshops and events.

Action E.8 Demonstration workshop, seminars, conferences and other events
The following workshops have been already planned:
- PROVIFI a project policy maker and Institutions workshop in Italy on June-July 2019
- CREA a final scientific workshop in CREA premises at the project end in June-July 2019
- DAMT and DUTH Greek workshop at the project end in June 2019

Action E.9 Dissemination to Institutions and policy makers
All the FoResMit beneficiaries will be responsible for organizing contact and meeting with Institutions and policy makers in order to disseminate and sensitize them on new normative issues based on FoResMit activities and results.

Action E.10 International fairs and other events
All the FoResMit beneficiaries will be responsible for the participation at events and fairs related to the progress of the project activities. CREA has already planned to participate at "*4th International Congress on Planted Forests*" which will be held in Pechino (China) on 23-27 October 2018.

Action E.11 Digital supports for international diffusion
CREA will define the final structure and the text of the project video and will produce the final project video to be distributed during the final project workshops in Italy and Greece.

Action E.12 After-LIFE Communication Plan
CREA, with the support of all the project beneficiaries, will prepare the FoResMit After-LIFE Communication Plan to be attached to the Final Report as Deliverable.

Action F.1 Project management
CREA, with the support of all the beneficiaries, will continue the daily work of project management in order to maintain a permanent flow of actions with the aim of achieving the objectives set. In particular:

- Organisation of Coordination meetings;
- Organisation of different meetings between some partners in order to plan and monitor the project technical activities;
- Management of the financial aspects of the project;
- Monthly reports to the LIFE external team monitor on the evolution of the project.

Action F.2 Monitoring

CREA, with the support of all the beneficiaries, will continue to monitor the execution of project activities, to verify the status of actions compared to the expected timing of the project. In particular:

- CREA, as project coordinator, will have continuous contacts with all project beneficiaries for monitoring project activities;
- CREA, as project coordinator, will continue to prepare and send a monthly indication of operative activities to be done to all the beneficiaries;
- CREA, as project coordinator, will continue to prepare and send a monthly summary of the project activities carried out to monitoring representatives and to all the beneficiaries.

5.3 Impact

Climate change mitigation

Up to now, the project supplied evidences of the following impacts of thinning:

- A larger amount of forest floor biomass, up to 30 %, on average of the two sites, corresponding to an increase of approx. 2 t C ha^{-1}.
- A larger C stock in soil up to a depth of 30 cm was recorded, corresponding to an increase of approx. 7 t C ha^{-1}.
- At the Monte Morello site, CO_2 emissions peaks were observed only during thinning interventions. This effect was not evident at Greek site, where thinning operations were shorter, suggesting an effect of timing of logging operations.
- The short-term impact of thinning on GWP was negligible both 3 and 6 months after, so measurements over longer time periods are required to have more consistent results on this trend, taking into account also the annual seasonal variability. In Monte Morello site, no significant changes on soil CO_2 effluxes in the short term were observed. In Xanthi site a 12.9% reduction in CO_2 emissions in the selective thinning treatment and a 2.8% reduction in the traditional thinning treatment, with respect to Control was observed after one year.
- The contribution of CH_4 to total GWP showed a persistent and significant CH_4 sink behaviour under selective treatment, with a CH_4 uptake higher of about 40 % after one year, compared to Control plots.

Social benefits

The results of the survey conducted at Monte Morello stand showed that visitors prefer mixed forests with a horizontal and vertical differentiated stand structure. The respondents prefer three benefits (ecosystem services) provided by the Monte Morello forest: recreational opportunities, carbon dioxide sequestration and biodiversity conservation. In addition, the results show that respondents prefer from the aesthetic point of view the peri-urban forest of Monte Morello after the selective thinning. Conversely, the scenario *status quo* (Control) is the least appreciated due to the high amount of deadwood. The results of the project provided quali-quantitative information useful for the decision makers (forest planners and managers) in order to define forest management strategies to enhance a peri-urban forest from the recreational point of view and to increase the site attractiveness.

Indirect impacts

Due to the limited knowledge of the response of thinning implementation on forest soil–atmospheric GHG (CO_2, CH_4 and N_2O) exchange system in Mediterranean Region, FoResMit is contributing also to the enrichment of GHG fluxes database from Mediterranean forest ecosystem.

As described in Action E9, FoResMit results are used to estimate the carbon sequestration potential from thinning in Regione Marche forests, generating C credits that can compensate CO_2 emitted during the realization of the third lane of the Regione Marche freeway.

Key Project-level Indicators (KPIs)

Project specific indicators foreseen in the proposal are confirmed. The project's progress towards achieving the KPI targets in the period covered by the present report are the following:

- A reduction of CO_2 emissions from soil 1 year after thinning of 0.26 Mg ha^{-1} y^{-1} in traditional and 1.03 Mg ha^{-1} y^{-1} in selective thinning, on average. The decrease is lower than the value of 3.3 Mg ha^{-1} y^{-1} expected at the end of the project, due to a short-term increase during thinning operations.
- As expected, N_2O emissions from soil 1 year after thinning were not significantly different between Control and thinned plots
- CH_4 uptake increased 1 year after thinning, on average 0.12 kg ha^{-1} y^{-1} in traditional and 0.57 kg ha^{-1} y^{-1} in selective thinning, on average, which is in line with expected values.
- C accumulation in soil was 4.8 Mg ha^{-1} y^{-1} with selective thinning, which was much higher than expected. The large variation was an effect of disturbance by thinning operations, thus we expect more reliable results with the next sampling planned by the end of the year.
- Production of wood biomass ware higher than expected (115 m^3 ha^{-1}): 144 m^3 ha^{-1} with the traditional thinning and 220 m^3 ha^{-1} with the selective thinning. Energy recover from wood produced 0,5 GWh of electric energy and 2,8 GWh of thermic energy (more than expected). Overall, this production saved 208 and 278 g CO_2 KW^{-1} for methane and fuel substitution, respectively.

Policy implications:

From the political point of view, the results of LIFE FoResMit Project are useful to provide guidelines to address at local level the new "EU Forest Strategy (2013): for forests and the forest-based sector" with special regard to the following two strategic orientations:

1- Explore and promote the use of wood as a sustainable, renewable, climate and environment-friendly raw material more fully without damaging the forests and their ecosystem services; assess the climate benefits of material and energy substitution by forest biomass and harvested wood products and the effect of incentives for using forest biomass in creating market distortions;

2- How they intend to increase their forests' mitigation potential through increased removals and reduced emissions, including by cascading use of wood, taking into account that the new LIFE+ subprogram for Climate action and Rural Development funding can promote and support new or existing forest management practices that limit emissions or increase net biological productivity (i.e. CO_2 removal). They should do this by mid-2014 and in the context of their information on LULUCF actions.

Moreover, the project is contributing to the following policies:

- 6^{th} Community Environment Action Programme concerning Climate change mitigation (decision no 529/2013/eu and regulation (EU) No 1293/2013 of the

European Parliament): the project at this stage is contributing with an account reflecting emissions and removals in degraded pine forests. Actually, the project is providing data on the short- and medium-term effects of thinning that will be used for guidelines for GHG emissions removals through sustainable forest management.

- EU 2020 strategy for biodiversity: the project is implementing a strategy for deadwood management with positive implication for biodiversity, considering the trade-off with other ecosystem services, such as the identification of a threshold for deadwood biomass inside the forest.
- Regional/local policies: the collaboration with regional authorities and municipalities is improving awareness of the climate problem targeted and providing solutions through sustainable forest management.
- Rural development program 2014-2020 of Tuscany enhance the sustainable management of forest resources aimed at balancing different ecosystem services.

6. Financial part

6.1 Costs incurred (summary by cost category and relevant comments)

Budget breakdown categories	Budgeted costs in €*	Costs incurred from the start date to 30/09/2018 in €	% of Budget**
1. Personnel	930,960	798,904.25	85.81
2. Travel and subsistence	77,990	36,714.14	47.07
3. External assistance	229,000	85,124.83	37.17
4. Durable goods			
Infrastructure			
Equipment	30,250	34,227.74	113.14
Prototype			
5. Land purchase / long-term lease			
6. Consumables	74,600	8,162.95	10.94
7. Other Costs	41,900	20,137.74	48.06
8. Overheads	95,868	68,829.02	71.79
TOTAL	1,480,568	1,052,100.67	71.06

The budget is being spent within the foreseen limits and there is no discrepancy with regard to initial estimations.

The following main budget movement for some beneficiaries are defined:

- CREA
  - Personnel: CREA has a deviation in personnel costs: due to a change in National Italian Law related to work contracts, a contract foreseen in the proposal (specific project collaboration contract CoCoCo, now prohibited) was changed in the new allowed contract (Timing determined contract) needed for the project personnel involved with specific expertise on analytical laboratories techniques for physicochemical characterization of soil, use and maintenance of laboratory instruments, gaschromatograph for GHG emissions determination with static chambers and and elemental analyzer for C and N quantification. This contract type

change caused an higher daily rate cost, related to higher predefined national contractual costs, for this specific project personnel.

- DAMT
  - Other costs: DAMT is organising to substain the unforeseen costs of catering for the monitoring meeting in Greece, needed for a better organisation of the event
- DUTH
  - Personnel: the personnel daily rate of Kalliopi Radoglou is slightly higher than foreseen in the project due to a wrong initial estimation of salary slips and hourly working rates defined by the University for the category of full professors, due to the specific period of Greek economic crisis and National salary reorganisation. The activities of Kalliopi Radoglou is extremely important for the project objectives achievement due to her many years of experience and deep knowledge of project topics.
  - Consumable: DUTH is moving around € 6.000 from consumable (reduction) to travel (increasing) due to the possibility to use internal consumable instead the foreseen costs and to the need to have more travels for progress meetings in Italy.

The following table presents the allocation of the incurred project costs per Action from the start of the project 01/09/2015 until to 30/09/2018.

Action type	Budgeted person-days	Estimated % of person-days spent
Action A: Preparatory actions	1,195	102
Action C: Implementation actions	1,150	101
Action D: Monitoring and impact assessment	2,502	75
Action E: Communication and Dissemination of results	92	79
Action F: Project management (and progress)	88	78
TOTAL	5,027	86

7. Annexes

We have inserted as Annexes of this Progress Report the following documents:

- Annex with the answers to the EC recommendations
- The following Deliverables:
  - Deliverable Action E12: Update of the main targeted stakeholders to uptake the solutions proposed by the project
  - Deliverable Action F2: Monitoring Report at 36 month
- The following Dissemination Reports:
  - Dissemination Report related to Action E9: Invitation and presentation related to the Regione Marche workshop
  - Dissemination Report related to Action E10: Evidences of participations at international fairs and other events